DISCOVERIES
On the Humane Use of Human Ideas
INTERNATIONAL
Symposium

COMMUNICATION IN HUMAN ACTIVITY

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Edited by Bruce M. Adkins

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D I S C O V E R I E S

Third International Symposium

Paris, 23-27 October 1978

PREFACE

The Third International Symposium organised by the DISCOVERIES Project of the Honda Foundation took place from 23 to 27 October 1978 in Paris, under the high patronage of Monsieur Pierre Aigrain, French Secretary of State for Scientific Research. The detailed arrangements were in the hands of a Scientific Committee under the Chairmanship of Professor Jean-Claude Simon, of the Pierre and Marie Curie University in Paris. There were some 50 participants (see Appendix 1).

The Symposium was devoted to "Communication in Human Activity" and the programme (Appendix 2) comprised two main papers each morning for four days, followed in the afternoons by "round table" discussions of various aspects - notably some case studies - of subjects arising from the morning papers. Each day's work was reviewed and summarised in a special session the following morning, and on the last day (October 27) a final panel discussion

with participation from the floor produced further comments and conclusions following the week's work.

This somewhat novel procedure was highly effective for covering a great amount of ground in a short time. However, the parallel "round tables" in the afternoons brought some participants to near schizophrenia, so much so that the last two parallel sessions were in fact taken sequentially, enabling all participants to follow both but with inevitable penalties in the division of time. Participants were in no doubt that the Symposium itself was a practical exercise in Communication in Human Activity.

Just as the working programme was structured in a novel way, so is this book which records the proceedings. It is neither a verbatim record (although the texts of the eight main papers are reproduced in full) nor a simple summary, but rather an appreciative review by one who was there. Thus the editor has assumed (with the agreement and indeed at the request of the Honda Foundation) functions which go beyond those normally attributed to one in his position. His responsibility has thereby become that much greater, and he is well aware that not everyone may agree with his interpretations.

To all participants, therefore, if he has misconstrued their own thoughts and expression, he offers his deep and humble

apologies; but if he has simply introduced contentious opinions, he defends this as his duty. Whatever the case, the responsibility for what he has written is his alone, discharged in good faith and in the firm conviction that the "DISCOVERIES" approach to world problems, through these interdisciplinary and intercultural meetings, has a very real contribution to make towards the humane use of human ideas.

bma

november 1978

D I S C O V E R I E S

Third International Symposium

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TEXT OF INAUGURAL ADDRESS BY PROFESSOR PIERRE AIGRAIN

FRENCH SECRETARY OF STATE FOR SCIENTIFIC RESEARCH

Je suis heureux de pouvoir aujourd'hui accueillir à PARIS, au nom du Gouvernement Français, les congressistes du troisième Symposium international "DISCOVERIES".

D'emblée je tiens à saluer la Fondation Honda-Fujisawa qui, après les congrès de TOKYO et de ROME, permet une nouvelle fois de recevoir d'éminents experts venus d'horizons aussi divers que les mathématiques, les sciences de la nature et les sciences humaines. Et je forme le voeu que l'initiative généreuse du Docteur Soichiro HONDA puisse contribuer à l'éclosion d'un mouvement de renaissance tellement nécessaire en cette période de crise dans laquelle aucune nation n'est épargnée.

Le grand débat de civilisation engagé par les DISCOVERIES a deux fois déjà touché à des questions essentielles, des questions "nodales" de notre temps.

A TOKYO, en 1976, c'est le problème de la conciliation entre le développement de la culture scientifique universelle et la préservation des cultures spirituelles spécifiques qui a été soulevé. On a souligné l'importance pour le progrès mondial d'un mouvement d'unification qui ne soit pas un mouvement d'uniformisation, d'abatardissement et finalement de disparition de la singularité des êtres et des peuples.

L'année dernière, à ROME, le congrès de DISCOVERIES a traité un autre grand sujet : celui de la Science source de progrès, -progrès intellectuel et

progrès économique- mais aussi source possible d'aliénation, de démoralisation, de destruction. Comment dépasser cette contradiction? C'est le problème de conscience du savant mais aussi, dans notre société scientifique et technique, de plus en plus fréquemment, le problème de conscience du prince.

Le thème de votre rencontre de cette année -la communication dans l'action humaine- est aussi un des problèmes dominants de notre temps, à la fois parce que la communication est la base même de la société et parce que chaque grande mutation dans les moyens techniques de communications a donné un cours nouveau à l'aventure humaine.

Après l'écriture, aux origines de l'histoire, après l'imprimerie, la plus grande peut-être des "grandes découvertes" de la renaissance, les nouvelles techniques de transfert d'information et de communication qui sont en train de naître des progrès de l'électricité, de l'électronique et de l'informatique vont, au XXème siècle, à nouveau jouer un rôle décisif.

La vie des chercheurs -qui, grâce au téléphone, au télex, aux réseaux de téléinformatique, communiquent désormais en "temps réel" avec la communauté scientifique internationale- est changée. La vie des décideurs et des politiques est changée. La vie de chaque individu est changée. Qu'il s'agisse d'une découverte en physique théorique ou en cancérologie, qu'il s'agisse de l'élection d'un nouveau pape, du sort de la communauté chrétienne du Liban, ou encore du championnat du monde d'échecs, l'humanité entière, grâce aux nouveaux médias, est juge, témoin ou partie.

Cette mondialisation, ce début de vie communautaire pour tous les peuples de la Terre, est un fait

historique majeur de notre temps. C'est à juste titre que votre Symposium la soumet en priorité à votre réflexion.

S'il fallait, selon la proposition du Dr HONDA lors d'un précédent congrès de DISCOVERIES, opter pour une "religion scientifique", peut-être me rallierai-je à celle de la communication.

Pour nous autres, scientifiques des sciences de la matière, la communication est effectivement une manière de religion. Qu'il s'agisse de détecter les signaux des galaxies, des cristaux de silicium ou ceux de nos collègues, nous sommes avides d'information. Afin de pouvoir capter les moindres signaux, nous avons mis au point des appareils d'une extrême précision capables de sonder le fonds de l'univers ou les structures les plus fines des réseaux atomiques. Comme les signaux qui nous intéressent sont toujours plus ou moins noyés dans des bruits perturbateurs, de caractère aléatoire, nous avons mis au point les méthodes et dispositifs appropriés pour les distinguer.

Cet effort intense, dans le domaine de la saisie et du traitement de l'information, a déjà permis, grâce aux progrès de l'électronique, de la physique du solide, mais aussi de la biologie, d'opérer une transformation considérable des technologies de production : d'autres suivront, plus étonnants encore. Une "société de la communication" est ainsi en train d'apparaître.

Mais cette nouvelle société de la communication ne marquera cependant par rapport à notre société industrielle un véritable progrès que si le progrès de la communication est aussi, dans tous les domaines, et à tous les niveaux un progrès de la compréhension.

Attention à ne pas généraliser abusivement le langage et la pensée des théories scientifiques de l'information. Le progrès de la communication humaine ne se mesure ni au nombre de "données" ni au nombre de "messages" que nous devenons peu à peu capables de "transférer", et "d'adresser" dans des laps de temps de plus en plus courts. C'est le progrès dans la qualité des échanges entre les hommes, entre les peuples qui est le véritable signe de progrès de la société.

Comment mobiliser les extraordinaires possibilités techniques de la communication moderne au service de ce progrès? C'est à vous d'apporter la réponse, ou un début de réponse à cette difficile question.

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En ouvrant ce congrès, permettez-moi de formuler un dernier souhait : que s'établisse entre nous une véritable communication intellectuelle.

Vous donnez ici l'image d'un monde réuni, pour quelques heures. Du fait même, vous réalisez le désir le plus profond du Dr HONDA qui, nous le savons, considère les "DISCOVERIES" comme "une leçon pratique pour la paix mondiale".

Cette entreprise peut également avoir une autre conséquence : contribuer à réconcilier deux communautés séparées à l'excès par le fossé entre la physique et la philosophie. Certes, l'attaque du réel et des méthodes de recherche sont différentes, mais les résultats des uns concernent les autres, et réciproquement. Au niveau le plus élevé, les deux démarches s'inscrivent dans un même effort

civilisateur, comme l'avaient compris les fondateurs de culture encyclopédiques, dans l'Antiquité ou pendant la Renaissance.

Aujourd'hui la tâche universelle de communication est beaucoup plus lourde que jadis. Tous les peuples de la Terre sont impliqués, et, malgré les différences de développement, ils arrivent ensemble au même tournant, indiqué par la même horloge planétaire.

En tant que physicien et en tant que membre du Gouvernement français, j'ai le ferme espoir que mon pays, comme en d'autres occasions historiques, parlera haut et clair dans cette rencontre décisive de l'homme avec l'homme.

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INAUGURAL SESSION OF THE SYMPOSIUM

The Inaugural Session was chaired by Professor Eduardo Caianiello of Salerno University, who had played a leading role in the first DISCOVERIES Symposium in Tokyo, was Chairman of the Organising Committee of the Second in Rome and, as Vice-Chairman of the Paris Scientific Committee, was a symbolic bearer of the intellectual flame linking the series of meetings.

After warmly welcoming all those present - and especially Monsieur Pierre Aigrain both in his personal capacity and as representative of the interest and support of the French Government - Professor Caianiello introduced the President of the Honda Foundation, Dr.Takeso Shimoda, thanking both him and Dr. Soichiro Honda for the initiative which had made the meeting possible. All present owed a great debt to the Foundation, said Professor Caianiello, and all were determined to make the fullest possible contribution both to the present meeting and to the long-term objectives of the DISCOVERIES Project.

Dr. Shimoda, referring to the growing conflict between the benefits and disadvantages of developing technology, emphasised the increasing problems of humanity

in controlling its inventions, and cited the recent accidental disintegration of a Russian nuclear-powered satellite over Canada, leading to fears of radioactive pollution in that country. He called for a new mode of thinking, treating the entire world as a single "village" in which no activity in one area could be without its influences in others. These influences could only be understood through a full exchange of views and ideas from all the intellectual disciplines involved, and Dr. Shimoda paid tribute to Dr. Honda for his vision in this direction, as well as to all those who were contributing to the practical realisation of that vision.

Monsieur Pierre Aigrain, on behalf of the French Government and of the French Minister for Universities, then welcomed all participants and also paid tribute to Dr. Honda's initiative. DISCOVERIES, he said, was a major step in the Great Debate on Civilisation. We were seeking world unification without the obligation of world uniformisation, and the contributions to be made by different cultures, especially the contrasting ones of East and West, were essential for the achievement of this objective. These contributions could not be realised without communication - hence the title of the present Symposium "Communication in

Human Activity". Today, instant "real time" electronic communication throughout the world gave the human race a tool which so far surpassed older inventions based on the written or printed word that it could lead to unprecedented advances of civilisation and of humanity. But also, if misused or abused, it could very easily lead to our destruction. The choice, and the responsibility, were ours.

Monsieur Aigrain was followed by His Excellency Ambassador Kitahara, Japanese Ambassador to France, who read the following message from his country's Prime Minister, Mr. Takeo Fukuda :

JAPANESE PRIME MINISTER'S MESSAGE

At the opening of the International DISCOVERIES Symposium in 1978 in Paris, I wish to send my sincere wishes for its success.

The work of DISCOVERIES, bringing together the elite of the whole world in an effort to highlight the perspectives of the coming 21st Century, are of very great interest to me. This third Symposium, with the theme "Communication in Human Activity", will I am sure play an important role in the advent of a new society based on harmony between culture and technology.

I wish to congratulate all the participants who, conscious of the great changes of our time, are attacking with determination the difficult tasks of resolving the problems of modern civilisation, and thus contributing towards a new era. It is therefore my sincere hope that the discussions will be fruitful.

Takeo Fukuda
Prime Minister of Japan
23rd October 1978

Professor Jean-Claude Simon, of the Pierre and Marie Curie University in Paris, and Chairman of the Scientific Committee of the Symposium, also paid tribute to the Honda Foundation, to Dr. Honda its founder, and to Dr. Shimoda its President, for the remarkable world-wide initiative of the DISCOVERIES Project. During the preceding Symposium in Rome, Professor Simon had been particularly impressed by the atmosphere of complete liberty for the speakers and other contributors to say what they thought and believed, without the constraints of "official policies" whether of their governments or their learned institutions. He hoped - and was sure - that

the same liberty would be a feature of the Paris meeting.

Professor Simon then introduced some of the subjects to be discussed by noting that, today, nearly 50% of current working occupations were concerned with the production or handling (processing) of information. Here indeed was perhaps the greatest "growth industry" of our time, which was why it was indispensable to examine its influence on our present and future well-being.

To conclude this Inaugural Session, Professor Caianiello declared his personal belief in what the DISCOVERIES Project was doing, and in the high if difficult objectives it has set itself. During recent visits to many parts of the world, both east and west, he had found everywhere a strong feeling of impending crisis, an urgent desire to meet this with appropriate action, but a widespread lack of certainty as to what such action should be. This was surely where DISCOVERIES should try to help, and the fact that the Project's Symposia were bringing together the most advanced realms of science and technology, as well as philosophies of the past and present throughout the world, emphasised what Professor Caianiello believed was an inescapable truth. It was not the case, he said, as some maintained, that the evils brought about by the technologies of civilisation could be overcome without further resort to those technologies. All technologies, in fact, were neutral - only the use made of them depended on the will of man.

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CHAPTER I

FIRST WORKING SESSION : "WHAT IS COMMUNICATION?"

The first Working Session of the Symposium was sub-titled "What is Communication?", but in fact comprised a great deal more than the definition which this suggests. In the morning, two papers by Professor Alain Touraine and Professor Louis Dumont, of the French Ecole des Hautes Etudes en Sciences Sociales, provided more than an introduction to the links between communication and "operational life", Professor Touraine sketching the causes and development of today's "crise de conscience" in the advanced countries of the west, while Professor Dumont examined (as examples of "communication between cultures") the process of "acculturation" of India to western values, and the interpretation or "translation" into German, by the philosophers Johann Gottfried Herder and Johann Gottlieb Fichte, of the French Revolution.+

Professor Touraine's paper was entitled "From Exchange to Communication". It began by examining the conditions under which societies tended towards self-modification, showing the tendency to be strongest where there was a high degree of historical character (historicity) and weakest in societies where communications with environments had the nature of "balanced exchange". Today's crisis

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+ For the full texts of the these papers, see pages 29 and 78 respectively.

(or series of crises) could not be explained in the same terms as those of the past - far more was involved than purely economic problems, and in fact the basic cause was the ending of three centuries of European cultural domination of the world. The resulting crisis was not only hegemonic but ideological - a crisis of civilisation - and Professor Touraine saw three possible courses for the future : decadence (as evidenced by preference for immediate consumerism rather than preparation for the future); various counter-cultural movements implying changed values (preoccupation with more "primitive" cultures mainly concerned with survival); or a growing movement towards a qualitative rather than a quantitative society - an important change for which a part of production would need to be retained within a society to enable it to modify itself appropriately (rather like preserving seeds to ensure future crops).

Professor Touraine certainly favoured the third of these courses, involving important changes not only in industrial production and distribution but also in industrial organisation... involving far more attention than hitherto to "management", and to the advanced information and communications systems which alone could bring about a revolution in this field. In short, the preferable post-industrial society would be a communications society.

Meanwhile, there were alarming trends in the increasing need

for systems to regulate and control individual activities (a not entirely trivial example was the proliferation of traffic control signs on our road networks) and this was giving rise to a special form of popular anguish and resistance to the regulatory system. There was a growing gulf separating "the leaders" and "the led"; a growing concentration of power in mass-communication (via the mass-media); and growing apprehension that information and communication - the keys to future well-being - could if wrongly used become the keys to disaster. Furthermore the trend was virtually identical whether in the centrally-planned (socialist) societies of "the east" or the market-economy (capitalist) societies of "the west" : the fact that the former were"closed"in comparison with the latter depended on political not social reasons.

The result was that a new ideological (and often "ecological") elite was today becoming ever more prominent, tending to displace the bureaucratic administrative and business elite of former years. "Programmed society" could raise many fears, and would be more and more resisted unless the "programmers" were (in the terms of DISCOVERIES) devoted to the humane use of human ideas. In the field of communication, this meant its use to meet social needs rather than as an instrument to confirm and perpetuate the dominance of the already dominant.

In contrast to this overall analysis of communication in relation to societal direction, the paper by Professor Dumont was a full and detailed account of "case histories", showing the extent to which ideas absorbed by one culture from another are re-modelled and re-interpreted within their new social contexts.

Examining the "Germanisation" of the French Revolution, Professor Dumont deduced certain traits in the former nation's culture which could approach a reasonable apologia for some recurrent trends in its relations with others. It became almost possible to understand - if not to accept - ideas of superiority and totalitarianism as natural and justifiable[+]. It was also possible to discern some of the many faces of national superiority, and so to infer that communication between cultures leading to mutual "acculturation" had far more to offer to the world of today than it did in the times of Herder and Fichte.

Following these two impressive papers by two very impressive sociologists[++], the second (afternoon) part of the Session was devoted to two Round Table discussions, on "Misunderstanding - the impossible transfer" and "Interactions with Computers - the evolution of expression". These were chaired respectively by M. Yves Jaigu, Director of the French radio programme "France Culture", and by M. André Danzin, Director (inter alia) of the French Institut de

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[+] Though Professor Dumont did not suggest it, there seemed to be implications here for the developing relations between some developing countries.

[++] Professor Dumont is in fact a social anthropologist.

Recherche d'Informatique et d'Automatique (IRIA).

M. Jaigu, introducing his discussion programme, remarked on the proliferation in the mass-media of esoteric "languages" relating to different specialist activities, and the overwhelming quantities of widely assorted classes of information which nowadays constantly bombard the listener (or indeed the newspaper reader and the television watcher). Public selectiveness was not renowned for its intellectual basis, and education had hardly kept pace with the technical progress in the field of media reproduction. M. Jaigu was by no means sure that reporters - and information purveyors generally - always appreciated their responsibility to make their subject matter accessible, meaningful and clear to the unavoidably heterogeneous public which they served. He was sure that the "more serious" radio programmes (such as "France Culture") were aware of this problem, and hoped they were overcoming it.

Professor Boris Rybak of the Paris Institut d'Etudes Linguistiques et Phonétique, and Director of "NATO-ASI sur la Technologie", spoke of the considerable dangers of assuming that majority opinions, because they were of the majority, were necessarily the most deserving of attention. In fact, the exponential advance of knowledge ("information explosion") had led to ever widening gaps between those who understood, those who

misunderstood, and those who were "simply deaf"; while attempts to remedy the situation - which must involve considerable effort by those willing to become better informed - tended to be either disregarded by the majority, or to be shunned as part of an indoctrination campaign to confirm power and authority on those already in their possession. This necessarily meant that people who were both responsible and knowledgeable were usually in the minority, although their opinions could well be more valid than those which overrode them. Proliferation of and in the mass-media did nothing to ease this situation, and Professor Rybak went so far as to assert that our survival could depend on our timely diversion from reliance on majority opinions. He also warned against the encouragement of "institutionalised aggressive rivalry... which has confused liberty and licence", calling on all society to avoid "becoming a mad, ant-like mass, leading to entropic obliteration of all human personality".

Professor M. Alliot, of the French Laboratoire d'Anthropologie Juridique (Paris), reminding his colleagues that all human beings have a basic need to communicate with each other, suggested that much of today's media use was an abuse of this need. The use of "non-communication" (the refused rather than the impossible transfer) to protect cultural individuality had many champions among today's liberal thinkers, who believed strongly in individual rights to

secrecy about many personal matters.

Greater efforts to improve inter-cultural communications were called for by Professor Isac Chiva (Laboratoire d'Anthropologie Sociale, Collège de France) who pointed out that particular importance of the implied rather than the obvious content of such communications, which meant that meanings could depend substantially on both cultures involved, and the relationships between them.

Lastly, Professor Ulf Himmelstrand, of Uppsala University, Sweden, called attention to the fact that all communication, when received, was interpreted by reference to any existing framework of connected information. This was why an uninformed public was unable to assess satisfactorily an item of information in a novel or unexplored field... or in a field where there had been previous misinformation. Many examples could be found in media handling of related news events over considerable time periods - such as of the Nigerian War from 1967 to 1970. These events were all too often (invariably?) given media treatment according to their "market-value" or saleability to the public, and not according to intrinsic value or importance.

In his final résumé[+] of this Round Table discussion, M. Jaigu identified the emergence of three major questions. The first, of fundamental importance in any integrated society, was whether the mass

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[+] The following morning.

of the people should be "protected from the dangers of over-information", on the grounds that they were incapable of correct comprehension (whatever that might be), or whether a policy of maximum mass-education and total information (a "transparent society") was to be preferred. The former course must inevitably lead to an elitist-run society, which although capable of great efficiency might well be questioned as a true fulfilment of man's destiny. On the other hand there were clear risks in seeking full transparency, firstly because its achievement could never be guaranteed, and secondly because of the immense pitfalls of the byways should the main road being followed be lost or prove too difficult.

A second major question - derived largely from the analyses of Professors Chiva and Himmelstrand - was whether, in view of the impossibility of achieving a "purely linear" communication (due to metamorphism being present at all levels and in all exchanges), the efficiency or meaningfulness of any communication could ever be determined.+

Lastly in his résumé, and reflecting discussions which had continued well after the ending of the Round Table Session, M. Jaigu questioned whether, from the mass of information which everyone was continutally receiving, it was possible to abstract

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+ This appears to be a matter of almost metaphysical depth, and is perhaps a useful reminder that communication and understanding must always have an approximate quality, the degree of approximation being itself only approximately determinable. Similarities with the Uncertainty Principle in physics come to mind - Editor.

"the Truth". He saw a problem in distinguishing transmitted (received) information from simulated or created information, and asked whether a basic core of transmitted information could be communicated intact within an "outer envelope" dependent on geographical, individual or ethnical variations. This led to the realisation that communication need not necesarily rely on the written or spoken word, but can result from meditation following any form of sensory perception. In this respect the west had much to learn from the Zen tradition, which emphasises communication through meditation... and M. Jaigu believed it would have been valuable to include, among the Round Table, participants, a Zen practitioner. This last remark drew attention to the fact that, despite the proclaimed objectives of DISCOVERIES for the combination of eastern and western philosophies and approaches to world questions, the Paris Symposium had so far remained firmly anchored within thoroughly western cultural traditions, tending to recognise only visual and audible forms of communication and largely ignoring the silent forms which are a major characteristic of oriental culture. Probably inevitable, this demonstration of the pervasiveness of western attitudes surely highlighted their aggressive nature in contrast to the submissiveness that is epitomised in oriental meditation. The message was loud, the lesson to be learned was clear.

If this first Round Table discussion tended at times to lose

itself in the abstract and the metaphysical (the comment is made with no derogatory implications) the second discussion, on "Evolution of Expression : interactions with computers", was much more down to earth. Besides the Chairman, M. André Danzin, who is an engineer, the participants comprised a lawyer (M. L. Mehl, Maître de Requêtes in the French Conseil d'Etat); a medical doctor (Professor J.P. Lévy, Cochin Hospital, Paris); and a mathematician (Professor J.L. Lions, Collège de France).

As a preliminary to the debate, each participant gave a short appreciation of how he saw the impact of computers in his profession, beginning with Professor Lions who, as Secretary General of the International Mathematical Union, was able to report on attitudes at the Union's recent conference in Helsinki. Clearly, this had hardly been starry-eyed about computers, there being in fact no papers on computers or computer science. Nevertheless, all mathematicians recognised that the computer (due to its very high speed of operation) had invaluable applications in calculational methods that had long been proposed but, because they would have been too tedius (and expensive) in "manual" use, had not previously been adopted.

It was also generally recognised that computers offered some very important advantages in modelling complex social and

similar systems. But this did not necessarily mean they were possessed of super-mental powers, or merited such descriptions as artificial brains. From the purely mathematical viewpoint, real intelligence was still very far from the artifical variety.

Next, Professor Lévy gave some details of a computer-based haematological data-bank and information-processing system, which was being developed in France and was already yielding useful results in time saving and accurate diagnosis from predetermined standard medical tests. The system was also being used in the training of haematology students, where the rigorous logic of "informatique" had obliged all concerned to analyse the reasoning behind their methods to the point where intuition and "art" were virtually banished in favour of totally iterative mechanical processes. This elimination of the doctor's "professional magic", and its replacement by a system which almost any intelligent "operator" could use with reasonable effectiveness (if never with total confidence), was among the reasons why, according to Dr. Lévy, the medical profession was neither enthusiastic nor optimistic towards expanded use of computer-based diagnosis. In short, while it could enable the fullest use to be made of existing knowledge, it tended to stifle research into new concepts and aspects of medicine, particularly those which might upset the bureaucracy of a computer-organised medical establishment.

M. Mehl then spoke of the use of computers and electronic data files for the classification, storage and rapid retrieval of legal information. M. Mehl, who is President of the French Centre d'Etudes et de Documentation d'Informatique Juridique, and author of a recent report on the use by French Parliamentarians of the Administration's various data-banks and models, at once demonstrated that computer-based information systems could be invaluable in the legal field, where so much depended on precedent and case law and where the information explosion in recent years had been no less violent than in other fields. Not only this, however, but the compilation of rules and principles, applications and judgements from countries where legal customs were traditionally different (notably, in Europe between those of romano-germanic law and those of common law) could be particularly helpful in the elimination of practical divergencies and the eventual evolution of full uniformity.

M. Mehl also put forward the suggestion that, given suitable modelling of societal "machinery", it should be possible to test by computer the consequences of new draft legislation before it was adopted as law... rather than, as he said, adopting the new law first and discovering afterwards all its possible interpretations and consequences, sometimes "relatively unforeseen". Despite its

success being evidently dependent on both the representativity of the societal model used and the method of pre-testing adopted for the draft legislation, such an application seemed to be generally accepted as possible and probably valuable.

Finally, concerning a more general use of "informatique" in maintaining administrative records, M. Mehl suggested that the greater (virtually total) "transparency" which must result would lead to the treatment of every individual citizen in a way which would not only be scrupulously fair and impartial, but would be publicly seen to be so. Taking as an example the assessment and payment of taxes, he believed that society as a whole, able to examine the detailed application of "the rules" throughout the community and thus to verify that this was equitable and impartial (and above all that it virtually eliminated the possibility of illicit tax avoidance) would welcome the system.

M. Mehl did however recognise, in company with all the participants in the debate which followed, that this somewhat utopian situation was as yet far from practical realisation. In a spirited intervention from the floor Professor Harry Gunning (President and Vice-Chancellor of Alberta University, Canada) declared that in his country the advent of computerised personal files, far from being welcomed, had been attacked by many individuals who

felt themselves assaulted and victimised by computers, which they sensed were depriving them of both privacy and individuality. The desire to be a unique human being, said Dr. Gunning, was no less strong than the desire to live, and he implied that much of today's resistance for even the most "innocent" use of computers was due to this desire being unrecognised.

M. Danzin, with support from M. Mehl, remarked that the much-feared encroachment by computers on personal liberty was somewhat illusory, and further that acceptance of some "restraints to life" at this level could be compensated by greater freedom at higher levels. Thus, for example, the very considerable limitations to complete freedom in the use of a road system (speed limits, obligatory directions, etc.) were essential to guarantee to all road users that they could in fact use the roads. The more general theme, that complete freedom for one must mean strict controls for all others, though not evoked was clearly not far below the surface of thought.

On a further suggestion, that computers were essential to resolve the complexity of life today, Professor Murray Eden (National Institutes of Health, Bethesda, USA) commented that computers could very easily make complexity worse. Furthermore, every complex problem which might be resolved could usually be guaranteed to point to an even more complex problem as yet unresolved. There was, in many areas of planning and analysis which could be submitted to computers,

a saturation point beyond which additional data processing could not be expected to yield improved practical results.

But whatever the reactions to the actual or expected impact of computers on life in all its aspects, there was no doubt that all present at this "Round Table" agreed that tomorrow's society was going to be far more dependent on information and on communication than was today's, while on the contrary it must be expected that material possessions and comforts (such as washing machines and motor cars) would be considered less important. Whether representatives of developing countries, still obliged to do their washing in the cold waters of a nearby river and still dependent on animal-drawn carts for their transport, would have agreed with this was not to be determined, for none took part in the Session.+

One further point arising from this Round Table should be mentioned. It was made by M. Danzin in his summary presentation the following morning, and was to some extent provoked by Professor Touraine's paper. Referring to the widespread feeling that a computerised society must necessarily be also a centralised society, with ever-increasing concentration of power in the hands of an elite few, M. Danzin pointed out that virtually instantaneous electronic information exchange could equally well - and perhaps

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+ "Third World" representation in DISCOVERIES Symposia to date, in fact, though certainly not absent has been somewhat slim, despite the probability (United Nations estimates) that over 80% of the total world population by the mid-2100s will be in Third World countries.

more effectively - lead to devolution of real (decision-making) authority among a multitude of quite small though interdependent communities. This must mean that the individual, rather than being dominated by the (national or world) state, could expect to preserve both a degree of freedom and a degree of influence in relation to the evolution of society about him. In other words the computer and its associated complex of automation even in "informatique" could and should help mankind towards a new freedom of the spirit as well as material prosperity. If this were not achieved it would not be the fault of the machines.

Further comments on the subjects of their papers were presented by Professors Touraine and Dumont in the summary session the following morning (Tuesday, October 24) which was under the chairmanship of Professor Maurice Marois (Faculty of Medicine at the Pierre and Marie Curie University, Paris, and also Founding President of the French "Institut de la Vie"). Introducing Professor Touraine, Professor Marois (whose special field is sexual endocrinology) drew attention to the gradual increase in the economy of the sexual reproduction process as one followed the process from "lower" organisms to humankind. "A great many more spermatozoa are needed to make an oyster" he said, "than to make a man", and he pointed out that the

greater efficiency in man was due to an evolution based on information, which had enabled the human mechanisms of reproduction to develop so that they involved far less waste of spermatozoa than occurred with the oysters. The evolution and gradually increasing efficiency of societies, as they became more information-oriented and communications-dependent, was perhaps a similar type of phenomenon, effective precisely because, in Professor Touraine's words, of the self-modification which the communications society could achieve by action on itself. Concluding his introduction, Professor Marois asked, but did not attempt to answer, how much of evolution was chance and how much necessity.+

Professor Touraine, in what was virtually an extension of his paper, recalled that throughout history one of the ideological ideas repeatedly attracting attention was that of a society which through "perfect" (albeit continually improving) communications could become completely centralised, with an end to all social and cultural divisions and barriers. Such a society, the ultimate in rationality and efficiency, was seen also by some as the ultimate development of man's ability to organise himself and manage his destiny ... the ultimate in the exploitation of perfect communications.

+ It is perhaps interesting to recall here a remark, many years ago, by Professor Fred Hoyle when discussing the "astonishing fact" that the conditions on planet Earth had proved exactly right for the evolution and continuing life support of so many living species including man. Professor Hoyle pointed out that, since these species could not have come into existence unless the conditions were appropriate, it was not in fact surprising that the conditions were right for the species as they now existed. - Editor

But Professor Touraine found himself led rather in the opposite direction, believing that communications today faced a basic dilemma in the progressive separation of the messages and social rôles of those who gave out information and those who received it. Whereas "traditional" societies had been based on the social interdependence of its component groups, today these groups seemed to be moving ever further apart, and it was information - through the largely one-way communication systems of the mass media - that was at the root of this movement. Information in this sense was, it seemed, already much more than communicated data - it was the essence of decision-making, it was power.

Yet there still was a truly communicative component in information, a complementary and essential component which, however, had no value unless combined with adequate comprehension. And the current "crisis" in communication - which no-one denied - was a crisis of comprehension. "As a result" said the Professor, "in a world where we are surrounded by a plethora of information, we are also surrounded by the silence of non-communication."

Professor Touraine then referred to some comments made immediately following his paper the previous day, when several of those present had drawn attention to the increasing conflict

which appeared to be developing between the state and society. There was evidence that this was in no way confined to any particular forms of state organisation (e.g. capitalist or Marxist-inspired) but rather that it was a general indication that "no society was a blank page or screen on which could be written or projected, without opposition, any informational message that happened to be circulating". In other words no society wished to surrender itself to the dictates of new information technologies any more than in the past it had willingly surrendered to other technologies. People wished to keep for themselves the control of their destiny, and it had been particularly interesting, in the "case studies" presented by Professor Dumont, to note how existing cultures (expressions of existing societal values) had accepted the impacts and influences of other cultures only with a certain diffidence and not without some modification which, at least to the "receiving culture", were improvements.+

Developing this theme, Professor Touraine believed it could be highly instructive to make a systematic and comparative study of the ways in which different national societies accept and control the flow of information expressing (representing) economic change and "modernisation". There were many possible

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+ The Editor may here have allowed his own interpretation to modify somewhat that of the speaker, perhaps thus providing a further (miniature) case-study. He would strongly recommend study of Professor Touraine's full paper.

compromises between a purely civic society, at one end of the range, and at the other what he termed "la société anglaise" - a society which was both "extraordinarily permeable and extraordinarily insular[+]". The tendency towards compromise had many roots in France and French history (though Professor Touraine admitted that the French idea of a nation-state was something of a local speciality) but the general inference could be drawn, from examination of this and some other countries, especially the USSR, that progress within a state structure was dependent on the degree of willing cooperation between society and the state concerned.

Summing up, Professor Touraine saw two evolving models for future society. In the first, ancient social and cultural structures would be mobilised - largely without modification - as forces for progress. This was what could be seen today not only in Japan but also, for example, in Brazil and Mexico.

In the second evolutionary direction, these ancient structures would be absorbed within the "models of civil and cultural permeability" which Professor Dumont had evoked in his discussion of the processes of "acculturation". Interacting on each other and with their surrounding environments, the new structures would continually evolve until their ancestry would be hidden and (probably) eventually lost.

[+] Insular for reasons other than geographical. This societal category, with characteristics probably inseparable from those of economic dominance, had truly embraced England in the nineteenth century, subsequently the United States, and today the Scandinavian countries.

Obviously, the two types of societal model must pass through a lengthy period of co-existence, each exchanging information with the other, which was why a comparative study of practical examples of each should be of particular value.

Professor Dumont agreed with Professor Touraine's insistence that information and communications were only two elements in a three-element chain, the third element being comprehension. Evidently this was essential; without it there could never have been coherent discourse in the past, and could not be today or in the future. Professor Dumont also suggested that the analytical division of social operations such as the communication and comprehension of information into a number of separate and distinct "items"or "phases", an approach which had yielded brilliant results in so many fields including sociology, nevertheless implied certain sociological consequences, perhaps summed up in the succinct observation "There is the life of the specialist, there are specialist activities ... and then there is human life, multidimensional life or, quite simply, culture. And it is on culture, finally that comprehension depends." If this salutary remark left the many specialists present unperturbed it was surely because, besides their specialisation, each one had a wide background of basic culture.

But Professor Dumont had a further message, for specialists and non-specialists alike, concerning modern sociological research as a whole. It was that, despite the efforts which society had always devoted to understanding itself, its structures and mechanisms, such knowledge as had been acquired in this field remained rather minimal, rather empirical, and rather unsure. What was more, efforts to develop it further were (as in the past) much restricted by the fact that different researchers often started with different and incompatible major assumptions - sometimes adopted more intuitively than for scientific or logical reasons - which could not help influencing very substantially the interpretation of results from the field.

Currently, there was a particular ideological concept which could seriously hamper such studies as comparisons between civilisations. This was the concept of a virtually universal egalitarianism. All factors were assumed equal to all other factors; while for the anthropologist, the ethnologist, called on to examine societes or civilisations, the opposing concept of hierarchisation was essential and inevitable. "You constantly need to know what is predominant and what is less important", said Professor Dumont, "what facts or effects are primordial, what are secondary".

This "unthinkable" idea of hierarchies and non-equalities was also vital to the study of information, communication and

comprehension, and however much our intuition might be opposed to it, it represented a reality we could not escape. It also embodied substantial dangers: "It is", said the Professor, "precisely because we have in modern society a juxtaposition of deeply-rooted individualist values as well as an effort in search of the holism of a global society ... an effort to re-invest such society with primordial value, that we may encounter totalitarianism. That, after all, was the origin of Nazism."

One was tempted at this point to extend the earlier remarks of M. Danzin concerning whether improved communications and "informatique" would help mankind forward to a better life, or impose on him new and perhaps unbearable difficulties. Despite the near-overwhelming forces of circumstance which Professor Dumont envisaged, the optimist must surely assume that man can, and will, retain control over his destiny. He will not surrender that to his machines.

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Text of paper by Professor Alain Touraine

FROM EXCHANGE TO COMMUNICATION
THE BIRTH OF PROGRAMMED SOCIETY

INTRODUCTION

Industrial Society is in a state of crisis. Cyclical crises previously seemed to be an integral part of the capitalist mode of industrialisation : alternate phases of expansion and recession, or the longer phases of Kondratief's cycle, structured the history of industrial economy. The state of crisis was thus seen both as a disease and as a mechanism of growth. In any case, it was a part of a particular type of economy and society : those who believed that the capitalist system would degenerate into a general crisis and would disintegrate as a result of its internal contradictions, after being apparently justified by the great crisis of the thirties, saw their predictions disproved by 20 years of exceptional and virtually uninterrupted growth.

Nowadays, when we talk of crisis, what we are referring to is of an entirely different nature, or rather it includes two quite distinct kinds of phenomena, neither of which can be accounted for merely in terms of the degeneration of an economic system. In the first place,

it is the worldwide leadership of the capitalist nations that is now at stake; on the one hand as a result of the sharp increase in price of various raw materials from developing countries; on the other due to the massive export of capital and factory plant from the high-wage to low-wage nations eager to encourage new industries. In the second place, a whole system of values is being challenged. This crisis of civilisation was in fact becoming apparent several years before the critical recent events in the economic world had taken place, namely the 1971 dollar crisis and the steep rise in oil prices following the Yom Kippur war of 1973. The meetings and declarations of the Club of Rome, Ivan Illich's books, and the student movements in Japan and the United States, then Germany and lastly France and Italy, were the most spectacular manifestations of this crisis of values, which, as generally happens when one particular type of culture and society gives way to others, gave rise to various utopian concepts. By utopian concept I mean the concept of a necessary and desirable order rather than an order which has no justification beyond individual interests, political compromises or the constraints of force. An order

which is necessary because of the natural limits of growth, the thresholds beyond which progress becomes repressive, and the laws of stability of the eco-system which no species may transgress without incurring the risk of extinction; an order which is desirable because it substitutes basic needs, voluntary associations and communal relationships for the false logic of bureaucracy, the ravages of technical progress and gigantism, the horrors of totalitarianism. More suggestively, we sense that the nature of authority and the methods of socialisation, attitudes towards work, and concepts of the future have undergone radical changes. The crisis affects not only institutions, but equally our motivations and our social behaviour. It is indeed a crisis of civilisation as a whole, not one affecting merely the functioning of a particular area of social organisation.

What is the nature of this crisis? We are moving away from the outskirts of industrial society, but whither? Are we just to drift, perhaps to land on a Cytherean island, or perhaps to enter a hyper-industrial society? Are we living through a period of decadence, or are we witnessing the tail end of several centuries of growth and the return to societies essentially preoccupied with their own

stability, as were our rural societies not so long ago in both Asia and Europe? Or are we perhaps moving towards a society marked by a greater capacity for self-modification than Industrial Society, that might provisionally be called Post-Industrial Society? There is no doubt that the threat of decadence exists. Accustomed as they are to plenty, our societies are tired and irritable, preoccupied with self-protection and enjoyment, and perhaps allowing themselves to be dragged into a degenerate future as new Lower Empires or a later-day Byzantium.

But this is surely only one of the possible answers to the challenge of history; not only are there others, but the study of these collective movements does not preclude our asking what problems they do, or do not, resolve. The great choice remains : are we facing a new phase of growth or a return to equilibrium, to a Post-Industrial or indeed a Post-Historic society; are we at the end of a development phase, or the end of development itself? We have just lived through a vast counter-cultural movement, which has directly questioned the values of industrialisation and growth, and which has sought stability and identity in any form. I believe

this could only be a brief transitional phase between rejection of the values of Industrial Society and awareness of the transformation of the whole economic order. We must understand that the "exhaustion" of Industrial Society, in the countries where it had achieved its greatest development, may herald the difficult but indispensable transition to a new type of society, more active and mobile, but also more voluntaristic and dangerous than the society we are leaving behind us.

I LEVELS OF HISTORICITY

A self-confident society considers itself to be the ultimate product of history, and only defines other societies by the lesser degree to which they possess an attribute identified with historical progress or with the essence of social existence. Merchant societies contrasted civilisation with barbarity and prided themselves in being the most civilised because they had more formally defined the rights governing people and possessions. Industrial societies have more recently explained their superiority through the greater number of their mechanical slaves, the available power of their machines. In the same way, we are already beginning to class societies, or at least

countries, according to their capacity to process information, insofar as this capacity is indicated by the number or cost of their operational computers... an indication that we have already entered Post-Industrial Society, despite the fact that the vast majority of the population is still employed in an Industrial or Market economy. Such an approach has above all the merit of indicating the shifting of human activity, from one type of society to another : from commerce to manufacture, and from manufacture to communication, and of introducing the idea of passage from one type of culture and society to other types, from one type of relationship between a collectivity and its environment, and one type of relationship between social actors, to others. This disproves the previously and generally accepted idea of evolution in terms of increasing differentiation, enrichment or rationalisation. The rift separating trade and industry, which has been analysed from many different angles, reappears between Industrial and Post-Industrial Society, to use - however provisionally - a superficially historical definition. But each of us resists the idea of a succession of entirely different societies, especially when the transition from

one to another has taken place smoothly. We can easily accept that a conqueror could transform a society, and that the closure of trade routes, invasions, and the decadence of the Roman Empire could have brought about the enclosure of vast domains and the birth of feudalism; but Great Britain, the Netherlands and France, to mention but a few, developed without so sudden a transition from Merchant societies into Industrial societies, and almost everywhere there were industries already extant within merchant societies. Neither do the more ardent supporters of the notion of a Post-Industrial Society deny that it could be considered, at least partially, as a Hyper-Industrial Society. How then can we combine discontinuity and continuity in the succession of societal types? It is necessary to answer this general question in order to situate the Communication Society that is forming before our very eyes in relation to the Manufacturing Society in the midst of which it is appearing.

A society acts upon itself in a primarily material way. It sets aside part of the available production and re-invests it in the productive system. True, there are some societies which are not self-modifying in this way, but these might be called 'societies without historicity -

which does not mean without history, if we define historicity as action which prevents reproduction of the established order and therefore demands a capacity for transformation and development. These societies are ruled by models which prescribe the equilibrium and control of the exchanges within the social order, or with its environment.
Beyond such societies, which may thus be defined by their structure, we can distinguish a succession of historical types, that is to say societies defined by a certain level or mode of historicity.

Many societies are self-modifying only at consumer level, that is to say they invest in order to increase the quantity of available products by increasing the available work-force or animal power, and by extending cultivated areas and increasing their yield. These may be called Agrarian Societies. They have little historicity, for they undergo self-modification only at the final stage of their economic system, which may be simply described as a co-relation of production with collective organisation of the means of production with a "social" mode of distribution, and with individual or collective consumption patterns. Historicity in agrarian societies

is therefore only found at consumer level.

Merchant societies, on the other hand, undergo self-modification at distribution level. By organising trade and transport of goods, guaranteeing the quality of goods supplied and the value of currency used, by maintaining order over trading routes by land and sea, and by formalising legal rules, merchant societies also allow specialisation of production, leading to greater efficiency (and profitability). However, manufacturing itself is not directly affected by commercial progress. Craftsmen working at home or in workshops continue to respect professional traditions and to use their skills in conformity with the rules of a corporate working organisation. This clearly shows the limits of self-modification within a merchant society.

If we talk of industrial revolution, however unsatisfactory this expression may be from the historical point of view (at least in the case of European countries) it is because the transition from trade to industry indicates that historicity has spread beyond the fields of consumption and distribution and penetrated the world of production. But we must again note that industrial society does not invest directly in the production of

production, and is not therefore directly associated with what has been more recently called a scientific and technological revolution. By definition, industrial society represents revolution, through investment, in the organisation of labour. This is the process described by Ure and Marx in their celebrated writings. The Industrial Revolution begins the moment the merchant no longer merely controls the product of the craftsman's craft, but also organises the workers' working system (factory) and the conditions of collective manufacture, by imposing new methods of work division and specialisation. Industrialisation is not defined by the use of machines, but by the organisation of labour. It is not by chance that one of the first philosophers of industrialisation, Saint-Simon, gave the name "l'Organisateur" to the journal he published during the early years of the Restoration; nor is it by chance that towards the end of the century the phrase organisation of labour was used to describe the activities of the two great figures of mass industrialisation, Taylor and Ford. Rational or scientific organisation of labour (as it is sometimes called) is not a mere characteristic of industrialisation, it is the very definition of it. This means that industrial

society, like any other society, cannot be defined in terms of technology, productivity level, or income per inhabitant, but rather by its mode of self-modification.

This definition of Industrial Society calls for the concept of a Post-Industrial Society which would promote historicity, and primarily investment, to a level not attained by industrial society, that of the production of production. The organisation of labour only affected the relationships of the workers among themselves, and therefore the level at which manufacture took place. Post-Industrial Society acts more globally at managerial level, i.e. on the overall mechanism of production. This action takes two main forms. Firstly, it is innovation, that is to say the capacity to produce new products, in particular as a result of scientific and technological investment; secondly, it is management itself, that is to say the capacity to make use of complex information and communication systems.

Obviously, these levels of historicity do not form a simple succession; on reaching a certain level, a society continues to exhibit lower levels of historicity charcteristic of preceding societies. An industrial society does not forego the benefits acquired through trade,

and a Post-Industrial Society does not forego the organisation of its labour force; but it is in the nature of a particular society that it recognises the greater importance of a certain type of investment and chooses in its favour whenever it conflicts with some other type, characteristic of some other type of society. Thus a post-industrial society cannot be defined, any more than an industrial society could be, by a particular technology. It is just as superficial to speak of a "computer society" or a "plutonium society" as it is to speak of a "steam-engine society" or an "electric-motor society". There is no reason why so great a privilege should be granted to a particular technology, whatever its historical importance. The important point is to recognise that a Post-Industrial Society is one where all the elements of the economic system are affected by the actions of the society on itself. These actions do not usually take the form of conscious will embodied in one person or even in a group of people. This is why such a society must be termed a programmed society, a designation which fully indicates its capacity to create models for the management of production, organisation,

distribution and consumption; thus a society of this sort appears, at all levels of operation, not as the result of natural laws or of specific cultural characteristics, but rather as the result of the production, by society acting upon itself, of its own systems of social action.

II PROGRAMMED SOCIETY IN HUMAN EXPERIENCE

We must now change our perspective to the viewpoint of those who are living in this society and who, particularly as individuals, behave towards it as consumers rather than as producers. This is where quantitative analyses can help us - in the same manner that, in the course of industrialisation (what Carl Polanyi called "The Great Transformation") it was possible for sociologists to consider not the organisation of labour, but rather the differentiation and growing rationalisation of social relationships, and still more simply, increased exchanges within a social unit. This is what Karl Deutsch in the US and Gino Germani in Buenos Aires recently and almost simultaneously termed a society's degree of mobilisation. A programmed society involves a noticeably higher degree of mobilisation than an industrial society. In the latter,

individuals were drawn into directed systems of collective organisation almost solely in the field of employment, though sometimes also - but in a much more limited manner - in connection with housing. It is characteristic of a post-industrial society that it sets up large centralised management systems in the most diverse areas of social life. There has been talk of the industrialisation of information, of consumption, of health, of scientific research, even of general education. In fact the word is inexact, but it is true that decision and management centres are being formed which are capable of producing not only systems of "means", but also goals for social action; systems of care and treatment are presented as models of consumption or as educational curricula.

This extraordinary acceleration and multiplication of more or less intensely programmed communications has already given rise to some very positive attitudes, that should not be eclipsed by the force of counter-cultural protest of recent years. In the first place, the majority of participants in this type of society are attracted by the multiplication of information and the consequent multiplication of available choices. There is

no justification here for citing in opposition the concentration of decision-making and the uniformisation of programmes or messages : where such a uniformity does exist, it is not due to the intrinsic nature of a programmed society, but (which is entirely different) to the nature of the political and ideological control system which forms part of certain national societies. We should beware of facile and merely elitist criticisms of the mass-media. Those who in the past enjoyed a great freedom of choice with regard to material or intellectual consumption now enjoy a still greater freedom of choice ... as witness the intense interest in access to cultures temporally and spatially distant from our own. And those who were imprisoned within the confines of parochial existence, subject to the influence of the traditional educated classes and the limits of popular literature, now have access to a much wider and more open repertory. Programmed societies cause people, goods and ideas to circulate to a far greater extent than did the preceding societies.

Again, we must recognise that societies possessing a high level of historicity, and a high capacity for self-production, considerably reduce their capacity for self-reproduction. It is even paradoxical to find so

many critics insisting so much on the importance of the mechanisms ensuring reproduction and the maintenance of the established order in our type of society. It is my contention that this is an indirect and almost paradoxical expression of the growing awareness of mobilisation in our production societies. These societies are increasingly hostile to anything that seems to be oriented towards reproduction, despite the fact that less and less conduct, ideas and behaviour patterns are being reproduced. This is often brought to our notice in the so-called liberation movements. Whether simply liberal, libertarian or revolutionary, their principal direction seems to be towards the destruction of acquired positions, transmitted roles, and "ascribed" statutes, thus allowing all categories of the population to participate in more and more intense exchanges and communications. The most noteworthy of these is without doubt the feminist movement. While it is true that one may see in it other meanings (which to my mind would be even more important if they were more militant in nature, and challenged particular aspects of social power) the most significant aspect of the feminist movement is undoubtedly the fact

that it accompanies the general crisis in reproduction systems.

The most visible aspect of the feminist movement is thus analogous to the movement instigated by the prophets of capitalist industrial society against slavery and against anything which might oppose the free circulation of people on the labour market. Here lies the ambiguity of a movement of this sort. It does indeed break down barriers, prejudices and taboos, but we should not allow ourselves to be misled by the revolutionary or libertarian language it often employs. It is already noticeable that the breakdown of barriers between private and public life, the "publicity" given to sexual conduct and the more egalitarian participation of women in the economic and professional world, can be largely explained in terms of the interests of a consumer society which needs to increase the available income per household and to expand the areas of behaviour that can be influenced by centrally established models.

This ambiguity merely points to the well-known fact that cultural innovation is at first closely linked with the formation of new leadership groups. On the other hand, dominated social categories remain culturally

defensive, embracing anything that enhances their particular identity and appears to offer protection against (new) external domination. Cultural progressivism can be associated with social conservatism; this is why groups of women wishing to oppose this conservatism are obliged, in order to maintain their image as cultural innovators, to dissociate themselves in a particularly spectacular or violent manner from the ruling classes and their behavioural patterns.

It is nevertheless true that the behaviour patterns just mentioned are part of a modernising attitude, tending towards a more open society and therefore constituting a new manifestation of the philosophy of Enlightenment. On the other hand, both in the non-ruling social categories and in broad areas of the intellectual sphere - especially among those whose level of education is above the "economic" level - the fear is often expressed that individuals and groups will be imprisoned in ever more complex networks of signals, rules and prohibitions. Expressions such as "meshed" or "cable-linked" society, are heard in references to increasing pressures towards normalisation. In pre-industrial and culturally traditional societies, certain rules were maintained or taught in a very authoritarian

manner, but they were part of a loose network and there were many areas of behavioural indetermination. In a modern city it is literally impossible to take a step without receiving orders, without being exposed to publicity or propaganda, without being confronted by scales and systems for self-evaluation of social level. This is why there is such a strong desire for non-social inter-personal relationships, or to build communities representing so many "holes" in the ever more closely-knit social network. Thus marginality, considered for a long time as a failure to integrate, becomes a sign of opposition, a laboratory where a new culture, a counter-project of society, could be born.

At another, more global level of criticism, the idea appears that a programmed society increases the distance between the leaders and the led. It is true that the idea is repeatedly expressed that the new technologies allow greater decentralisation. This same idea was expressed towards the end of the 19th century when many social philosophers contended that electricity would encourage decentralisation just as coal had meant centralisation. In fact, the idea that technology rules

society is yet again found to be wrong. It is not in the nature of electricity to determine how it is used in society; and the same is true of the computer. On the other hand, it is true that the creation and increasing diversification of production and information management mechanisms leads to a concentration of power. Such concentration has long been a highly developed feature of industrial organisation; it continues to progress, but above all it is the power to make decisions in other areas of social life that has undergone ever greater concentration. A frequently studied example is that of scientific research and the transition from "little science" to "big science", especially following the fearsome arms race between the two super-powers. It could even be said that a programmed society permits and encourages a greater interdependence between the mechanisms of domination, apparently justifying de Tocqueville's classic idea in the second part of his American journey. Modernisation, the destruction of roots and the increasing pace of change, do these not lead to the overwhelming authority of a central power capable of imposing its will on a society fragmented by the destruction of communities and traditions?

Beyond these positive or negative ideas, the most important thing is to tackle the question raised earlier of the nature of the relationships between technology and society. Have we become a "technologised" society? Can we expect technical progress to lead to social progress by increasing living standards and multiplying the number of available choices? Or should we, on the contrary, recognise that certain techniques have become a direct menace? Questions of this sort are of course unprecedented, and the definition we have given of a programmed society no longer allows us simply to draw traditional conclusions, as handed down from the 19th century, concerning the effects of technology. It is no longer possible to say that technology and science have positive effects of themselves, but that these may be turned in a negative direction by the social use that is made of them. If this were the case, it would be sufficient to exchange that use for another - to replace oligarchy by democracy in order to transform death forces into life forces and sources of power into fountains of well-being. Such a distinction between the productive forces and the social relations of production is nowadays devoid of any meaning. It could only apply to an

industrial society in which social power had not yet begun to affect the level of production itself, but merely that of labour organisation. But today the choices are more radical, and it is in the nature of the ruling powers to be identified with the development of the productive forces, the management of information systems. However, this simple observation in no way implies that our society is directly dependent on the technologies it uses.

The time has in fact come to reverse the traditional logic. When anti-nuclear campaigners state that the nuclear industry is leading to a centralised and authoritarian society and that a plutonium-based civilisation necessarily implies a police state, whereas a solar society would be democratic and decentralised, their logic is standing on its head. In fact it is the power wielded by the main decision-making bodies that imposes a particular type of energy policy. In France, it was the powerful position of Electricité de France and the Commissariat à l'Energie Atomique which led to the adoption, in 1973-1974 and in the absence of any truly democratic debate, of an all-nuclear policy. This policy was in

fact a logical development from the all-electric policy imposed some years previously by EdF, for commercial reasons. It is in this way that technological choices are also political choices, and their effects are merely indicative of a relationship between the social forces involved. This is not entirely novel : for over thirty years industrial psycho-sociology has emphasised the fact that the effects of technical changes are less dependent on the necessary consequences of these changes, which are generally very difficult to determine, than on the social mode of their introduction. Studies of the changes introduced in administrative work by new methods of data-processing show even more directly the impossibility of identifying the specific consequences of these technical changes. The extreme diversity of the reactions, and the wide variety of changed situations observed, show that it is no longer possible to isolate a technological cause in a programmed society, in which it is characteristic that social power operates directly at production level, at the level of models for the determination of both demand and supply. It is precisely in the case of societies most dissimilar from programmed society, even from industrial society, that we

can speak of technological determinism inasmuch as the society's process of self-modification had little effect on technology and production, and a much greater effect, as we have already noted, on consumption and distribution. We can quite reasonably speak, as Roger Bastide has in the case of Brazil, of a civilisation based on wood, or of others based on coffee, cocoa etc. On the other hand, in industrial society, we are witnessing the disappearance of occupational autonomy, of specific cultures linked with particular trades or products. Occupational activity is increasingly defined in terms of the place occupied in a system of communications, and psychologists are already measuring levels of skill in these new terms. Again, we must add that the structure of this communications system is not itself determined by the technology involved, but is increasingly determined by the socio-political relationships within the organisation.

This leads to two more general observations. Firstly, the advent of programmed society is a new and decisive step towards the decline of society as presently known. Are we not witnessing the emergence of an increasingly restricted notion of society, both as an analytically

defined whole and as a particular geographical and historical reality. Pre-industrial societies spoke in broad terms of Roman or Athenian civilisation, which clearly indicated the direct link between a societal type and a political unity. When we talk of industrial society, we are aware of a considerably greater distance between it and a national state; nevertheless, we still use the same word in speaking of industrial society or, for example, of French society. When talking of programmed or post-industrial society, it would be more correct to replace the word "society" by "culture" thus denoting the increasing dissociation between the management of a collectivity's relationships with its environment, and the determination of social order. We shall return later to this central problem; let it suffice here to say that the increasing complexity of a programmed society means that its degree of integration can only decrease. A programmed society corresponds to a much more complex, less mechanical and less stable model of organisation than pre-industrial societies. We can all sense this. Different experiences of participation in this society cannot be traced back to the same central point, but rather to centres of decision situated at

very variable distances from this theoretical point; in fact, these centres of decision more probably constitute a system without a central point, in contrast to the "pyramid structure" of societies having the lowest levels of self-modification of their functioning.

The second general conclusion we can draw from this analysis is that the idea of ordered society, cherished in the past as was order itself in relation to chaos, nowadays appears to be fraught with danger. From the moment when social power takes the form of intervention at all levels of collective existence, it is bound to seek the universal rather than the particular, as happened during the French Revolution. We are therefore facing an extremely rapid reversal of attitudes, leading to an increasingly positive appreciation of individuality, difference and uniqueness, whilst order appears synonymous with imitation, uniformity, loss of information and therefore, ultimately, with disorder and entropy.

III NEW CLASS RELATIONS

We must now return to an expression used at the beginning of this analysis, one that is central to

our argument. What is meant by society's process of self-modification? What is this society that is thus considered as a person, even as a god? In fact, it is difficult to imagine a society or social whole undergoing a process of self-modification. This is the most constant object of a form of utopia that reappears regularly in the course of every century, and that might be called the populist utopia. It is hoped that the same can become something different - that change can take place without loss of identity. Albert Hirschman has analysed this very well in relation to social and political change in Brazil. It is in this sense that the 19th century Russian populist movement hoped to avoid the great social and cultural rupture caused by the capitalist mode of industrialisation, together with the proletarianisation it entailed. They wanted to use certain forms of traditional Russian organisation for the creation of a future society : pre-capitalist social patterns would have been transformed directly into those of an industrialised post-capitalist society. This desire to avoid rupture is fundamental, but it is as impossible for structural change to take place in a continuum as it is for a

revolution to be accomplished by existing laws. Historicity, and the more material aspect of it which is investment, cannot be set in motion by a whole society. In fact, for a whole society to exist in the first place, it is necessary to construct systems for the maintenance of order, for socialisation, for reproduction, for social control and for repression. It is because these instruments of social order and maintenance of social order exist that historicity can only be introduced by a portion of society, a portion that is able to escape the constraints of the existing order or, as is more often the case, to use them to its own ends by redirecting them from their original purpose. The real controlling class is the group that takes charge of historicity, the particular "actor" which exerts the most widespread action on the operation and transformation of society. This controlling class, in identifying itself with historicity, simultaneously identifies historicity with its own self-interest. On the one hand, it is progressive, in that it brings into play a greater degree of a society's capacity for self-modification, and resists earlier dominant social categories and earlier instruments of social control. On the other hand it raises barriers to protect its own privileges, that is to

say its identification with the interests of society as a whole. Each particular society possesses a specific class relationship. No single social actor, whether dominant or dominated, always plays the same part in class relationships, nor remains the permanent trustee of an eternal mission. The further we go from industrial societies, the more we find the distance between classes matches that between the internal agents of reproduction of the existing state and the external agents of change. The controlling class is also a class of warriors, both conquerors and defenders of the collectivity. At the same time, this social distance is institutionalised in the form of status "rules", transmitted from one generation to the next, which appear as strong segregations, prohibitions that are impossible to overcome, and innumerable signs indicating membership in particular social levels. In merchant societies, class relationships become more "civil", separating the productive craftsmen from the merchants who control the exchange system. The site of these class relationships is the labour market, because the craftsman must sell his products or his labour to the

merchant : thus class relationships are for the most part shaped in the market place, i.e. in the town and within its legal and political organisation.

Class conflict in industrial society is between the worker and the organiser, that is to say the boss, and the scene of their conflict is the factory, or to be more precise, the workshop or workpost, in other words, the place where organisation imposes its law on the worker's trade. The vital breakthrough in the development of a working class consciousness occurs precisely when patterns of rationalisation enter large-scale industries, a process which threatens but has not yet broken the resistance of skilled workers, many of whom have become toolmakers.

What then is the nature of class relationships in a programmed society? At first sight we are tempted to say that the central conflict is between directors and employees, between those who design, formulate and direct production programmes, and those who execute or "undergo" them. We are witnessing a process of proletarianisation of junior and even middle-level white-collar employees, just as we saw that of the workers; new techniques will next threaten the professional status of executives, and even

doctors and teachers. But in reality the division between those responsible for conception, and executive personnel who bring the concepts to realisation, merely delineates a stratification scale and therefore relationships based on authority.

We mean much more than this when we talk of class relationships. The dominant controlling class is that which has the power to guide the creation of cultural models and social norms; the dominated class is that which can only attain historicity in a subordinate manner, by accepting to play the part assigned to it by the controlling class, or else by attempting to destroy the monopoly of historicity held by that class. If it is the controlling class in programmed society which has the capacity to create models of social consumption, the dominated class cannot comprise those who execute and put these models into practice, but rather those who have to conform to them. Even if it is dangerous to say so, we must, in order to emphasise the separation between programmed and industrial society, recognise that the main social conflict of today is between the machinery of production and management, and the consumer

himself. The conflicts of authority which exist within large organisations between directors and executive staff are by no means the most important. This is why the first manifestations of new social conflicts have brought consumers to the forefront in a spectacular manner, or at least have made them involved and concerned. Those who have spoken out against schools and universities in the name of education, against the politico-scientific machinery in the name of public welfare, against hospitals in the name of health, against urbanisation schemes in the name of interpersonal relationships, and against the nuclear industry in the name of ecology, have always championed what at first may seem like a form of consumerism against the influence exerted by the "big machine" on the determination of demand. The power of the machine is generally referred to as technocracy. Just as, in an industrial society, the controlling class is the organising class, whether the organisation is private or public, we must not confuse technocracy with state-dominated administration. There is both a private technocracy and a public technocracy, just as there is a capitalist and a collectivist technocracy. The

strength of technocracy, as pointed out by Galbraith, is that it is a machine, not simply a willpower, and that it protects the interests of a technostructrue rather than those of the owners of capital. Confronted by technocracy, the consumer speaks out in terms of his real needs, in contrast to the traditional logic of industrial societies which conceived these needs as being a simple copy of economic growth. Engel's famous principles attempted to show that an increase in income led to an increase in consumption of non-essential goods, and to a relative decrease in consumption of basic goods, e.g. food. In fact, a violent rejection of this quantitative concept of needs is now taking place. This rejection appeals to deep, fundamental, natural needs, notions which do not have clear sociological meaning, but which indicate the desire to counter technocratic demand modelling with another life-style, other preferences, determined by the will to regain control of the instruments of production and organisation in social life.

In a programmed society, social conflict is characterised by the fact that the controlling class appears to rule over all aspects of social existence, thus preventing the dominated classes from speaking or acting from the standpoint of their own social and cultural autonomy.

These classes are therefore obliged to oppose social domination in the name of the only thing that could escape the grasp of the controlling class, namely nature. This explains the importance of the ecological movement, champion of life in face of genetic manipulation, pollution and the dangers of nuclear contamination. It also explains the importance of protest movements based on biological rather than social status : feminism, youth (also old age), the fact of belonging to an ethnic group or even, to some degree, belonging to a local or regional culture (for example, with regard to language, since the same language can be used by a collectivity at extremely different levels of social and economic organisation, it cannot be considered as one simple social product). However, this protest action can become wholly utopian, resulting in total rejection of the concept of social life, if it fails to establish links with some counter-offensive movement, i.e. a movement endeavouring to channel modern science and technology into a counter-model social and political organisation. Such a counter-model can no longer restrict its impact to the field of work organisation, as was the case in industrial society. And since the idea of management has superseded that of organisation, it is natural that the concept of self-management should replace that of

socialism, that is to say the concept of workers' control of the organisation of work. But the protest (defensive) action must link itself with the counter-offensive action by finding common ground between the two. In merchant societies this common ground of protest was called freedom, because it was concerned both with defence against the political and legal power of the merchants and with the creation of another order, equally defined in legal terms. In the industrial era, the common ground was called justice, being concerned with returning to the workers the fruits of their labour and of industrialisation. In programmed society, the common ground behind both protest and counter-offensive is happiness,that is to say an overall concept of the organisation of social life based on the estimated needs in the individuals and groups within the society. This means that the field of social strife is no longer as well defined in programmed society as it was in the preceding societies : in agrarian societies, everything was clearly related to the soil; in merchant societies it was the citizen, the inhabitant, who was the principal "actor"; in industrial society it was the worker. But in programmed society, it is the "social actor", in any of

his many roles, so that one could almost say it is the living being. This is why protest movements act in the name of a collective entity, whether it is the individual considered in terms of his bodily nature and his projects, or whether it is the community itself. However, all the different facets that apparently invest social conflicts in programmed society with an exceptional vitality and widespread nature are also a cause of their weakness, for the generalised nature of these conflicts has incidentally deprived them of a common ground. To use a crude analogy, fires may start anywhere, but society seems less threatened than previously by a huge conflagration. This is perhaps the reason why the future development of social movements and conflicts is more dependent in this society than in others on the state of the political order, that is to say either on the intervention of political parties or on a crisis involving the state as a whole.

IV SOCIETY WITHOUT STATE, OR STATE WITHOUT SOCIETY

Is this vision of programmed society too conservative? Ten years ago, when industrial society seemed to be at the

height of its strength, it seemed rash to imagine that it might already be in the process of being superseded by another societal type. Today, the notion of post-industrial society has often been abandoned because it was apparently linked with the optimism of the industrial period and therefore reduced to the image of a hyper-industrial society, which was not a solid foundation for the idea of societal change. Today, awareness of a crisis of values and of industrial organisation leads one to make the opposite criticism of the idea of a programmed society, namely that this idea has been left behind by transformations that have already appeared. However, criticisms diverge at this point, because the situations already described may be subjected to two different analytical approaches, which will now be described.

As already noted, for some it is not a stage of growth which is reaching its final development, but growth itself, the very essence of development. The very great capacity which programmed societies have for self-modification precludes their pursuit of the destructive creativity which was the hallmark of industrial society. For a long time we had a finite capacity to act on an

apparently infinite environment; today we are in a contrary situation - our capacity for action appears to exceed the resources on which it can draw. Should we not therefore think in terms of survival and stability rather than progress? Is it not time we realised that man is not in confrontation with nature, but that he is a part of it? The most extreme manifestation of this attitude calls for the return to a society of exchanges, a society without historicity. Certain anthropologists such as Marshall Sahlins have even spoken of a return to plenty, pointing out that our industrialised societies are dependent on scarcity and that the societies of the great North American plains knew how to maintain social stability by consuming or ceremonially destroying the available surplus.

Others, such as Pierre Clastres, have called for a return to stateless societies. On all sides there is a widespread nostalgic desire not for order but for an end to growth, which would give back some of their lost importance to personal experience, direct exchange, the life of the body and local organisation. Concurrently, the mainstream of protest, which seemed to be

focused on social relationships based on power or ownership, now seems to be focusing anew on the social actor himself, on his identities and differences. These two notions have occupied a central place in the majority of counter-cultural movements - in the feminist movement and in those instigated by ethnic or national groups.

This calls for at least two criticisms. Firstly, the emphasis on identities and differences is not a new phenomenon. It is, as I have already pointed out, a characteristic of rising social categories and especially of new controlling classes, to assert their own identities and differences, in other words to demand freedom for their initiatives and the dismantling of traditional barriers which resist the advent of any new power. Secondly, there is an obvious contradiction between the libertarian search for identity and the desire to free this identity from the web of social relationships linked with work, because for a society to destroy its historicity and reduce its activity to the process of self-reproduction, it needs to exert strong social controls. Athens would have to become more Spartan than the real Sparta, preventing investment and the progress of knowledge,

and reducing work to a series of acts which could easily become obligatory and rituralistic ceremonies. These criticisms are so obvious that the idea of outgrowing growth can only be linked to a very short period of our history, namely that when it seemed possible to abandon industrial society without abandoning abundance. This extremely brief period began in the early sixties, is already over in countries such as the United States, and is probably coming to an end in Western Europe. The study of student behaviour clarifies this point. Since about 1975, a plethora of counter-cultural models and social and political utopias has been brutally displaced by defensive behaviour and anxiety concerning professional prospects. This certainly does not mean that we should abandon criticism of industrial society, but rather that we cannot maintain very much longer the separation of cultural criticism from social and political criticism. Cultural criticism must become a criticism of the social forces which are leading towards a new type of society. Nor does this lead to a rejection of growth, but rather to the conception of ways for the collective reappropriation of the instruments and the products of this new growth.

A completely opposite criticism is implied in the notion that the idea of a programmed society is inadequate, since it still believes in the existence of a civil society and therefore of relations which can properly be called social. Critics of this persuasion maintain that such an image has corresponded to reality only in a very restricted area of the world and only during a very short time. This episode in civil society is in fact drawing to a close, and once again the state and the systems of maintenance and enforcement of social order are everywhere reasserting their domination. It is easy to perceive the reason for this criticism : the great hopes of industrial society were carried by the working class movement, and this movement gave the name "socialism" to the societal model opposed to capitalist society. Historically, however, this societal model which bore the workers' hope of freedom is embodied in a totalitarian state based on the reasoning of absolute power, and not the protection of the dominated classes. This is why the criticism of the communist model (which the more cautious would prefer to call Stalinist so as to limit its field of application) has led to the majority

of industrialised societies being seen in terms of domination, in one way or another, by a state-imposed order. Instead of analysing new conflicts and new social movements, emphasis has been given only to repression, inculcation and restriction. This has in fact brought to light a certain number of social phenomena which had previously been hidden in the shadows; and which could severely distort social analysis to the extent that this picture of contemporary society appears to exclude the possibility of conflict.

However, reality is in complete conflict with this picture, leading to the conclusion that there is increasing disconnnection between social relations, civil society, and the state. It is true, and this is probably the most important phenomenon on a worldwide scale, that an increasing number of countries are engaging spontaneously in an ever more rapid process of industrialistion. The more spontaneous this process is, the less it is guided by social forces which have as yet been unable to form; the more, therefore, is it State-directed whether nationally or from another (foreign) State. It is in fact beyond doubt that today's world is far more State dominated than Western society was during the last century

when undergoing the process of industrialisation. Yet once again, this phenomenon is not of the same nature as the passage from industrial to programmed society. It is wrong to speak here of a "power-elite", of monopoly State capitalism, or simply of a "total State". On the contrary it is more and more important to separate the analysis of the State from that of civil society. Even in a country such as France, have we not witnessed the development of the great, technocratic machineries taking place independently from political upheavals, from the weak Fourth Republic to the present industrialist State and including the truly Stately State of the Gaullist era, so much concerned with sovereignty or grandeur. The more weakly integrated civilian society is, the more it is made up of multiple networks of decision-making centres and fields of social influence, and the more the activities of the State are separated from those of society as such. For the State is concerned with historical change, and with maintaining the identity of a social entity caught between its past and its future and threatened by other surrounding entities; whereas civil society is an assembly of complex social

relations, subjected at increasingly numerous points to conflicts and negociations. The illusion of a possible return to equilibrium, like the illusion of an "all-devouring" State, can today serve only to delay analysis of the new directive forces, the new protest movements and of the interplay of their conflicts.

CONCLUSION

Thus there is not such a complete rupture between industrial society and whatever will follow it, as some have supposed. We shall not see the rebirth of "primitive" societies; nor shall we see social problems being absorbed within purely political issues, except perhaps in cases of extremely authoritarian states. The new society will be defined, just as were earlier societies, by its own process of self-modification which, through the medium of class relations, will evolve its own modus operandi. Production societies, which followed exchange societies, are in their turn being superseded by communications societies. What is radically new in these latest societies is that their capacity for self-modification extends to all areas of economic activity; they no longer see themselves as

being subordinated to an order transcending social phenomena. All the preceding historical societies saw themselves in terms of an intermediate level somewhere between the realm of the Gods and that of Nature or of Demons. Merchant societies developed as a means of escaping extremism and of respecting the essential principles of civil life and peace. Industrial societies attempted to transform raw materials into historical progress. Programmed society can no longer perceive any superior order beyond itself, neither can it recognise the existence of a nature separate from itself. This is why it recognises on the one hand that it is both a part of nature and also responsible for nature's protection - that is to say it must undertake the management of all the likely consequences of the modifications it carries out on the natural order; and on the other hand it no longer recognises any god but itself, since it has the capacity to transform itself almost completely, or even to destroy itself. This is why society's understanding, for the first time, can no longer appeal to principles external to the social phenomena themselves. This had already been sensed by the first sociologists towards the end of the

nineteenth century, notably by Durkheim, and is today becoming more and more obvious. We can and must study a communications society solely in terms of social relations. The meaning of the social actors' behaviour is not to be sought in principles, in an order of the universe, or in the current of history; it is purely and simply to be found in the social relations in which the actors belong. This is why society as a whole should be seen as a system of activities or, in the widest sense of the term, as a game. This also means that the analysis of society is, for the first time, necessarily sociological. Yet another result is that the mechanisms of social control or socialisation, since they can no longer be presented as respect for natural laws, or as the maintenance of traditional precepts, appear increasingly repressive. Everything that appears to be objective, established or institutionalised is found more and more, in this type of society, to be an impediment to the foundation of social relationships, an impediment to communication. This justifies the importance given to problems of the state in contemporary social thought. Programmed society is necessarily also a society of

protest, imagination and utopianism because it is completely divided, on the one hand, by the social conflict of machinery which has the capacity and the power "to programme" and on the other hand by the call for creativity and happiness, which are constantly being threatened by the logic of the machines. This leads us to consider that such a society embodies a process of radical disinstitution-alisation, the most obvious victim of which is the educational system. Insofar as this system had a socialising function, through the transmission of a cultural heritage, it is today devoid of all meaning. As can be seen, the entire system is exploding : on the one hand, the new controlling classes are demanding that schools should become centres of training and preparation for professional life; on the other hand, there are those who oppose this process of professionalisation, on the grounds that it is part of a plan produced by those in power, but who would still like to see the demise of traditional school institutions, and make them into centres for play, creativity and communication. These two examples, the one concerning the understanding of society, the other concerning schools, show that the main area of confrontation is

constantly getting closer to the realm of knowledge and ideas. This is explained not only by the fact that knowledge has become a productive force, whose appropriation by society is a problem as basic as that of industrial ownership, but above all by the fact that, the more a society extends its capacity for self-modification, the more it is guided by symbolic representations of itself and of social action, so the intellectual world, which had seemed to exist somewhere between society and the realm of principles and values, today finds itself at the very heart of social conflicts, completely unable to take refuge in the objectivity or the ivory towers of the scholars of earlier times. As a result this analysis of programmed society, rather than indicating a situation in which both knowledge and action should act simultaneously, points to a new relationship between knowledge and society. Sociology can no longer consist simply in bringing to light a social nature, it must analyse the component parts of all social objects so as to reveal the social relationships they hide, and thus the meanings concealed in what seem to be purely administrative or technical categories. It is in this

sense above all that we must avoid all attempts to define this society as technological or to name it after certain of its technical instruments; this would be giving way to a partisan illusion - it would mean using a language whose partisan character lies precisely in its objectivity.

It is rather by seeing society as a field of conflicting social relationships (which is not to say that these conflicts cannot be resolved and cannot lead to relatively stable compromises) that we can most successfully approach the new characteristics of a society which no longer possesses a nature of its own, being entirely the product of self-generation, the result of its own action.

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Text of paper by Professor Louis Dumont

COMMUNICATION BETWEEN CULTURES

The title of this paper implicitly poses a question of fundamental importance in today's world and as to its future.

Can one talk of communication between different cultures? From one language to another we talk of "translation", and as we are well aware, only the simplest messages may be passed on by translation without loss, and only on condition that the languages and cultures concerned are fairly similar. Thus, translation of the message "bring me some bread" presents no problem from one European language to another, but would be impossible in the language of a culture not acquainted with bread. In order somehow to convey the meaning of the message, we would then have to resort to an explanation of the nature of bread, in such terms as "he is asking for some of the basic nutrient consisting of..." If culture is intimately linked with language, it constitutes a presupposition of the latter, or it may be regarded as a code underlying that of language. To do justice to the empirical act of "communication" imperfect though it may be, we should discuss it in terms of meta-communication, or we should admit that, in general

communication is accompanied by a varying proportion of non-communication.

There are two factors, or let us say two empirical "facts" to be considered. The most important factor is that one can learn a foreign language, one can become fairly acquainted with a foreign culture and even live within it as easily as within one's own, thus achieving, in a sense, communication in vivo between cultures. Communication thus exists pre-eminently within human experience, within individual experience. The second factor is that cultures are not without "doors" or "windows". They borrow elements from one another in a more or less intensive and more or less extensive or global way; thus, in a sense, they "communicate". However, the difficulties mentioned earlier, together with the fact that each culture is manifest as a whole, lead away from a language of abstraction towards one of action : we talk of adoption, influence, and of the "interaction" of cultures. To make an initial approximation, we could compare culture to a living organism : the problems encountered with blood transfusions, organ transplants, hybridisation, even reproduction doubtless have parallels on the cultural level : a culture may adopt or reject foreign elements, it may or may not survive in contact with another. We might add that, wherever there is a great number of given

factors, the theory does not lead far beyond some general remarks of a rather statistical nature, for instance : "a culture only borrows what it could have invented", or again "a borrowed element is always reinterpreted in some way, whilst it modifies the whole into which it is integrated".

To go further, to study the interaction of cultures more systematically, I personnally believe we must resort to a systematic comparison of global cultures; I believe that this comparison is possible if based on the living experience of a specialist in the field - a social or cultural anthropologist for instance; and I believe that it could lead, ideally or eventually, towards an improvement in inter-cultural communication. To give some idea of this, I have selected three examples from different areas of my own research. Obviously, within the limits of this paper, I shall have to restrict myself to an approximate use of language, and forego analytical rigour in all but essential points.

My first example concerns technology, or rather it has a technological facade. In India there is an anomaly in the manufacture of earthenware pots. India has, doubtless since very early times, known the potter's wheel, the so-called spun-wheel. However, the wheel does not give the pot its definitive shape. After throwing, the pot is reshaped by paddling, as if ignoring the wheel's work. Very simply

(and hypothetically at present), the wheel is not used to its full potential but is integrated into a pre-existing process. It is as if the wheel had been adopted not because of its technical superiority but for extrinsic reasons... let us say from what we already know of this culture, by imitation, as a symbol of prestige or social superiority. I am aware that some may consider this example rather extravagant, but I chose it purposely as an extreme. The process has something to do with conservatism in the use of the pots; however, a technical explanation that might satisfy our prejudices has not been found. This shows above all that our background of expertise (in this case, technology) and corresponding rationality needs to be transcended when studying this type of phenomenon for the benefit of culture as a whole[1].

The two following examples concern the intellectual aspect of cultures, their systems of ideas and values, which I shall refer to as ideology. I have studied the intellectual interaction between India and the West during the 19th century. From the Indian point of view it offers a superb and well documented example of the "acculturation" of one great civilisation exposed to another. The integration

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(1) List of references is in a separate paper.

of Western values into Indian culture as achieved by the intelligentsia throughout the century, is a process which has impressed all those who have considered it and one which we cannot fail to admire. I should like to quote my own summary of this process :

> From 1820 to 1890 approximately, each decade, movement, region and personality marks a stage in a movement which begins - naturally in Bengal - with Ram Mohan Roy's conversion to liberal ideas without rejecting Hinduism (a more radical conversion to Christianity has been known to take place, for instance in the case of the famous writer Megha Sudan Dutt, but this is unusual amongst intellectuals). The social and political superiority of the Christian religion is recognised and reform is sought. Opinion divides the Brahmo Samaj, founded by Ram Mohan Roy; Keshab, a founder of religion, is but little removed from Christianity, prompting Max Müller to state that, with a little imagination on the part of the Christians, union and synthesis could have been possible. Dayananda's activities in Banjab, however, bring about an entirely different situation : he knows nothing of Christianity but paradoxically discovers monotheism in the Veda.

The Arya Samaj, of which he was the founder, was actively militant amongst the vast peasant populations of the north and campaigned in an unprecedented manner for the re-conversion to Hinduism of the apostates.

Meanwhile, Bengal was witnessing the rise of the disciple of the mystic Ramakrishna, possessed by the Mother and all the gods, the dynamic Vivekananda who welcomed the Chicago congress of World Religions. Vivekananda was no stranger to Christianity, he had transcended it.

Finally, the cycle begun by Ram Mohan Roy was completed by the beginning of the 20th century. To quote Panikar :

> "Strange as it may seem, the fact is that the Hindu political leaders of the early 20th century were firmly convinced of the superiority and orthodoxy of their own beliefs and showed no more than a tolerant and gently benevolent interest in the Christian doctrine".

The challenge met by Hindu thinkers is not only that of religion - namely religion represented by Christian missionaries, to which I shall refer later - it is the challenge of Western political and social values. We have

seen how these values were accepted, then assimilated and at last integrated as a part of Indian tradition, to the extent that reform appeared to be a repetition of the past, a return to one of the many possibilities recognised long ago by the Indian sages. Integration of these values not only gave rise to neo-Hinduism, it led to the creation of a politico-religious movement that we shall, in the absence of anything more appropriate, call Indian nationalism, and to the final eviction of the British.

Before these events took place however, there was to be a wave of political protest, but of moderate tone. In Bombay and Poona, the Prarthana Samaj was marked by the practical approach of the Maraths, and still concerned essentially with moral reform. The arrival of the militant Tilak ousted Gokhale from his position as leader of the public society of Poona.

Tilak, an ideologist as Dayananda was, cleverly and in a most radical and violent way set the Hindus not only against the British, but also against the Muslims (he created societies dedicated to "the protection of the cow"). His activism, in contrast to the more traditional passivism, was a sign of complete conversion to the

Western way of action, which he turned against the West. It has been claimed that he attempted to use Hindu passions towards a nationalist goal, but in fact he combines and confuses nation and religious community and, even if one considers this to be necessary, one at least has to admit that a form of nationalism created in this way is not free of religious content.

Yet another example indicates that it probably could not be without religious content. The author and political writer Bankim Chandra Chatterjee, influenced by sociological works, in particular those of Auguste Comte, undertook the daunting task of creating a form of nationalism. He knew the necessary sociological formula, and he knew well enough what this corresponded to in India, or rather in traditionally-minded Bengal. He was in the best tradition of the Bengali intelligentsia, combining lofty ideals with fiery patriotism. The hero of one of his novels, having conquered the Muslims, was given the mysterious advice not to oppose the British as they were indispensable in bringing about the country's maturity. Bankim wrote the hymn Bande Mataram, Hail to the Mother, which has been used for a long time as a National Anthem; it is here that, with

remarkable talent, he achieved the transition from religion to patriotism, from Goddess to national emblem. But what was this nation at the outcome of Bankim's efforts? It was Bengal, for he was unable to raise his sights beyond the province; and, unfortunately, it was Hindu Bengal, for by this time the Muslims had been ousted. Who could succeed where Bankim had, ultimately, failed?

If as regards religion the movement was over, the circle completed with Vivekananda whose form of rejuvenated Hinduism had shown a fine self-confidence, the political branch of the movement ended, not with Tilak, but with Gandhi. Gandhi was able, whilst remaining radically opposed to foreign influence, to return to Indian tradition both in his person (by becoming a sort of ascetic) and his deliberately non-violent action, thereby ensuring his popularity with the masses. He was, as Vivekananda had been, convinced of the superiority of his views. Mentally, India was already independent.

Assuming this example is typical of Indian culture, I have applied the resulting pattern to the understanding of some very important if less well known historical

developments. I refer to the reconquest of India by Hinduism at the expense of the Buddhist and Jainist "heresies" (themselves indigenous faiths, but seen as awesome, alien and therefore heretical by the Hindus). The reciprocal process, India's impact on the West, although less pervasive and less radical, is no less characteristic, and I am able to conclude that "both India and the West have borrowed from one another strictly that which would not prevent them from retaining their identity. The difference lies in that India absorbed everything within an unaltered framework, whereas the West was adding to a movement, sure of its principles but devoid of any permanent structure". (2)

My last example, though still on the ideological level and more particularly pertaining to social philosophy, concerns modern Western culture. Here we find national sub-cultures communicating with one another less easily and less immediately than common sense would lead us to suppose; particularly French common sense which, basically, refuses to acknowledge these sub-cultures. Modern culture, in fact, calls for a deep sense of universality which causes it to consign such diversities as it meets into another domain : we talk of "national character", and every European country has created its own stereotypes of

its neighbours. So, denied recognition by an explicit or implicit universalism, the national sub-cultures are much more opaque to one another than one might suppose. The Franco-German relationship is a case in point : the difficulties and misunderstandings that mark the 19th and 20th centuries are not only the results of the confrontation of two national states of unequal age, as witnessed by the dispute between historians over Alsace-Lorraine in the years following 1870, or the heart-searching reconsideration that several French-Germanist philosophers had to undertake around 1914. Henry Heine and Ernst Troeltsch saw, the former as an heir to the Romantic era, the latter as an historian and sociologist witness to World War I, the distance between the two mentalities, and the difficulty of communication between them. On the basis of an objective study of modern ideology, which avoids identification either unconsciously or implicitly with one of its national variants, I am attempting to consider the two sub-cultures as equivalent variants of modern ideology(3).

Let us consider a major aspect of the historical interaction between these two sub-cultures. From the 18th century onwards, and more especially from the Sturm und Drang movement or German pre-romantic era, particularly during the French Revolution and Napoleonic Empire,

German culture underwent an unprecedented development in the intellectual sphere. In particular, this took the form of emancipation from French cultural supremacy and created the essence of modern German ideology. There is no need to emphasise the importance of this movement and of its achievements for modern ideology as a whole. To present it in this way must, however, give rise to some measure of dissent. It will be argued that all great philosophies are universal and have nothing to do with national ideologies, and even admitting that German thought was stimulated by the French and English Enlightenment and the French Revolution, one would hesitate to see in it a result of the interaction of national cultures, with the French Revolution as a part of the common heritage of modern culture. However, these objections must be overruled where the suggested approach correlates known facts better than do the usual interpretations.

Due to the brevity of this paper, I shall limit myself to two precise applications of the suggested approach which, taken together will clarify the same theme, namely that of the nation and of nationalism. This theme is the basis of both Herder's and Fichte's thought.

In 1774, at the dawning of the Sturm und Drang movement, or German pre-romanticism, Herder, who was then

30 years of age, published "Another Philosophy of History" (Auch eine Philosophie der Geschichte). The title of this work heralds it as a rejoinder to Voltaire, the philosophy of history it contains is complex, and its relatively short volume (110 pages of the complete works) is in fact primarily an impassioned polemic against the Enlightenment, its dull rationalism, its narrow-minded idea of progress, and more particularly against the hegemony of the type of universal rationalism which despises all that is foreign to it and has the presumption to impose everywhere its senile refinement. Herder rehabilitates everything the Anglo-French 18th century rejects or ignores, the supposed cruelty of the Middle-Ages, Egypt sacrificed to Greece, religion. Rather than making history consist in the advent of a disincarnate and constantly identical form of Reason, Herder sees in it the interplay of contrasting cultural individualities, each one of which constitutes a specific community, or people (Volk); in each of these communities, humanity expresses a unique aspect of itself - the German people, bearers of Western Christian culture, being the modern example. In the flow of history, there is not only a form of progress (Fortschritt) but, within the main cycles of civilisation, ancient and modern, there is what one might call a succession of flourishing eras

(Fortgang, Fortstreben), all of "equal necessity, equal originality, equal merit and equal fortune"[4].

To sum up, Herder passionately maintained, in 1774 and in the face of the then dominant universalism, the diversity of cultures; these he in turn glorifies, without however overlooking the borrowed elements - a process which always entails a profund transformation of the borrowed element itself[5] - nor, even though he does not dwell on it, the fact that each point of excellence is compensated by a deficiency, and each cultural perfection either unilateral or incomplete. One could say that Herder, anticipating the future Human Rights, was pressing for cultural or national rights. This supposes a profound transformation in the concept of humanity: instead of an abstract individual, representative of the human species, possessed of reason but devoid of any inherent particularities, man according to Herder is what he is, in all his ways of being, of thought and action, by virtue of his belonging to a distinct cultural community. Here as elsewhere in his work, Herder is not entirely novel. One has only to think of Rousseau, who disagreed with the Encyclopaedists precisely over this point, as a "citizen of Geneva" who fully recognised the social nature of man, that is to say his belonging to a tangible society being a necessary

condition of humanisation[6].

Here, we are contemplating two essentially different ways of considering man : either we consider there is a fundamental value in the individual, and it is in this sense that we can discuss the individualism of Voltaire, and the Encyclopaedists, or else we consider this value to be within society, or culture, in the collective being, and I shall mention in this context the holism that appears in Rousseau's and Herder's work. If the advent of individualism distinguishes modern cultures from all others, and certainly from the other great civilisations, as I think it does, we have in the resurgence of a holistic aspect of modern civilisation a fact of considerable historical importance. In traditional holism, humanity is mistaken for the society of us, and foreigners are devalued as, at best, imperfect examples of mankind - and moreover all patriotism, even modern is coloured by this sentiment. By contrast, Herder considers all cultures to be of equal status. Clearly, this attitude is only possible because the cultures in question are seen in terms of as many individuals, equal despite their differences : cultures are collective individuals. In other words, Herder transfers the individualism he has succeeded in transcending holistically from a primary level to that of previously unrecognised or

subordinate collective entities. Herder therefore not only rejects the (principally French) universalist culture, he also accepts a major characteristic of it in order to assert the Germanic culture, together with all the other cultures which have flourished in the course of history. On the global level, Herder's reaction takes place from within the system of modern values. His holism is well and truly based within the individualism he attacks, which may be the reason for the sometimes forced, grating, almost breathless style of Auch. Later, in the more serene environment of Weimar, he attempts in his Ideen to reconcile universality and concretism with the notion, which he has lost hope of defining, of Humanität. This is, back in 1774, a case of what is now known as acculturation. We can rigorously state that Herder posits a German sub-culture as distinct from a French one within modern culture as a whole. We are also at the source of what is known as the ethnic theory of nationality as opposed to the so-called elective theory, of French origin, in which the existence of the nation depends on a consensus, Renan's "daily plebiscite". However, we have just seen that the ethnic theory is not, in its ideological basis, independent of the other, but is the result of a transfer of the same principle from the level of individual man

to that of collectivities. This is an essential point.

I have drawn attention to the combination, in Herder's work, of individualistic and holistic elements, or to be more precise I have seen the holistic component subordinated to the individualistic component - though this is barely noticeable and almost surreptitious. One would prefer to see this combination differently, but in layout it is just as I have described it, and many other traits point to its being so ordered; and, on reflection, it must be so ordererd for Herder's thought to fit within modern culture. On the global level, the holistic tendency is limited by, contained, or as I used to say encompassed in an individualism that is itself drained of its substance on the secondary levels : each people is taken as a whole, and is not split into individual beings. Naturally, one could question the strength of this hierarchical synthesis when put to use, and it is a fact that Herder's German successors have hierarchised cultures or nations more often than they have equated them. This may well be a general trait of German syntheses, which tend to be both bold and fragile. History has rarely proved the point of the philosophers who believed they had reconciled liberty and totalitarianism.

In view of what remains to be said, I shall not attempt a precise definition of hierarchy based on the example that we have just considered. This was an example

of encompassment of an opposite. To my mind, such is the principle of hierarchy, which we commonly tend to equate with power, and which we would do well to distinguish absolutely from this notion. There is no better example to paint than that of the creation of Eve from Adam's rib, in the first book of Genesis. God created Adam first, or mankind as undifferentiated, prototype of the human species. Then, in a second stage, he extracted so to speak a being of different sex from this undifferentiated creature. We have Adam and Eve face to face, this time as male and female of the human species. In the course of this strange operation, Adam's identity has changed; meanwhile, a creature has come into being that is both a member of the human species and yet different from the main representative of the species. Adam, or in our language man, is two things at once : he represents the human species and he is the male prototype of the species. On a primary level, man and woman are identical, on a second level woman is the opposite of man. These two relationships taken together are characteristic of the hierarchical relationship, which could not be better symbolised than by the material encompassment of the future Eve in the body of the First Adam. This hierarchical relationship is broadly speaking that between a whole (or a group), and

an element of the whole (or group) : the element is a part of the whole, and is in this sense consubstantial or identical to the whole, whilst at the same time being distinct or opposed to it. There is no other way of expressing this relationship in logical terms, other than by juxtaposition of these two propositions on two different levels, whilst taken together they are contradictory. This is what I mean by "encompassment of the opposite". This logical difficulty, together with the egalitarian inspiration of our civilisation, accounts for the poor view we take of hierarchical relationships. One could even say that we spend our time avoiding them, and finding inconspicuous outlets for them. It is an easy matter, however, to discover them where one would least expect to find them(7).

I shall not systematically seek out the hierarchical traits in Herder's first philosophy of history. I shall merely draw attention to the fact that, implicitly at least, they are to be found in each period of history, to the extent that a particular people play the leading part in it, and represent for some time humanity as a whole, leaving other cultures in the background. Thus in the ancient world, the Oriental, the Egyptian and Phoenician, the Greek and finally the Roman cultures in turn held a universal value in that they represented a lifetime of

Ancient humanity, from infancy to old age. This identification of a particular people with humanity as a whole, for a given era, is common amongst the German thinkers following Herder, and we shall encounter its modern equivalent in Fichte's work.

Before leaving Herder, let me remind you that we have explored but a single aspect of one of his works, although in truth one that is fundamental not only to Herder himself but also to his posterity. Herder had a profound influence in this respect - as was natural - on the acculturation and nationalism of peoples who were to be exposed in turn to the full impact of modern values, in particular the slavonic populations of Central and Eastern Europe. In Germany, Herder's influence provided the impetus for one of the major branches of romanticism and, to a lesser extent, for German idealism. Using Fichte as my example, I shall now briefly explore an aspect of this idealism.

Even nowadays, Fichte's social and political philosophy presents certain problems. Fichte tried to be the philosopher of the French Revolution, and yet in Germany he has often been considered, notably by the historian Meinecke, as a precursor of pangermanism or of the theory that links the state with the people's drive towards collective power. Martial Guéroult, a French interpreter of his philosophy, took great pains to show that Fichte remained perfectly loyal to the Revolution and that any other affinities in his work were of minor importance : for example, his thoroughly German method of thought and action, his "German messianism", together with the various misinterpretations and falsifications it has attracted(8). I should like to point out that the difference between the two sub-cultures, the French and the German, clarifies both Fichte's social philosophy and its subsequent destiny. I should particularly like to draw attention, in the egalitarian Fichte's work, to a truly hierarchical way of thinking, of which it would be difficult to find an equivalent amongst the French Revolutionaries.

The crux of the problem is to be found in Discourses to the German Nation, a series of lectures given in occupied Berlin after the Iéna disaster at the hands of

Napoleon. A reconciliation of the differing if not contradictory appreciations of M. Guéroult (loyalty to the Revolutionary ideal) and Meinecke (but one step towards the more or less pangermanist concept of State), can form the basis of our analysis : there is a universalist component in Fichte's work, and we can even admit, along with M. Guéroult, that it is the essential or encompassing feature of the Discourses, if not that of the whole of Fichte's social philosophy. The problem, now, is that of discovering what Fichte added to this universalism, or what he combined it with so as eventually to reach the exaltation of the German Nation (which did not yet exist as such).

Fichte, like Kant and even Hegel, belongs to the universalist, as opposed to the Herderian tradition, which one could call historicist or monadic, exalting the specificity of each people or culture. Meinecke may well condemn his ultimatae exaltation of the "nation of reason" rather than the concrete nation as the determination of a particular way of life. Let us bear in mind that universalism, or cosmopolitism, does not preclude patriotism. This we have seen in the case of the French in '93, and it is quite understandable : as an individual representing the human species, I live in a particular society or nation, and

I spontaneously and empirically refer to this restricted circle as being representative of the entire human species; I can therefore be attached to my country without explicitly justifying my attachment by these characteristics which differentiate my nation from others. But there is something else in Fichte's writings, there is essentially the proposition that "universality is a characteristic of the German mentality", and this proposition is profoundly ambiguous. Xavier Léon has shown that in texts of this period, and in the Discourses in particular, Fichte correlates his theses with those of Romantics such as August Wilhelm Schlegel and Schelling, and that although he does not adopt all their views, he adopts some of them. Here in particular, Fichte echoes Schlegel in saying that the German people are destined to dominate the world, but one must understand that he profoundly modifies the meaning of this statement, by basing it on the coincidence of universality and germanity, an idea which is to be found earlier in his Patriotic Dialogues[9]. He is essentially concerned with the development of humanity. Fichte is ambiguous in that, when he insists upon the regenerative vocation of the German people, and therefore on the precedence due to Germany, we do not know whether we are dealing with a form of unilateral universalism

applied to a particular population - in other words a hypertrophy of patriotism, or with the hegemonic affirmation of a mode of existence for which universalism is but a justification. In order to reinstate Fichte's thought, I think one has to conclude that one is in the presence of neither one nor the other, but that, for Fichte himself, there was a quasi-miraculous coincidence of the two aspects.

We have already said that Fichte is on the whole a long way from the Herderian notion, which was to be taken up by the Romantics, of the diverse characteristics of peoples as being a manifestation of the Universal in all its richness. He does mention this notion in a passage of the 13th Discourse, but it is used in a clever argument directed against the romantic dream of a new Germano-Christian Empire. In general, even if it is true that Fichte at this time re-used the current stereotypes of the excellence of the German mentality, the German language, etc..., it was principally to assert a hierarchy of peoples in terms of the universalist values themselves. And we can show precisely that there is in Fichte's thought, independently from any elements borrowed from the Romantics, both a strong universalistic and individualistic accent (both occuring coincidentally) - a holistic

and more especially a hierarchical component. I shall mention only briefly the holism, which is much in evidence in the authoritarian socialism of the "commercially closed state", and which one could also find in passages from other texts in uncomfortable proximity to individualism - however, this is ultimately a common feature of modern thought, even among sociologists[10]. The emergence of a form of hierarchical thought is more noteworthy, in clear contrast to the Enlightenment and French revolutionary thought, throughout Fichte's work.

This is all the more remarkable as Fichte is fiercly egalitarian on the political level, in contrast to Kant and the majority of Germans, and similarly to Herder (and Rousseau), and again in perfect harmony with the French Revolution in its Jacobin phase. It is surprising to find a perfectly formalised example of hierarchy precisely in the work that the young Fichte wrote, in 1793 in defense of the French Revolution : the Contributions towards the Rectification of Public Judgment... we find only one diagrammatic figure in this work. It is designed to show the state as necessarily subordinate to the individual. It shows 4 concentric circles of which the largest encompasses or "embraces" the second, and so on: individualism in its moral form, or "realm of conscience", embraces the

realm of natural right, which in turn embraces that of contracts in general, which again embraces that of civil contract, therefore of the state[11]. Thus we have here, thrice repeated, precisely the pattern of encompassment by means of which I have defined hierarchy, occuring precisely in a work dedicated to the defence of the French Revolution. There is certainly no clash between the content of the book and this diagram of encompassment, for we are speaking in terms of pure hierarchy, which has nothing to do with political power. Nevertheless, is it not paradoxical that egalitarian individualism should resort to a hierarchical form of thought? It would indeed be difficult to find anything comparable in France at this time; and it does appear that Fichte was already combining egalitarianism - thus enabling him to be in harmony with the Revolution - and a very different intellectual approach which, however refined, if it is compared to the holistic concept of the "commercially closed state" indirectly invites a more general acceptation in Germany of social hierarchies.

"The Commercially Closed State" (1800) contains an equally obvious expression of hierarchy, but of a different order. In this work, the alimentary and other needs of different social categories are carefully distinguished. In the interest of what we would call his

working efficiency, the intellectual requires rich food and a refined environment, whereas, at the other end of the social scale, the peasant's condition enables him to assimilate coarse food, which is sufficient for his needs. This form of hierarchical thought is interesting by contrast to the egalitarian basis of the work, and especially to the French Dirigist Movement, to which Fichte's preoccupation links the book[12].

However, these are still but local, if not anecdotal manifestations of the hierarchical spirit. Far more striking is the presence of hierarchical opposition at the very heart of Fichte's philosophy, in the dialectical argument of Ego and Non-Ego which constitutes the basis of the Doctrine of Science (1794), a "transcendental dialectic" according to M. Philonenko,[13] which establishes the conditions of all knowledge. It is the Ego that posits the Non-Ego. As in the case of Adam and Eve, there are two levels : on the first level, the Ego is undifferentiated, it is the absolute Ego; on the second level, the Ego gives rise within itself to the Non-Ego, incidentally establishing its position as an opposite to the Non-Ego; thus the Ego is brought face to face with the Non-Ego. The Non-Ego is therefore on the one hand contained within the Ego, and on the other, its opposite. This strictly

hierarchical pattern of Fichte's dialectical argument is remarkable from many points of view, notably in that it allows Kant's theoretical and practical Reason to be integrated into a whole, and by comparison to Hegel's dialectic which is no longer hierarchical. And yet! Hegel's basic formulations are very similar in form to Fichte's basic theory : life as "connection of the connection and the non-connection" (from Frankfurt), "identity of the identity and the non-identity" (from Iéna)[14], the infinite as union of the infinite and the **finite** (in Logic). But we perceive through this that Hegel's efforts, or a good proportion of his efforts, were used in the attempt to eliminate the hierarchical aspect, and that his dialectic may owe some of its complexity to this trait. Thus he says not only that the infinite contains the finite, but also that the finite contains the infinite, though obviously not in the same sense. Hegel tried desperately to overcome the dissymmetry of these formulae, and to place the two terms on an equal footing. In this sense, we could say that the process of acculturation is more complete, more thorough in his case than in that of Fichte, that the egalitarian content of Hegel's work is more ambitious, more encompassing. Hegel goes further, in a way, in his loyalty to the French Revolution. May I

add, to close this brief discussion of Hegel, that the notion of hierarchy nevertheless does reappear in his work, and it does so in two ways : explicitly, at the ultimate level of Absolute Intellect[15], and implicitly - if not ashamedly - on less exalted levels, as for example on the level of social philosophy, for it is clear that Hegel's State (holistic) in fact encompasses in our sense of the word, his civil society (individualistic).

But let us return to Fichte. We have seen that, from the Contributions written in 1793, to the Discourses written in 1807-8, via the transcendental centre of the Doctrine of Science, Fichte's work contains a hierarchical component. This discovery enables us to answer the question invited by the Discourses : what, apart from any more or less anecdotal "borrowing" from the Romantics, Fichte adds to the individualistic universalism of the Revolution, is precisely this meaning of the term hierarchy : there is nothing surprising in that, for him, a particular people as opposed to others, in the same way that the Ego is opposed to the Non-Ego, should embody at a given time the whole of humanity, in other words the Human Ego as a whole. It is in this sense that he is able to link up with the main stream of German thought, in particular with the Romantics.

In this way, Fichte helps us to understand a dimension of pangermanism that might otherwise have been overlooked. The German people as a whole in the 19th - and even in the 20th - century has been inclined to obedience, and has acknowledged the need for subordination within society (Kant : "Man is an animal who - in society... needs a master"). In presence of a plurality of nations, it seemed only natural to Germans generally that some nations should dominate others. In the work of egalitarian thinkers - determined, if exceptional among Germans - such as Herder and Fichte, who abhor the domination of man by man, only the notion of hierarchy subsists, as distinct from that of power to which it ordinarily adheres. In the work of the historicists, as opposed to Fichte, each era of history is identified with a concrete culture, and humanity only completely realises its potential throughout the entire course of history.

At the end of this brief analysis, we see how it is insufficient to consider Fichte either as a loyal partisan of the French Revolution, whose work presents certain secondary German characteristics, or as a precursor of the theory of the "will to live and dominate" of the German nation which would have suffered from adulteration by the abstract universalism of the French. He "translated" the French Revolution into German. As a determined Egalitarian,

not recognising subordination as having any social basis, he still adhered to an extremely strong form of hierarchical thought which he was able to translate into philosophical form. As Herder did before him, he applied modern individualism at the collective level, consigning the people, or the nation, into an individual of superior order, and, again as Herder had done, he saw humanity in the modern era essentially embodied in the German people or German nation. In order to understand this last belief more clearly, which nowadays doubtless appears obscure or aberrant, we must return briefly to the German process of acculturation, which we have ultimately characterised by a combination of traditional holism and modern individualism, and to the national ideology.

In a comparative perspective, emphasising ideology, the nation - in Western Europe in the 19th century - is the modern socio-political group corresponding to individual ideology[16]. On the one hand it is a collection of individuals, on the other an individual on the collective level, face to face with other nation-individuals. We can predict, and the comparison of the French and German sub-cultures confirms, that these two aspects are not readily combined.

If we consider the two predominant national ideologies, we can characterise them as follows. On the

French side, I am human by nature and French by accident. As is generally accepted in the philosophy of the Enlightenment, the nation as such has no ontological statute : on this level, there is nothing, only a vacuum between the individual and the species, and the nation is simply the most comprehensive empirical approximation of humanity that is available to me on the level of everyday life. This is no arbitrary hypothesis, as the main developments on the French political scene, and the evolution of public opinion in France around the two World Wars, shows. This is saying that the concept of the nation as a collective individual, and in particular the recognition of other nations as different in their own right from the French nation, is virtually absent from the global ideology. The same is true of inter-national antagonisms : French liberalism seems to have thought, as the French Revolutionaries did before it, that the constitution of peoples, and particularly European peoples, into nations would be sufficient to overcome all problems and to bring about peace : ultimately, French liberalism considers the nation to be merely the background for individual emancipation, which is the be-all and end-all of political problems.

If we consider German ideology from the stand - point of some well-known writers, there is no reason to

think that their position differs from that of ordinary people. Here, I am essentially a German, and thanks to my being German I am human : man is immediately recognised as a social being. Subordination is generally recognised as normal and necessary within society. The desire for individual emancipation is less strongly felt than the desire for a common framework of reference. Thus the primary aspect of the nation as a collection of individuals finds little support. On the other hand, the second aspect - the nation as a collective individual - is strongly represented; whereas the French were content to juxtapose nations as "fragments of humanity", the Germans, recognising the individuality of each nation were concerned with the precedence to be given to nations within humanity according to their merit or impact. We may notice that the old ethnocentrism or sociocentrism that tends to exalt us, and despise them, survives here and there in the modern era, but in different guises : the Germans were posing, and trying to impose themselves, as superior in their quality of German-ness, whereas the French only consciously postulated the superiority of the universal culture, to which they naïvely identified themselves - to the point of seeing themselves as tutors of the human species[17].

Ultimately, both universalism and pangermanism fulfill a similar purpose, despite the different values that these expressions imply. Both convey the aporia of the nation which is at the same time a collection of individuals and a collective individual; both convey, in fact, the difficulty faced by modern ideology in trying to give a sufficient account of social life (on the intra- or inter-social level). The difference resides in that the French ideology manages, with great difficulty, to remain unadulterated by any compromise with reality, whereas the German ideology has, due to the process of acculturation which gave rise to it, amalgamated a greater quantity of traditional elements with the modern ones, and therefore runs the risk of serious distortion when this amalgamation is taken for a genuine synthesis.

What are we to conclude from this? Personally, I conclude that,provided modern civilisation is considered in a comparative perspective, it is possible to overcome the particular sociocentrism pertaining to each of its national sub-cultures and, recognising as Herder does their equality, to see through their differences and to lay the foundations of a system of transformation that would allow free cross-cultural movement. However, a step of this sort is so far removed from the dominant trends of our social sciences, and the procedure would necessarily be so

delicate and hazardous, that an attempt to achieve this seems for the moment to be as improbable as it is unlikely to lead to a new form of specialised activity.

It is my hope that this brief analysis will help some to appreciate the extent to which cultures, whilst having "doors" and "windows", possess their own laws of existence, just as Leibniz's monads did; and that these laws direct a culture's very own way of communicating with others, or rather its means of adapting itself to, and gaining nourishment from others, as noted by Herder. We might well wonder why we are still reduced to these, and other such approximations or metaphors. The reason for our lack of progress in this field is I think to be found primarily in our predominant concerns, our preconceived ideas and prejudices. In the first instance, we have seen from my three examples that a global and comparative consideration of cultures and ideologies is absolutely necessary for the progression of knowledge in this area, and there is little need to remind us that this is not one of the major concerns of the social sciences. Secondly, assuming that this absolute necessity is recognised, we are immediately faced with another imperative if we are to elaborate a differential theory of adoption, in its simplest or most difficult, most indifferent or most

revolutionary form; this imperative is, in the culture concerned, the distinction of levels of relative importance, from the most valuable to the most insignificant, the most encompassing to the most specific. In other words, culture should be seen not simply as an inventory of national characteristics, nor as a collection of completely inter-dependent organs, but rather as a hierarchy of meanings. However, present day ideology, which weighs heavily on our analyses, obviously fails to encourage a view of this nature.

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CHAPTER II

SECOND WORKING SESSION: "THE DEVELOPMENT OF COMMUNICATION"

The second Working Session of the Paris Symposium was devoted to "The Development of Communication", a subject vast enough to occupy a series of symposia and still remain barely broached. The papers and discussions were therefore necessarily devoted to a few specific aspects, most having strong and close links with computers and computer programming; and the casual observer might have been forgiven for wondering how the world had survived, and had even developed a civilisation (of sorts) during the thousands of years before the advent of these now ubiquitous benefits of esoteric thought and high technology.

The Session at least began with its feet on the ground, when Professor Murray Eden, of the US Department of Health, Education and Welfare, presented a review of the "Consequences of Technology for Communication"[+]. These consequences had in the past mainly related to information transmission, rather than to its transformation or use after receipt by man or machine; and Professor Eden noted the persistent universality and still unrivalled versatility of the written word, particularly in printed books. Books could be read at any desired rate, chapters and pages in any order the reader chose; reading could be in periods of any

[+] For the full text of Professor Eden's paper, see page 129.

duration, with omission of some sections and repeats of others as desired; reading could be indulged in virtually everywhere, with negligible environmental effects (particularly no noise); and when a book had been read it could be easily stored, preserved, used for a multitude of non-literary purposes - even firelighting - or simply and quickly disposed of. And above all, books were comparatively cheap, therefore widely accessible and, to some people at least, they were things of beauty. Although books had generally survived the rivalries of electronic communication - and even profited in areas such as library operation, micro-page recording, and invaluable current developments such as print-to-speech conversion for the benefit of blind people - there was no denying the challenges of radio and television, and Professor Eden remarked that the streets of American cities nowadays are deserted in the evening because so many are watching TV[+]. Nor could it be denied that information transformation after receipt was now a growing field for electronics, a field where miniaturisation and microcircuitry had revolutionised so much of our lives. On the physiological and pyschological planes, Professor Eden drew attention to relationships between the needs, priorities and goals of an information sender and of the receiver of that information - which might be similar, complementary or even antagonistic. "Intention on the part of the participants in communication " he said "plays a critical role in shaping both the directions which the technology has taken and the evolution of their social impacts".

[+] This effect had been both unforeseen and unintentional: another unforeseen but (according to Professor Eden) hardly unintended effect was the "selling" of election candidates over the media by the same techniques as used to sell toothpaste. This was a highly lucrative market for marketing technology.

The paper offered a vast amount of extremely interesting information, not the least being a reminder that many of the great inventions in electronic communications - the telephone, radio, TV itself and others - had come from "backroom amateurs". Professor Eden thought there was a good chance that this flowering of individual intellect would continue even in the much more scientifically-advanced world of tomorrow: it would certainly be encouraged by the fact that basic components - even for quite complex and powerful computer systems - could be bought on the retail market for prices within the reach of most "ordinary" citizens.

The Professor concluded his talk with two fascinating accounts ("case studies") of recent developments in the United States. The first concerned the phenomenon known as CB (Citizens' Band) Radio, which has now manifest itself through the installation of nearly 14 million low-power VHF (27 Mc/s[+]) transceivers mostly in private motor cars. The "big business" aspect of this aside, the really intriguing part-consequence/part-cause is the widespread use of these devices for citizens to establish anonymous radio relationships - talking together of matters which they would never mention within their own circle of recognised friends and relations. Here, surely, is the proof that man today needs a confessor no less than in the past.

[+] The Editor has no objection to calling this frequency 27 megahertz, but is unattracted by the naming of audio frequencies (or the frequencies of electric power supply mains) in this manner. Cycles per second, however, are universally applicable.

The second case study concerned the introduction of the "Universal Products Code" for the labelling of supermarket sales items in such a way that electronic scanning at the check-out desk provided not only the customer's account but also much additional information notably for continuous "on-line" stock control, ordering of new supplies, etc. Perhaps the most interesting feature of this study was that, when a final choice of system had to be made from a number developed in response to a "competition" among manufacturers, the choice was not based directly on technical features or a technical evaluation, but on the similarity of the system with one earlier suggested by a well-known and well-trusted corporation in the electronic data-processing field, namely IBM. It seemed clear that this corporation's reputation was of over-riding importance among supermarket owners knowing "nothing about laser scanners, coding theory, or micro-computer architecture", but knowing full well the disastrous consequences of a technical breakdown at the check-out desks[+].

Going from the rather general to the highly particular, Professor Eden's paper was followed by a no less fascinating but very much more esoteric one entitled "Communication and Understanding: a comparative approach to language behaviour". The speaker was Professor R. Narasimhan, of the Tata Institute of Fundamental Research in Bombay (India), who gave an extremely detailed account of computer modelling techniques applied to the study of human behaviour dependent on language[++]. As noted by Pavlov, animals relate to their environment directly, via a complex "sensory-motor"

[+] Full details of this are given in Professor Eden's text on page 145 et seq.

[++] For full text see page 163.

system, while human beings make use of a "secondary signalling system" namely language, which profoundly affects apprehension and comprehension of a given situation, enabling - inter alia - experience to be stored for future reference. Language is acquired by example, by identifying sound patterns with certain situations and not, as traditionally supposed, through "internalised" grammatical systems. This is of fundamental importance when simulating situations from which to deduce behavioural patterns: if a computer is fed with incorrect assumptions or data as basic information, it cannot normally correct the error and so must deliver false conclusions.

Professor Narasimhan emphasised a matter which was not perhaps recognised by everyone in the Symposium, and which might even have been denied by some: namely that the electronic digital computer was "basically stupid", and derived any "intelligence" it might appear to possess from its creator, man. This was not to reject the concept of Artificial Intelligence, though it was a valuable reminder that - at least among some thinkers - the famous dictum of Descartes remained valid.

The first of the two afternoon Round Table discussions, under the title "Communication between Human Beings" had much relevance to Professor Narasimhan's paper. It was enlivened at the start by the projection of a teletape recording (incidentally noteworthy for the technical excellence of its production) showing the reactions of a 4-day old baby to sensory (mother's voice) and tactile (mother's touch) communication. This preceded a paper by the Round Table Chairman, Professor T. Ishii of Tokyo University, which

dealt with experiments on pattern recognition in living beings and attempts to model these on computers. Significant results had shown that babies were able to appreciate their mother's voice long before birth[+] - also that communication was "two-way", in that her baby's cry will stimulate a mother's secretion of milk. Understanding the mechanisms of these (clearly not unreasonable) phenomena, and those governing the baby's subsequent acquisition of its first fragments of language and language structure, are of great interest for the developers of computer simulation of language learning, right to the most sophisticated levels of (returning to Professor Narasimhan's paper) what is becoming known as Artificial Intelligence.

The genetic transmission of (genetic) information has now been examined and investigated by very many researchers, prominent among them being Professor Marcello Siniscalco of the Sloan Kettering Institute for Cancer Research in New York, who gave a brief discourse on communication within molecular biology (storage, replication, translation and transmission of genetic information) and its relationship with the ecological environment in which it must take place. Professor Siniscalco, who was already familiar to many DISCOVERIES participants[++], brought a welcome breath of "real" (i.e. non-modelled) science to the discussion, not to mention the welcome observation that "cultural communication" can be looked upon as the most sophisticated biological feature developed by Homo Sapiens (over and above societal instincts equivalent to those in other mammals) and that this feature is seen by many as the factor which will eventually

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[+] Some have maintained that this is true from the moment of conception.

[++] He and his colleague, Dr. Luzzatto, presented papers at the 1977 Rome Symposium dealing with the role of genes in the transmission of heredity and resistance to disease.

enable mankind to direct the course of his own evolution.

Professor S. Aida of the Tokyo University of Electro-Communications (and incidentally Secretary General of the Paris Symposium) noted the distinction between "internal" human communications (physically inside the body) and communication between the body and the environment. Assembling a valid model of the combined communication structure was a fascinating, important and difficult task, additionally complicated by the fact that traditional regional customs (he cited the American practice of telephoning daily between husband and wife to confirm continuing affection) could also affect the overall structure.

Next Professor Eduardo Caianiello (Salerno University and Vice-Chairman of the Paris meeting) reminded his colleagues that - as had been said many times already - communication was above all a matter of translation of information, and that without this there was in fact no communication. He was today, he said, after some 40 years of scientific activity, trying to "unlearn" much of the conditioning which his early training had given him, for he realised how much this conditioning could affect the way in which he would translate incoming information. As a simple (though certainly not trivial) illustration of the different interpretations which could be put on the same event, Professor Caianiello remarked how a geologist, once lost in the snows of Canada, had said to his Indian guides that he believed they were all lost. "Not so", came the reply, "we know very well that we are here: it is our tent that is lost".

Finally in this discussion, Professor Barrington Nevitt of Toronto University (also well-remembered from the 1977 Rome Symposium) took further forward the appreciation by babies before birth of their mother's voice, saying that a baby's first knowledge and mental formulation of his mother tongue (so correctly termed!) had also been shown to begin before birth[+]. Professor Nevitt saw the human learning process as comprising three simple factors: rhythm, rhyme, and reason ... which were acquired in the order given. He also insisted - as he had done at previous meetings - on the importance of distinguishing between concepts and percepts, and of recognising how much the former depended on the framework (cultural, intellectual, mathematical, etc.) in which they were conceived. All "learning models" were necessarily conceptual also, and he pleaded for more attention, in trying to understand communication between living beings, to percepts ... not only visual or audibly acquired percepts, but also those involving the important sense of touch. "We must", Professor Nevitt concluded, "understand what the communication process is doing to us, or we can never hope to control it."

The second Round Table discussion, under the title "Communications and the Media", was chaired by Professor J. Vidal Beneyto, President of the International Committee on Communications, Knowledge and Culture. Professor P. Tannenbaum (BBC London) introduced the subject by emphasising the importance of the media in entertainment and in providing escape from

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[+] This would seem to restrict those validly claiming to have several mother tongues to children of linguists.

everyday life to new or at least different horizons. He suggested that the supply of information to the public (news bulletins, educational programmes, etc.) although important should normally be subordinate to entertainment ... which in practice it usually was.

Professor Kurt Lang (Oxford University) spoke of the political uses of the media, insisting on their importance in the formation of public opinion. Information inevitably plays a considerable part in establishing modifying or qualifying our opinions, political or otherwise, and it is via the media (and usually the mass media) that we normally acquire this information.

Dr. A. Willener (of the Institute for the Sociology of Mass Communication in Lausanne, Switzerland) described various practical experiments with local television, which evidently must usually have greater relevance for the local population than could national networks. Experience to date in several countries (on both sides of the Atlantic) had shown that local TV was by no means as simple as it appeared at first sight: it was often difficult (and costly) to cater specially for local tastes; in industrial areas most viewers were most of the day at work and therefore not available either to produce programme material or even to watch the programmes; and both stage and transmitting equipment was expensive.

Professor Reikichi Shirane, of the Telecommunications Science Foundation in Tokyo, spoke of increasing interest in intercommunication between media and the people (i.e. feedback) to enable the needs of

particular sectors of the population to be, first of all, made known and then accommodated. He recognised that this was not normally possible for the true mass-media, but it was being adopted - with some success - by the "medium-media".

Finally, M. Mario Borillo, Research Director on "Informatique" of the French CNRS in Marseille, postulated some wider uses for computers in Mass Communication, and also in scientific communications over wide networks. Bringing the Round Table to a close in this way was a powerful, though perhaps unintentional, reminder of the fascination that "computerology" seems to have for so many people in so many contexts. It is of course undeniable that these machines can be - and are being already - of immense help in very many areas and undertakings, and it would have been impossible for DISCOVERIES to examine the subject of Communication without much attention being given to them. Nevertheless, neither the papers nor the Round Table discussions in this second session of the Symposium offered any real evidence that communication in human society is other than a fundamentally (some might say by definition) human affair. That is, although it can be and today usually is facilitated by a variety of electronic devices, it remains essentially a matter of human exchange, the non-human links in the exchange system being extensions of the human intellects involved[+].

[+] Although it is commonplace in modern technology to speak of "communication between machines", the communication in fact achieves human significance (significance for "human activity") only when it is finally interpreted in a human mind and expressed as consequent human action. Furthermore, until there has been such action, there is no tangible evidence that communication has been achieved.

Further confirmation of this came the following morning, when Professors Eden, Narasimhan, Ishii and Vidal Beneyto presented their own assessments of the second session. Although all seemed ready to accept that any human process, once defined in terms of a human concept, could probably be simulated by some more or less complex non-human machine, all seemed equally clear that no such machine could be constructed (or even envisaged) until the process to be simulated had been so defined.

Professor Ishii believed that human communication took place at several distinct levels, for which he suggested the following (somewhat arbitrary but nonetheless useful) categories :

- micro-biological
- cellular
- individual being
- population.

At the first levels were such elements as those of the genetic code, as well as exchanges between living cells and their environment, leading for example (as had been described by Professor Siniscalco) to modifications in red blood cells in malarial areas[+]. These exchanges, which Professor Ishii described as "pre-cultural", were a necessary part of the "ecological balance" but were of a fundamentally different nature to those of "true" human communication. It was this latter which should be the principal concern of the present meeting, as indeed seemed to

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[+] A more detailed account of this phenomenon was given by Professor Siniscalco's colleague Professor Lucio Luzzatto in the third Working Session of the previous DISCOVERIES Symposium in Rome (See Rome Proceedings, pages 178 - 183).

be the case from the papers and discussions so far.

Professor Vidal Beneyto, and his Round Table discussion, had certainly been concerned with this more sophisticated category, and had become deeply involved in considering the role of the media and of interchanges (feedbacks) between these and the populations they served. Although no definite conclusions had been reached, it was certainly established that the media could have enormous influence both in current communications (day to day events) and in creating or modifying the cultural backgrounds against which current communications could be seen.

A particular (and perhaps, in view of the level of the participation, remarkable) aspect of this discussion appeared to be a widespread acceptance that the media in general were vast monolithic structures in control of, rather than controlled by, the communities responsible for their creation. It was rare indeed (a happy exception was the intervention of Dr. Willener concerning experimental local television) to find recognition that the media themselves were no more nor less than the products of groups of people (broadcasters journalists, entertainers in many fields) and that these people were no less subject than their audiences to the effects of communication in the complex integrated and inter-related structures of society[+].

[+] The tendency for groups of people - or even populations as a whole - to dissociate themselves from the sorcerers' apprentices they have created is certainly not new, but seems to be increasingly found in attitudes to advanced technological developments... especially those of communication in general and "informatique" in particular.

It was in fact left to Professor Murray Eden to put "the media" (with all the mystique and associated reverence which some seemed anxious to attribute to them) squarely back in their place as particular, and sometimes very inefficient, channels for communication in human activity. Professor Eden furthermore warned against drawing too many general conclusions from specific experiences : he had formed the impression that the Symposium as a whole was seeking universals where universals might not exist. His own approach seemed very much nearer to the late Professor Herbert Dingle's "operational measurement", or to that of an earlier mathematician who wrote "when I use a word, it means just what I choose it to mean - neither more nor less".+

Professor Eden wondered whether the whole DISCOVERIES Symposium should not be regarded as an experiment in communication, and if so whether participants could make themselves sufficiently "detached" to analyse the experiment in a rational scientific manner. This might not immediately yield any universals, but at least it should produce some reliable facts... more of which were needed before a truly constructive discussion could take place.

Finally, Professor Narasimhan, referring to the teletape recording which had been shown the previous afternoon before the start of the Round Table discussions, stressed that the earliest communications between a mother and her unborn child would necessarily be mainly through what he called "body movement", and that the first

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+ C.L. Dodgson (Lewis Carroll) in "Alice Through The Looking-Glass".

communication by sounds would not be vocal in the sense of using a language. The Professor believed these very early phases merited intensive study, not only because they probably offered our best chances of understanding the birth of comprehension in the human mind, but also because such an understanding could lead to simulation of the early phases on a computer... perhaps so providing the machine with its own elementary "learning capacity".+

This was a timely reminder that "communication" embraced a great many forms of information exchange, and Professor Narasimhan also drew attention to the systems and methods which children who are deaf or blind (or both) quickly develop as substitutes for the more conventional sensory modalities of those without such handicaps.

This opened the way for a final observation (or, as Professor Vidal Beneyto remarked, a "wonderful lecture") from Professor Barrington Nevitt concerning the very many mechanisms of human communication. As in other fields there was a tendency for the obvious (speech, writing... "the media") to conceal the less obvious but nonetheless very important. Not only was there communication by many variants of Professor Narasimhan's "body movement", there was also communication (i.e. a transfer of information) in architecture or in design generally; in flower arrangement (so finely developed by the Japanese) or the

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+ And thus creating a form of "artificial intelligence" which even Descartes would probably not have questioned.

display of goods in a shop window; in visual patterns and in acoustic patterns (such as the many forms of music). But more than this "the message" communicated depended, as had already been noted[+], on its position or arrangement relative to other messages and "communication patterns", and in addition on the quantities or "densities" of such patterns competing for attention.

Professor Nevitt recalled that a computer analyst had remarked some years ago that "information overload" led to a different form of appreciation (process pattern recognition), which in turn encouraged the use of unusual communications techniques to give emphasis to a particular message. "This", he said, "is what some people have called poetic licence, what rhetoricians call hyperbole, and what symbolists or poets use to gain attention by shifting a figure of speech... or shifting the context to show the figure in a new light". Here was a very special human faculty in communication which, the Professor believed, was much further developed in eastern than in western cultures... probably due at least in part to what he had already described as a <u>perceptual</u> rather than <u>conceptual</u> approach[++]. "In a Japanese flower arrangement", concluded the Professor, "they arrange the space between the flowers, whereas we in the western world arrange the flowers in space."

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[+] For example by Professor Himmelstrand in the previous session.

[++] See, for example, page 121.

Text of paper by Professor Murray Eden

THE CONSEQUENCES OF TECHNOLOGY FOR COMMUNICATIONS

Although the title of this presentation is "The Consequences of Technology for Communication", the topic cannot be discussed without at the same time considering the consequences of communication for technology and the consequences of communications technology for society. We are concerned to study these interactions precisely because innovations in the technology of communications have had profound effects on the life of people and societies.

Technological achievements in the years since World War II have been phenomenal in terms of speed of transmission, in messages per channel, in error correction and in noise suppression. But, more important, the integration of computers into communications systems has not only affected information transmission itself, it has also made possible the transformation of information, a transcendently important innovation.

Consider some types of current commercial applications. Airline reservations for a particular flight may be made at literally thousands of stations worldwide, and confirmed with no more than a few seconds delay. Similar systems make theatre, concert, and sports reservations, verify charge

card accounts, and transfer money based on these transactions by telephone line or satellite. Abstracts of scientific papers are indexed automatically and weekly, monthly, or annual volumes of such indices are prepared for printing with no human intervention other than the original typing and a small amount of error correction. Newspapers prepare the text of classified advertisements for publication by a device which "reads" a page typewritten by an operator who takes the advertisement from the customer either directly or by telephone. This system will also recognise hand-made editorial corrections. Photographic quality pictures are transmitted over telephone lines at rates of about 10 minutes per picture and much more rapidly by communications satellite. The receiver may enlarge or diminish the picture; change the tone scale in an arbitrary way; sharpen or blur the picture or prepare a photomontage - all by means of computation; produce a photographic quality picture of the transformed image, and even prepare a half-tone etched plate ready for the printing presses.

There are other systems not yet in commerce or not very successful as articles of commerce. For example, one system will recognise and transform written texts in English into intelligible synthetic speech; recognisable though not beautiful. The only commercial exploitation thus far is

as an experimental reading machine for the blind. The text need not be printed in any special font, nor need the vocabulary be restricted. Other systems are designed to identify persons by recognising fingerprints, signatures, a few spoken words. A few special systems are used to identify people authorised to enter restricted areas: for example, programmers at the central management computer of a large firm.

A particular technology consciously developed to satisfy a particular kind of communications need may be expected to have the consequences envisaged if the technology is successful. Thus, Gutenberg was surely aware that book publishing would grow if his invention of movable type and the technology for handling it were successfully implemented. But a technological innovation may also have consequences unforeseen by the sponsors of the technology, and in many cases it will be put to use by others for purposes quite different from those for which the development was intended. For example, one may contrast several phenomena in the United States that followed the introduction of television. The fact that television quickly became the principal entertainment medium and that a TV set would be purchased for even the poorest home was, if not entirely foreseen, at least a consciously sought-after outcome for both the manufacturers and the broadcasters. This result was a technological

success from their point of view. The fact that American city streets are completely deserted in the evening because so many are watching TV was however unforeseen and unintentional; while the fact that nowadays American political candidates now sell themselves by the well-tested techniques used to sell toothpaste, automobiles, or beer on television was also unforeseen but hardly unintended, at least in terms of the needs of the politicians and the advertising experts who create television images for this purpose.

It seems to me that the best way to study the implications of technology for communication is as an evolutionary process in which the interactions of many players and many different purposes shape society's response to innovation and in turn are transformed by it. In this respect technology should be distinguished from science. The historian of science, Derek de Solla Price, contrasts their history+:

> "When new knowledge arises from old in rather orderly fashion and on a world scale, it is a sort of serial story of a set of episodes, perhaps growing like a much branching tree with new things arising from old. And most of the things in the story are scientific observations and discoveries, theories and hypotheses, interpretations, new questions arising from old ones, old questions being forgotten or disposed of casually, and occasionally disposed of by disproof.
>
> "What you do not get very much is the feeling that suddenly everybody wanted to do something. Society wished it and it came to pass. That simply does not happen very much.

+ Price, Derek de Solla: "The Relations between Science and Technology and their implications for Policy Information". Science and Technology Policies, Shasser & Simons, 1975, pp. 149-171.

> "The history of technology in general consists not of very branching trees but of linear chains with an occasional branch point. Most steam engine slide valves arise from the immediately preceding steam engine slide valve. Patents have a habit of running in strings. Improvements in the motorcar go from this model to that model and then the next and the next. There are not usually great branch points.
>
> "When you write the history of technology, it is very plain that most technology arises out of prior art. It does arise consciously, when you are trying to explain it, from new scientific advances that are made. When science is used ... then what emerges from an honest history of the technology of radio is an inventor like Marconi. He, it happens, could not solve an electromagnetic field equation to save his life. One does not even see experimental scientists working in laboratories, doing things in the way that we imagine electrical engineers do things. Instead, we see in the actual history of radio a bunch of backroom tinkerers. In fact, two of the most important technologies - radio and photography - went through a whole generation of development by exactly such tinkerers, who not only knew no science, but knew no technology either."

The communications technologist, one of the parties at interest in this evolutionary process, approaches his tasks within a framework of terms that appear to be free of social or ethical value judgments. It is customary to represent a communications system by a flow diagram similar to the one given in Figure 1. The commonplace flow diagram for a communications problem will be labelled by terms such as transmitter, receiver, encoder, decoder, channel, noise, signal, input message set, output message set. In general, the technological goals are easy to express in these terms

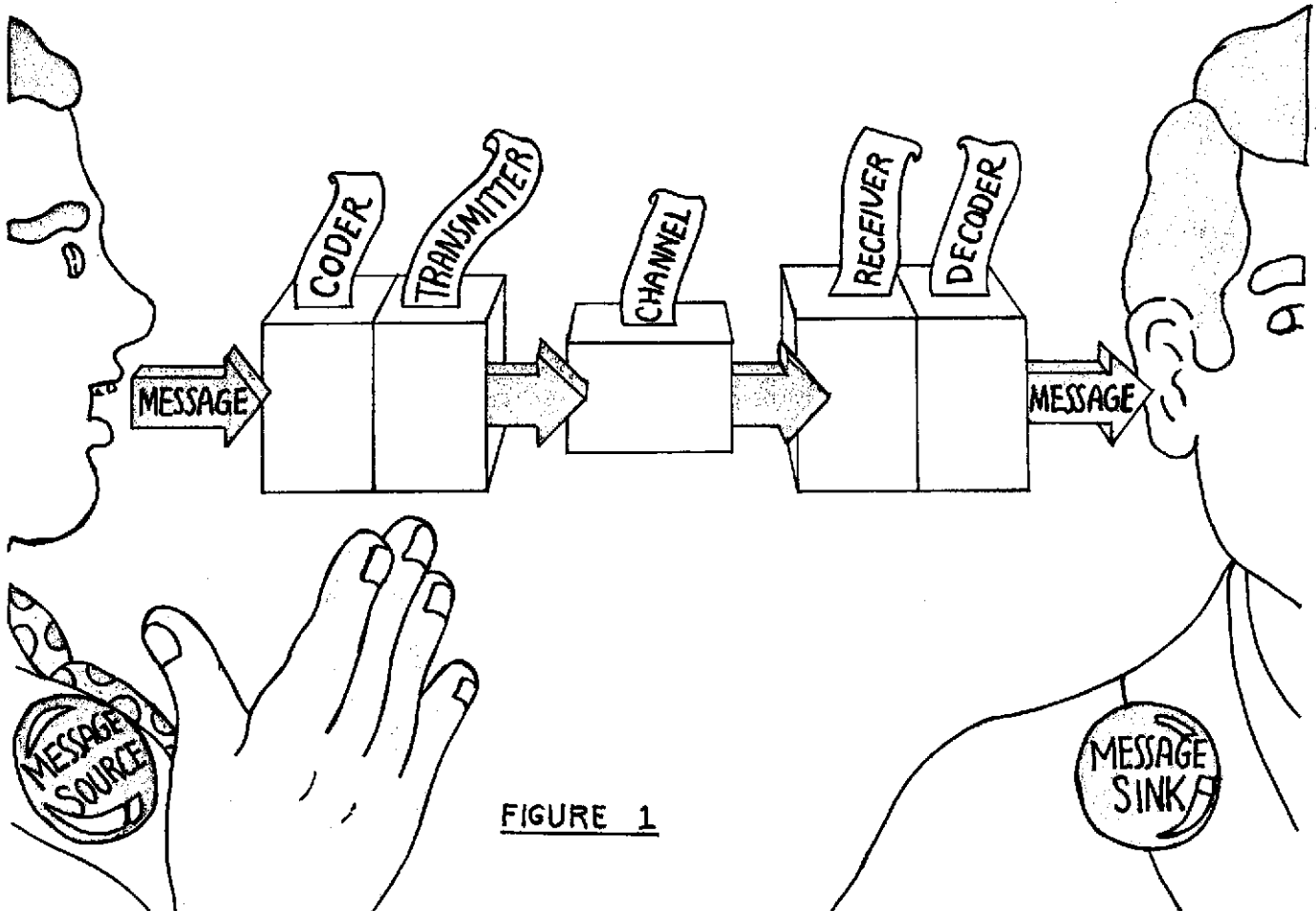

MESSAGE
CODER
TRANSMITTER
CHANNEL
RECEIVER
DECODER
MESSAGE
MESSAGE SOURCE
MESSAGE SINK

FIGURE 1

and are not intrinsically in opposition. In other words, one may wish to increase channel capacity, decrease error rate, enlarge storage capabilities or the size of the message set. The constraints are extrinsic; for example, given the physical limitations, power can be increased only at the expense of bandwidth. The quality of components and circuits is limited by cost, availability, the state of progress in semi-conductor technology, etc.

The framework given above for analysing communications systems has no explicit place for the purposes of communication, but that is our major concern. There are many parties at interest in any technological development. There is the innovator motivated by a desire to make money or perhaps to make life better or easier. There is the manufacturer who expects to profit by making and selling the artefact which embodies the development. There is the buyer who will use it for his purposes perhaps by selling a service. In the case of a communications system there will also be people ("actors") who originate the communications (the message sources) and those who will receive them (the message sinks). After all, every item of communication implies an exchange between an individual as the sender and (usually) another as the recipient. However, the needs, priorities, and goals of sender and receiver, not to speak of the other parties at

interest, may be similar, complementary or even antagonistic. Study of the history of technological issues in communication supports the judgment that intention on the part of participants in communication plays a critical role in shaping both the directions which the technology has taken and the evolution of their societal impacts. Sometimes the outcome is quite at variance with the expectations of the inventor, the makers and the controllers.

In this context, it appears worthwhile to consider how one might formulate a taxonomy of communications systems based on the intentions of the players in the game. I shall mention what I believe to be the more important of the intentional design criteria.

1. Symmetry. Is it desired that sender and receiver be able to exchange roles? The telephone is clearly intended to provide symmetry, the public address system does not.
2. Feedback. This is the central requirement of a public opinion poll. It is also a requirement in a military control system, an airline ticket system and most especially a computer, in that feedback confirms that the message has been received.

3. "Fan-out" and "Fan-in". Is the message offered by one person to be received by many others simultaneously? This is the criterion for modern commercial television broadcasting networks. Are there many simultaneous messages to be received centrally? An intelligence agency must operate in this mode. American television broadcasters use a specially selected panel of "typical" viewers who signal their choices electronically to determine the popularity of TV programmes. This is crucial to commercial success since the advertising rates are set on this basis.

4. Understandability. Is the communications mode esoteric and limited only to a "priesthood"? Secret languages are not uncommon in history. Current examples might include the languages of professions such as medicine or law. A scrambled voice channel or a message in cypher is designed to restrict understandability severely. Or is the communications mode intended to be used and understood by as many as possible? Esperanto and similar synthetic languages have some such goal in mind. Is this not also true of the

graphic arts, of dance and musical programmes?

5. Security. The message may be intended for a restricted group of receivers, while another set of potential receivers should not be able to receive it at all.
6. System, Receiver and Transmitter Control. Is the system receiver or transmitter controlled, and by what means? A radio or TV receiver in the home can be turned off; outdoor advertisements by the side of the highway or TV cameras surveying a bank teller's window cannot.
7. Systems Accessibility. A multitude of constraints, physical, economical and governmental, severely restrict access to the organs of the mass media. On the other hand access to accurate, rapid and cheap reproduction machines may enhance the circulation of "zamizdat" (underground papers) and other illegal publications.

One criterion always present is that of cost or profitability. In the minds of the entrepreneurs, the need for an advance in technology must justify the cost of its development and introduction. Any designer, especially a designer concerned with a commercial product, is cost conscious. Concern for frugality will colour virtually every step in the design process.

One facet deserves special attention.

8. Pragmatism versus the esthetic impulse. Esthetic forms are an obvious criterion in the develoment of written scripts, in type font design, and, one would hope, in the creation of radio and television programmes and advertising. The subsidiary and one might say the supine role of esthetics in these latter uses is too well known to be discussed further here. One may also note that the marks found on bank cheques or on the sides of grocery items that are now being read by machines were designed with little (in the case of bank cheques) or no (in the case of groceries) consideration for understandability in the sense of item 4 above, and none for esthetics.

It may also be useful to examine instances in which the intended innovation on the part of the inventor has not matched the intent of the user. For example, despite much public trumpeting, machine-aided instruction has had virtually no impact on education. Despite much enthusiasm and missionary zeal for more than a decade, machines for teaching are hardly used at all either in the classroom or at home. Contrast this with the "education" a child in the United States receives

by reason of the fact that he is likely to watch commercial television for more hours than he spends in school. This suggests another dimension of intention although not necessarily a conscious intention.

9. The Purposeful versus the Playful. It is well known that Playfulness in language is a very old phenomenon. It can be found not only in speech but there is visual playfulness in writing, cartooning, etc. It is also well known to every professor of computer science that students use computers to play "space war" and other games whenever the opportunity arises.

American manufacturers in their pursuit of new markets have been exhilarated by the potential of electronic games. The consumer who is willing to pay as little as $50 can buy a box that he can readily connect to his colour TV set. The box comes equipped with some knobs and dials for controlling little coloured dots, squares or triangles, symbolising balls, tanks or space ships that move on the television screen. Reports in the trade magazines claim that digital games will be a more important and lucrative consumer product than even the hand calculator.

However, what some regard as more serious applications of technology to communications have been a great deal less

successful. The picture-phone developed by Bell Telephone Laboratories at considerable cost and an extensive test period has been a commercial fiasco. The picture-phone made it possible for a telephone user to project a television-like image of himself to the person he was calling and to receive an image of his caller. Telephone users, however, are quite satisfied with sound alone and show no interest in two-way visual communication of faces.

One additional class of criteria needs to be considered; it comprises the desires and conveniences of the people who are participating directly in the transactions of a communications system. The communications technologist is likely to call them human factors. All too often, concern for human factors engineering is focused only on the obvious psychophysical and psychological properties of human beings relevant to the task, for example: How much will noise interfere with recognisability? How fast can attention be shifted? How many meters can a human monitor? Given the extensive plasticity of human behaviour it is not surprising that relatively little work needs to be done to match the human to the device. However, there is a subtler issue as well that seems to fit best with the notion of personal autonomy.

10. Does the individual control the way he carries out his part in the process or does the system drive the person?

It is my impression that wherever two technological solutions to a particular functional need are in competition, the one allowing the greater autonomy is likely to be favoured even when the other is more effective, inexpensive, etc. Contrast two ways of using high density information stored on microfilm or microfiche. The older system, which is also the cheaper, provides a drive which can be moved rapidly from page to page or even card to card (sometimes under computer control) and a projector-enlarger to display the required item of information. The newer system makes a xerographic copy of the microfilm. It is no secret that almost any reader prefers the paper copy to the film reader, despite the fact that on an objective basis the paper copy is likely to offer a poorer visual image than the projected film image. Is it some innate conservatism that leads a literate person to prefer the printed page which is the form he has used all his life? I think not. The long evolution of the technology of written language led some two millenia ago to the development of the book. Subsequent technical development made it easy to reproduce books by thousands and millions, to make them lighter, cheaper, more convenient, but did very little to change the original design features that make books so good for human beings. People can read books slowly or fast,

sitting erect or lying down, at a desk, in a bus, or in a bathtub, in bright sunlight or candlelight. People can read from first page to last, browse, skip, pay attention, doze, put the book aside or pick it up, switch from one book to another, write comments in the margins, tear out the pages when sufficiently aroused, or, having finished with the book use it to light a fire, or worse! Neither the clay tablets in prehistory nor microfilm today offer such a marvellous range of autonomous acts.

On a different level we can consider another modern example. An interesting side-note in the evolution of radio is the history of the Citizens' Band (CB). By the 1950s, a number of business firms were licensed to operate commercial two-way radios. For some businesses, for example taxi companies, they have proved to be essential. However, equipment costs and licensing requirements were prohibitively restrictive for the very small businesses. Accordingly, in 1958 the Federal Communications Commission authorised use of a very narrow portion of the electromagnetic spectrum at about 27 megahertz by virtually any resident of the United States older than 18 who wrote for a license. CB transmitters were limited by law to the miniscule input power of 5 watts, but there were no other constraints. This step is in striking contrast to the philosophy that the FCC has adopted toward the radio amateurs ("hams"). The hams are required to pass

stringent tests in receiving and transmitting Morse code, and also in the theory and practice of radio. There are at least ten portions of the spectrum from 1.8 megahertz to 420 megahertz allocated for their use. They may also use certain of the communications satellites. They can use far greater input power - up to 1000 watts. The amateurs have always operated with a considerable degree of self-discipline, sense of responsibility, and sense of community. Many if not most of the innovations in radio - for example, single side-band transmission - were first worked out within this community. They are also quick to respond in case of disasters and emergencies. Never very numerous, the number of hams actually decreased in the period following World War II though it has increased slightly in the past ten years. There are now some 100,000 licenses. By contrast, there are now more than 13.8 million active CB permit holders. I do not know what these 13.8 million people use their CB radios for ... perhaps mainly for amusement. However, they have had a definite impact in the United States. They have developed their own language, nowadays reflected in certain television programmes and popular music. As a cultural note it is interesting that CB operators normally preserve their anonymity and refer to themselves by colourful pseudonyms. They appear to use their CBs primarily in motor vehicles. In some urban areas they are so numerous

that their very density makes communication almost impossible. Popular culture has it that much of the communication relates to evasion of traffic laws and "smokey" (their word for a police officer). Fishermen on coastal waters tend to use CBs to communicate with their home base and with one another, although they are required by law to carry marine radios. One commercial fisherman put it as follows: "If you have trouble you know there'll be a lot more people listening on CB than on the marine band (radio frequencies reserved for ship-to-shore communication)". Newspaper reports suggest that in the more rural regions of the United States prostitutes have found CBs to be a valuable advertising medium for arranging mobile encounters.

The Universal Products Code - A Case Study

To offer some hint of the complex play of diverse interests and the way in which technological outcomes are shaped by them, I would like to present a summary of the history of one relatively minor modern development in communications, but one which within no more than five years has entered the visual environment if not the consciousness of every American and many Europeans as well.

In the decade immediately prior to World War II the technology of food processing, food packaging, and distribution began to favour the chain of grocery stores over the small

operator-owned stores which had predominated until then. The trend was considerably accelerated after the war with the creation of the supermarket, so that by the 50s the great preponderance of retail grocery sales in the United States were being made by giant food chains and supermarket owners. However the technology of marketing was rudimentary. Technology available for inventory control was so poor that inventories of products on the store shelves were made only twice a year, and then - to quote the president of one food chain - "only for ceremonial purposes".

Devices for automatically reading and routing bank cheques had been introduced about fifteen years earlier. They require that a bank clerk types the amount of the cheque on to the cheque with a magnetic ink; the cheque already has the customer's number and the bank number imprinted in the same magnetic ink. This technological system would be prohibitively expensive for any other industry and certainly for the food distribution industry. Its main virtue is accuracy.

In the late 1960s a few of the large food chains (Kroger stores in the United States and Migros in Switzerland) in collaboration with the electronic firms RCA and Zellweger respectively, began to experiment with electronic symbol-reading for price and type on packaged food items. A few

years thereafter a committee was formed representing the food chains, the supermarkets, and the food manufacturers to consider how best to proceed. It was already recognised that success would depend on an agreement to print only a single type of symbol.[+]

A management consultant firm (McKinsey and Company, Inc.) was hired to coordinate the studies and an open competition was announced. Any engineering firm could enter a symbol, and a coding scheme for this symbol. Each firm was asked to demonstrate a device that would read their symbol affixed to a typical sample of grocery items under expected operating conditions, that is, by a clerk taking the items from the check stand and passing them over a reader. A long list of criteria was furnished to the competitors. For example, the symbol was to be no bigger than 1.5 square inches, scan accuracy was to be better than 99.99%, the symbol was to be read in any angular orientation, no special inks were to be used, the symbol was to be difficult to counterfeit, etc.

Not all the parties at interest were equally happy with this development. The electronics and computer manufacturers were enthusiastic. After all, the food distributing industry represented a new market of at least \$10 billion (10^9). The food retailers themselves were divided. The potential

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[+] The author was for some time technical consultant to the Symbol Standardisation Subcommittee of the Uniform Grocery Products Code Council.

cost saving was readily appreciated, the prospect of being able to maintain an accurate and literally minute-by-minute inventory was exciting, but this was a highly competitive business. Speaking bluntly, some asked whether the savings would become profit for the owners or be "dissipated", i.e. returned to the consumer, because of competition. The food manufacturers were uniformly negative, a few were apoplectic. There were virtually no cost savings to be anticipated by the manufacturers. There would be many new expenses, printing costs would increase, a significant fraction of the label would need to be reserved for an ugly set of lines, etc. Nevertheless they participated on the committee, for they had no choice.

All the large business machine companies entered the competition, as well as a number of the electronic equipment manufacturers. Each developed a device that worked. Apparently, neither the coding algorithm nor the design of a device proved to be particularly difficult. An engineer from one of the companies remarked privately that his firm took only three months from the time they learned about the competition to the completion of the working model, although the company had had no previous experience in designing scanners, an essential feature

of such machines. Unquestionably there was no novel science being used.+

The committee also asked a panel of MIT experts in coding, communication theory, and pattern recognition to comment on directions that might be taken. The experts suggested that the industry might do well to wait a few years. They reasoned that methods of reading two-dimensional symbols, for example arabic numerals, could be expected in a few years and would permit substantial savings in printing and in label "real estate", that is, the space occupied by the symbol. The committee, however, was committed to act and in the final competition only one electronics firm - a tiny and therefore inconsequential one - proposed a two-dimensional symbol.

One surprise almost derailed the committee's progress. After the number of competitors had been thinned somewhat, samples of the symbols were submitted to printers for label printing cost estimates. When the estimates were received, they were uniformly so high that one participant at the meeting concluded that the increase in cost of labels would be as much as four times the anticipated savings of the entire automated reading system. Clearly, the printing specifications needed to be relaxed; the companies' designers

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+ Another company apparently based its scanning device on the principle of the Nipkow disk. Historians of television will recall that Paul Nipkow devised a rotating disk with perforations arranged in a spiral pattern that enabled a pinpoint of light to make a scanning motion. He described it in 1884.

were equal to the task.

Ultimately, a symbol and code were chosen. It turned out to be a minor modification of the proposal made by IBM. Curiously enough, the closed vote of a committee of some dozen members was unanimous. In the discussion that followed the decision, it became apparent that the one important determinant for choosing the winner appeared on no list of explicit criteria; what counted was the reputation of IBM for providing excellent service. When one recalls that the retail food industry has had little experience with modern technology, the rationale appears quite sensible. After all, the supermarket owner knows nothing about laser scanners, coding theory, or microcomputer architecture. But he certainly does know that he cannot afford a technical breakdown at the check-out stands.

What were the consequences? First of all, five years after the decision virtually all processed food products in the United States carry the Universal Products Code symbol. Many food chains have instrumented test stores, some are converting all their stores.

However there were two kinds of consumer response. Once the symbol choice was made and the purpose of the system publicised, public interest groups were critical on

the ground that food items would no longer be labelled with the actual price. (The code on the food item represents a number which has been assigned to the manufacturer and to the particular food item. It marks a location in the computer's memory. That location contains the price.) Several States passed legislation requiring that food items must carry a price tag. The expense of putting a price tag on each item of merchandise is quite significant - about one cent per item. The industry was not overly concerned. Experiments in test stores had shown conclusively that after a few weeks purchasers were untroubled by the lack of price tags on the groceries. Presumably they were reassured by the cash register tape which in the new system prints out the name of each food item as well as its price.

How will the price of groceries be affected if this system is universally adopted? At the time the systems were being developed, hard savings were estimated to be about 1.5% of gross sales. From the point of view of the supermarket owner this is highly significant since his profit before taxes is likely to be less 2%. In recent years the average has been about 0.7%. From the point of view of the consumer, it is utterly inconsequential. At present, inflation in the United States is approximately 10% per annum. A 1% change cannot even be detected by the individual consumer.

There is one consequence about which there is little doubt; the current "bar code" will continue to be printed on all food items for many years to come. Just as the sequence of alphabetic and numeric symbols on the dial telephone were fixed in the United States for more than seventy-five years (until the introduction of the touch-tone transmitter) we can expect the bar code to remain fixed until there is some strong economic reason to revise the system.

Microcircuitry

Central to virtually all modern developments in communication is the technology of digital circuitry. Digital circuits were first constructed of large, slow, and cumbersome devices, switches and relays, but the invention of the transistor opened the way for widespread use of the digital circuit. Today digital design is essential to every method of communication dependent on technology: television, telephone, radio, satellite communication. Paradoxically, even high-fidelity sound reproduction is best achieved by means of digital circuitry.

In particular, digital circuitry has been fundamental to the development of the modern computer. The introduction of the transistor in 1952 permitted great savings in space and power, but the development of the planar transistor in 1958 made it possible to fabricate integrated circuits, that

is, many circuit elements in one industrial process. Robert N. Noyce, Chairman of the Intel Corporation sums up the evolution from 1950 to the present as follows:[+]

> "A quarter of an inch square now can embrace more electronic elements than the most complex piece of electronic equipment that could be built in 1950. Today's microcomputer, at a cost of perhaps $300, has more computing capacity than the first large electronic computer, ENIAC. It is 20 times faster, has a larger memory, is thousands of times more reliable, consumes the power of a light bulb rather than that of a locomotive, occupies 1/30,000 the volume and costs 1/10,000 as much. It is available by mail order or at your local hobby shop."

The technological impact of the computer as an element in communications devices is hard to overestimate. Decrease in computer cost and the concomitant greater accessibility will surely have effects on the day-to-day behaviour of all of us. For example, record keeping by an individual has until now been constrained to the use of primitive paper-and-pencil technology. Home computers can now carry out virtually every function of record keeping that an individual or a family might require. Programs are readily available.

It is now possible to arrange special communications for special populations. As we have mentioned, there already exists a reasonably acceptable "reading machine" for the blind.

[+] Noyce, Robert N.: "Microelectronics". Scientific American, 273, N°3, page 67 (1977).

One can contemplate a "writing machine" for the deaf which will acquire speech as input and provide a written text.+

One can distinguish two tendencies in the historical development of computers. At first the predominant trend was to construct ever more powerful, faster computers with larger memories and carefully controlled access. The costs were high; they were operated within government agencies, large industrial companies, and the larger universities. The computer manufacturers in the 1950s competed for this market, but the substantial cost of a computer severely limited the size of the pool of purchasers. In the late '50s the second tendency, to develop smaller rather than larger computers, began to affect the picture. Since then small computers have taken an ever greater share of the computer market.

+ This is the first example of a communications device in which new scientific knowledge is essential. In all the other instances discussed here, development was within the state-of-the-art. One can find elegance in solutions to a design need and devices that fit the criteria better or worse, but any competent designer could in principle have suggested a workable solution and would need to pose no questions for which he could not find an answer in contemporaneous science. On the other hand, we do not understand speech, i.e. we do not have a tested theory of the spoken utterance sufficiently precise to know how to approach the problem of speech recognition. The need exists for a machine to translate spoken speech to written language, not only for the blind. The military are very much interested. In the United States, ARPA, the agency for advanced development in the Department of Defense, has spent many millions over a period of ten years before deciding to abandon vigorous pursuit of this goal at least for the time being. Now they are spending some of their money on "image understanding". Since there is an even skimpier basis for a theory of images than there is for speech, prospects for the successful development of a device for image understanding are somewhat in doubt.

The first trend has led to the notion of networks of computers, that is, communication between computers. An authorised user can now have the augmented power of the network at his disposal. It is only a small logical step to the concept of a computer network as a public utility. It makes no more difference to the user which computer is doing his computation than which telephone lines are used to connect a caller with the person he is calling. We note that a public utility is a very costly thing to build and to operate although one cannot question its effectiveness and relative low cost for each transaction. Thus, the analogy to a telephone exchange appears to be a good one[+].

The issues of verifying the legitimacy of users, preservation of the properties of other users, and protection from misuse are well known in all public utilities. Already we have popular accounts of the ways in which knowledgeable users have committed crimes by computer[++] and hand-books for computer owners describing how to safeguard against theft within their system[+++]. We have no way of knowing how much damage the computer thieves have done. Losses in the United States from "computer-modulated" theft are estimated conservatively at

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[+] The analogy is especially accurate because the great majority of users are connected to the computer network by an ordinary telephone line.

[++] Parker, Don B. "Crime by Computer", Ch. Scribner's Sons (1977).

[+++] Walker, Bruce J. and Blake, Ian F. "Computer Security and Protection Structures", Dowden, Hutchinson and Ross, Inc. (1977)

$300 million per year. Obviously, we do not know about the successful embezzlers; their tracks are not likely to be found by classical auditing methods. On the other hand, we can be quite confident that we will see no decrease in the fraction of people concerned with enriching themselves by the use of their natural intelligence and at the expense of a system that is becoming ever more remote from the scrutiny of human eyes and minds.

On the other end of the scale, commercial success of the minicomputer led some concerns (mostly small) to develop the microcomputer[+]. Less powerful and somewhat slower than the minicomputer, it is nonetheless entirely comparable in capability to the larger computers of a relatively few years ago. And it too can be incorporated into networks. What appears to be most important is that, when built in large enough quantities, the microcomputer is within the financial means of most people living in developed countries. Even today, at the beginning of the microcomputer development, anyone who can afford a

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[+] The diminution in the physical size of the minimal system which can legitimately be called a computer was made possible by a parallel increase in the number of digital circuit elements per unit volume prepared as a single item of manufacture. The progression has been from transistor and diode to SSI (small scale integrated circuit) with about 10 elements, MSI (medium scale integration) with about 100 elements, LSI (large scale integration) with 1000-10,000 elements on a single "chip". Chips with over 256,000 elements have been manufactured. They are being called VLSI (very large scale integration). Physical theory does not appear to prohibit several orders of magnitude further increase in packing density. The current limitation in size of element appears to be in the photoengraving process used to produce the circuits. They are limited to spacing of the order of magnitude of the wavelength of light used - about 0.25 micrometers; but x-ray or electron lithography are possible, in the latter case a wavelength of 0.001 micrometers is not unreasonable. Can we not anticipate ELSI (exceptionally large scale integration) and ultramicrocomputers?

colour TV can afford a microcomputer. In fact certain microcomputers are designed to be connected to a television receiver by the simple act of wrapping a wire around the antenna, thus converting the television set into a display terminal.

Microcomputers can be made quite small, the size of a hand-held calculator. One device recently announced for sale can also be attached to a wire carrying a continuous so-called analogue voltage, and with its built-in analogue-to-digital converter can proceed to make appropriate computations[+] on the voltage signal. Taking low cost, portability, and flexibility together with the computer's unquestionable capabilities, one feels safe in predicting a greater autonomy for the individual with respect to those functions that his computer will perform for him. Here one may be tempted to draw an analogy to other technological developments, for example, in transportation, the automobile compared to the railroad. Whereas the automobile enhanced apparent autonomy for choosing when, where and how to travel, it did nothing to diminish the individual's dependence on a technology of whose workings he was ignorant. So, too, with computers. Almost all owners of a home computer expect to use programs provided by others. How will the user

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[+] The Model 4100 Calcumeter made by Electro Scientific Industries and marketed by Micrometrics, Inc., Portland, Oregon, is a special-purpose device intended to be used by engineering in measuring voltages. Nonetheless, the principle can be extended so that any arbitrary waveform, for example an electrocardiogram or a radio broadcast, can be subjected to reasonably complex analysis. The Calcumeter price is under $400.

know the program is doing what he wishes? Perhaps the analogy to transportation will prove to be faulty. Experience has shown that the great majority of automobile drivers - at least in the developed world which in any case has the preponderance of drivers - know almost nothing about repairing their vehicles. But it is not difficult to learn to program a computer in one of the simple high level languages such as BASIC. Will the availability of a home computer challenge the curiosity and ingenuity of its users, or will it become yet another technological artefact that provides a service of marginal value?

The engineering community is divided as to the prognosis. Most computer specialists are euphoric. Alan C. Kay, who is an expert in computer science and the domain of scholarship called artificial intelligence by its practitioners, writes as follows[+]:

> "In the 1980s both adults and children will be able to have as a personal possession a computer about the size of a large notebook with the power to handle virtually all their information-related needs. Computing and storage capacity will be many times that of current microcomputers: tens of millions of basic operations per second will manipulate the equivalent of several thousand printed pages of information.
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> "The personal computer can be regarded as the newest example of human media of communication."

He goes on to describe what can be done.

> "Ideally the personal computer will be designed in such a way that people of all ages and walks of life can mould and channel its power to their own needs.

[+] Kay, Alan C. "Microelectronics and the Personal Computer". Scientific American 237: No. 3, pp. 230-244 (1977).

> "Architects should be able to simulate three-dimensional space in order to reflect on and modify their current designs. Physicians should be able to store and organise a large quantity of information about their patients, enabling them to perceive significant relations that would otherwise be imperceptible. Composers should be able to hear a composition as they are composing it, notably if it is too complex for them to play. Businessmen should have an active briefcase that contains a working simulation of their company. Educators should be able to implement their own version of a Socratic dialogue with dynamic simulation and graphic animation. Homemakers should be able to store and manipulate records, accounts, budgets, recipes and reminders. Children should have an active learning tool that gives them ready access to large stores of knowledge in ways that are not possible with media such as books."

Don Mennie, Associate Editor of the Institute of Electrical and Electronic Engineers' Spectrum, news magazine of the largest engineering society in the western world, has examined the current stage of development and projects a somewhat different view[+].

> "All the ballyhoo about a user-programmable microcomputer in every home has about run its course. Consumers are still interested, but right now they relate mostly to computing systems and advanced video games that can be set up with a prerecorded program cartridge ... Seeing the consumer as a reluctant spender in this price range, many former hobby computer makers have begun courting the small-business customer."

Historians of the technology of communications will be struck by the analogy to the historical evolution of radio: the invention of the device, its development for military

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[+] Mennie, Don. "Personal Computers for the Entrepreneur". IEEE Spectrum, pp. 30-35 (September 1978).

purposes, the development of a community of amateurs and hobbyists, recognition by the business community that there must be a market to exploit (but not finding it where they expected it to be). Mennie notes:

> "Available software includes a selection of sophisticated games (chess, Othello, Star Trek)+, a chequebook balancing program, income tax, and a payroll package ... Software programs in personal finance, medicine and games comprise GRT Corporation's initial offering."

Another expert, Jerry Wasserman, of the industrial consultant firm Arthur D. Little, Inc., is quoted in the same article:

> "At the Winter Consumer Electronic show in January 1978, I went through all of the exhibits looking for a home computer that was well conceived and for which a target market had been identified. I came away discouraged. There was none. We are no longer a society which is technology-driven, with customers who will buy a product simply because it is better, smaller, faster or different. In fact, the typical electronics user today does not understand the technology, does not want to deal with it, is afraid of it, and would rather avoid it if possible. Home computers, as they are currently conceived, will be suitable for the individual who reads Scientific American ... probably.
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> "Given that as a premise, what would cause the computer to be bought in quantity by the consumer world? There is an ever-increasing concern about security in the home. Many small towns where people never locked their doors have now become communities where one uses house-sitters. The incidence of burglary is increasing. A reliable, inexpensive, and effective electronic security system could be an immediate success."

+ Lest there be any doubt, the programs cited here do not play chess, rather they provide pictorial representations of the board, the pieces, the moves. They also will reject illegal moves. Chess playing programs usually require the largest of computers and despite some 20 years of programming effort, still play a relatively amateurish game.

Portia Isaacson of Electronic Data Systems, Dallas, Texas, is also quoted:

> "Do not underestimate the sales appeal of the computer game as an entertainment form. Look carefully at the computer as a new form of personally available, intellectually challenging, interactive entertainment. The computer offers the opportunity for simulated experiences without risk. The simulated experience computer game is a powerful new entertainment form."

Alan C. Kay, who was quoted earlier, has a comment on simulations:

> " ... the computer user has a strong motivation to emphasise the similarity between simulation and experience and to ignore the great distances that symbols interpose between models and the real world. Feelings of power and a narcissistic fascination with the image of oneself reflected back from the machine are common. Additional tendencies are to employ the computer trivially (simulating what papers, paints and filing cabinets can do), as a crutch (using the computer to remember things that we can perfectly well remember ourselves) or as an excuse (blaming the computer for human failings). More serious is the human propensity to place faith in and assign higher powers to an agency that is not completely understood. The fact that many organisations actually base their decisions on - worse, take their decisions from - computer models is profoundly disturbing given the current state of the computer art ..."

The contrast between the dream and current expectations is striking. The applications that sell today are banal and uninspiring. The implications for a human society are disheartening. One would believe that where burglary is increasing, society would wish to respond by seeking ways to return to a world in which locks are not needed on every door. Instead the

responsibility is further shifted from the society to the individual. Instead of technology being used to enrich human experience, we can now be prepared to simulate experience.

Currently, we can be sure of one thing: today's technological achievements will have profound effects on the transmission and processing of information. We are, however, a long way from understanding its implications. Ironically it does not appear that technology has provided us with the information or the wisdom to know how we might shape the evolution of communication, perhaps because at the core, communication is the engagement of one human mind with another. In this arena, Socrates talking to his students may still be the best we have been able to achieve.

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Text of paper by Professor R. Narasimhan

Communication and Understanding : A Computational Approach to Language Behaviour

1. Introduction

1.1. Animal and Human Communication

In this DISCOVERIES Symposium the principal theme of which is 'Communication' from the human viewpoint, I have chosen to discuss language behaviour and some central issues that arise in trying to model natural language behaviour in psychologically relevant ways. Although not all human communication is language-based, language undoubtedly is what gives human communication its enormous power, versatility and effectiveness. Medawar (Medawar 1976) has persuasively argued that "what is characteristic of human beings considered as animals is not the making and use of tools but the communication from one person to another, specially in the next generation, the knowledge and know-how to do so". It is by virtue of this faculty that human beings come to enjoy a kind of cultural evolution which, Medawar points out, is, in contrast to Darwinian 'endosomatic' evolution, "Lamarckian in style, that is, it embodies a learning process; for what is learned is passed on and becomes part of the evolutionary heritage". Also cultural heredity is mediated through non-genetic channels, and it is also reversible. And Medawar notes, "this characteristically human system of heredity calls for and depends upon the existence of language and other forms of conceptual communication".

Although communicative competence is something that human beings share with other animals, the implication of Medawar's argument

is that this communicative competence seems to have resulted in cultural evolution only among human beings. The reason for this would seem to be the crucial role played by language as a medium of communication among human beings. Language behaviour is a modality that seems to be functionally available only to human beings. Although speech is the most important constituent of language behaviour, clearly, it is not indispensable. The deaf and dumb are able to use gesture (or sign) language with almost equal efficiency. In view of this, the first question that calls for an answer is: why is it that no other animal has developed language behaviour for use? Perhaps, to answer this we have to ask another related question: what minimal organization of behavioural mechanisms is necessary to acquire and use language behaviour? It seems plausible that we would be in a better position to tackle this second question if we could first determine, what types of behaviour, otherwise unavailable, are made available through language usage. Behaviourally, in what sense do human beings differ from all other animals because of the availability of language behaviour? What is it that human beings can accomplish that other animals cannot, and that is predicated on the availability of language behaviour?

Concerning this last point it would seem that Pavlov's insight, that language behaviour is a <u>second signalling system</u>, really provides the basis for characterizing its role. Without the language modality one has merely the sensori-motor behaviour complex that directly relates to the external world and can only deal with the "now" and "what is out there". But with language behaviour one is able to separate out the sensory and motor complexes and mediate them via the

language behaviour schemata. That is, one is able to refer to the sensorily apprehended aspects of the world and one's own action schemata independently, and talk about these using the language modality. In this way language behaviour becomes a second signal, a signal of signals. However, as Pavlov has emphasized, "it cannot be doubted that the fundamental laws governing the activity of the first signalling system must also govern that of the second, because it too is the activity of the same nervous tissue". (Pavlov 1958)

Animal communication seems to lack this second signalling aspect except in extremely rudimentary forms. Vocalization is made use of to indicate need states (say, hunger), affective states (say, anger), and for purposes such as warning of predators, ensuring mother-child bond, maintaining social cohesion, announcing food, and so forth. Thus, vocalization serves to manipulate the environment as well as to describe it, in a certain fashion. However, two important points deserve to be emphasized. Vocalization always relates to situational aspects (external and/or internal) that are present here and now. We do not have any evidence that an animal uses (or, can use) vocalization to warn another animal (say, its young one) of potential threats: e.g., "when you go near the water-hole, watch out for tigers".

Secondly, the descriptions of situational aspects conveyed by vocalizations lack structure. It has been claimed that vervet monkeys have three different kinds of alarm calls: one for hawks, one for snakes, and the third for other terrestrial predators. It has also been suggested that the variations in the way a given song-bird

sings may be correlated with the various activities the bird engages in. This would enable the listening mate to monitor some of the activities of the hidden singer: (see Smith 1968). But such subtler aspects of descriptions would seem to be exceptions. In a true language, a description would enable one to discriminate between 'a lion', 'a big, fierce-looking lion', 'the big, fierce-looking lion that we saw yesterday', and so on. There is no evidence that animal communication is based on such structured descriptions.

These considerations lead us to repeat our earlier question: why is it that animals lack lnaguage? Lieberman (1968) concludes from a detailed spectrographic analysis of a variety of primate vocalizations that, (1) these animals do not move their tongues during a cry, and (2) their laryngeal outputs tend to be aperiodic. According to him, their vocal apparatuses are not adapted to producing human speech because they lack laryngeal control, and a pharyngeal region capable of varying its cross-sectional area. The several unsuccessful efforts that have been made to teach speech to chimpanzees would seem to confirm Lieberman's views.

However, as we remarked earlier, speech is not indispensable to language behaviour. Geschwind (1964) conjectures that the ability to develop language in man is very likely the outcome of two features: (1) that the major part of the human brain consists of association areas directly linked to the primary sensory and motor areas, and (2) that these association areas are themselves richly interconnected through a centralized association area of association areas. In other animals, including the higher primates, even the primary association

areas are not present (or, are only poorly developed), and the sensory and motor areas are only linked to the limbic area (concerned with behaviour immediately relating to survival). Geschwind's claim that higher primates cannot accomplish intermodal transfer (not involving the limbic system) has been shown to be not valid: (see, Davenport and Rogers 1970). The Gardners' success in teaching sign language to a chimpanzee would also seem to establish convincingly that non-limbic intermodal transfer is possible at least among the higher primates. Geschwind's main conjecture could still be true so far as spontaneous language acquisition is concerned. As we shall see later, the model that we develop is also based in an essential way on the availability of associative connections between the various modalities.

Even if animals do not acquire language on their own, the question remains whether they could be taught language through systematic training. The most widely known attempt to answer this question is, of course, that of A and B Gardners', of the University of Nevada, to teach the American Sign Language to a young female chimpanzee named Washoe (Gardner & Gardner 1971). At the end of 3 years of training, Washoe could reliably use close to 90 different vocabulary items of sign language. These included signs denoting objects, commands or requests, attributes and proper names. She could construct meaningful sequences of such signs (e.g., please tickle more, come Roger tickle, out open please hurry, you me Greg go, etc.). After having been taught the sign for 'dog', she used it appropriately to refer to pictures of dogs and, once, even to the barking of a dog not in view.

Although the communicative competence displayed by Washoe using the sign language medium is certainly impressive, there is one aspect in which Washoe and a human child differ significantly in their use of language. Washoe's use of language still relates only to the 'here' and 'now'. Practically all her utterances deal with her own desires and needs, with what she sees and hears. There is little indication that she ever uses language to describe impersonally what other people around her do. Also, she does not use language as an instrument to explore. The Gardners do not say that she ever asked her human companions, "what is this?" or "what is that?". Children at a comparable developmental stage undoubtedly begin to use language to explore, not only the world around them, but various imagined possibilities and potential situational aspects; for example, "what would happen if I do this and that?", "why not this and that?", etc. There is no indication that Washoe ever attempted to use language in this way to create a world for herself, to fantasize or mythologize. Clearly, these are some of the very early uses of language that children make, in addition to using language in monologuing and role-playing.

After 5 years of training, I believe the experiments with Washoe had to be discontinued because she had grown too big and potentially too dangerous to work with. She was hence removed to a primate colony. Unfortunately, I have come across no published information of Washoe's subsequent language behaviour history among her chimpanzee companions. It would be of great interest to know

whether her training in language had given her the motivation to act as an agent of cultural evolution in her primate colony.

1.2. Human use of language

The distinguishing feature of human language behaviour is that through its use one is able to deal with a world not necessarily immediately present to the senses. Thus, one is able to perform gedanken experiments instead of being limited to performing only actual experiments. Once this capacity is reached, one is able to talk about the talking-about aspect itself. In other words, language modality for the first time becomes capable of self-referencing. This gives rise to the object language — metalanguage distinction. This also gives rise to the well-known semantic paradoxes of logic and the foundations of mathematics.

Primitively, however, language behaviour is used only in the instrumental mode. That is, it is used to describe and manipulate the external, non-linguistically given, world of objects and events. The central computational problem involved in modelling language behaviour is concerned with the methodology of mediation. How is one enabled to make use of language behaviour to talk about — to describe, command and query — the world normally dealt with through the sensori-motor modalities? How does a child manage to acquire this competence to use language behaviour in these ways?

The more recondite use of language behaviour is, of course, associated with cognition, with the highly-complex, symbol-manipulation activities. Complex problem-solving, the construction and use of

theories, and similar overtly syntagmatic activities would presumably be impossible without the use of a language of some kind. However, one should approach the complexities of language behaviour with some caution. It is very easy to be misled into the belief that the seemingly unlimited complexities of language behaviour necessarily imply a comparable complexity in the underlying behavioural mechanisms. It is worthwhile to note that the recondite syntagmatic aspects of human behaviour are untypical. They are based on prolonged and systematic learning and training. It is an exceptionally small proportion of human beings that come to exhibit these aspects of language behaviour with facility. The behavioural mechanisms underlying language behaviour can only be articulated by studying what is typical of language behaviour among all human beings. And this is, as we said earlier, the use of language behaviour in the instrumental mode which is related to its ability to mediate sensory-motor behaviour. So we must answer the question, what are the primitives of language behaviour that enable its being put to this mode of usage? Given these primitives, we could then proceed to investigate how systematic training procedures could enable them to be used to realize the symbolically more complex forms of language behaviour?

In the next section we shall study the instrumental aspects of language behaviour in some detail. We shall try to analyze what does interaction with one's environment in the language modality consist of. That is, we shall be concerned with an analysis of natural language behaviour in order to be able to answer questions of the following kind: In the instrumental mode of behaviour, how is natural language made use of? What is there in natural language which allows

it to be used in these kinds of ways? Since, both phylogenetically and ontogenetically (in the case of humans), an organism's ability to interact with its environment is acquired, to begin with, without the mediation of the language modality, we should develop a framework in which we can first talk about an organism's interaction with its environment in a neutral sense independently of specific modalities. This would then allow us to discuss how, when language behaviour is acquired, it is enabled to assist, mediate, and ultimately replace such overt and immediate interactions.

These arguments would lead us to the view that there are definable aspects to a natural language that enable the members of a language community to use it the way they do. We shall then argue that acquiring a language consists essentially in acquiring these aspects of the language and relating them to their usage. The validity of this thesis can be tested in two ways. Firstly, we could try to analyze some particular natural language with respect to its definable aspects as formulated in our thesis. This would enable us to demonstrate, both in terms of structure and function, how natural language behaviour is enabled to play its second-signalling role. Elsewhere I have attempted a partial analysis of English with this end in view. (Narasimhan 1973). Secondly, we could try to validate our thesis by considering its implications to child language acquisition and studying to what extent these implications are verified by known empirical facts relating to the developmental stages children go through in acquiring language. In the report cited earlier I have attempted this analysis also. However, I shall not repeat either of these here since they would take us too far outside the scope of this paper.

I shall confine myself here to discussing the relevance of our analysis of language behaviour to the structuring of computational models to simulate aspects of this behaviour. Our primary concern will be with the kind of constraints a viable simulation model should satisfy. I shall argue that currently prevailing grammar-based models of language-understanding cannot cope with the developmental aspects of language acquisition. In contrast to grammar-driven syntagmatic processes that form the foundation of computer programming, we shall be led to the view that example-driven (i.e. paradigmatic) processes such as imitating, analogizing and rehearsing should form the basis of natural language acquisition and usage. I shall illustrate some of these ideas with the first version of a Paradigmatic Language Acquisition System (PLAS) that has been implemented.

2. The Mediating Role of Language Behaviour

2.1. Organism as a behavioural system

In trying to discuss what role, primitively, language plays in behaviour and how it is able to play this role, we must first of all note two fundamental points. A child acquires its language through intimate behavioural interaction with a language community. In other words, it acquires a language by functioning in the language as part of its normal process of growth. It should, hence, be reasonable to suppose that the developmental aspects of language behaviour should reflect both the developmental aspects in the growth of the child, and the developmental aspects of the language learning process. Secondly, a child,

that is capable of acquiring and using language in this manner, when viewed as a behavioural system has certain well-defined and characteristic features. It has inputs coming in from the external environment through its sensory interfaces: eyes, ears, nose, skin, etc. It has certain kinds of motor actions available to manipulate the external world. There are well-defined internal state variables that define the internal state of the system; for example, the affective states, need states, and so on. These characteristics define various aspects of the world available to the child considered as a behavioural system. And these must be mirrored in some sense in language behaviour if it is to be possible for the child to function in the language modality to accomplish various things in the world.

We shall try to develop now a somewhat formal view of a child as a behavioural system taking explicitly into account the two basic points outlined above. This would enable us to relate language behaviour to the universals of behaviour, in general, and discuss how language is able to play its mediating (i.e., second-signal) role.

We first note that an organism is always embedded in some (stimulus) situation and, hence, its behaviour must be characterized relative to this situation. In doing so, however, it is the <u>total</u> situation that must be taken into account. This total situation can be broadly divided, in an obvious way, into that aspect of the situation that is external to the organism (the external situation, or the so-called <u>external environment</u>), and the aspect that consists of the organism itself (the so-called <u>internal environment</u>). Let us now make the following postulate.

> P1: Behaviourally, the organism consists of a set of external and internal interfaces. Various aspects of the total situation are defined (or determined, or realized) at these interfaces. From the point of view of the behaving organism, its behaviour is related to the total situation through the aspects of the total situation as available at these external and internal interfaces.

What is being asserted by P1 is, of course, that so far as the organism is concerned, its "awareness" of the total situation is completely characterized by the aspects of the situation available to it at its various interfaces. This postulate would be pointless if all that exists in the entire world is a single organism. For, then, it would be unnecessary to distinguish between a 'total situation' and 'what the organism is aware of'. Implicitly, then, we are assuming the existence of a plurality of organisms in the world and that some of these could observe the behaviour of others. A behaviour theory could be meaningfully developed only in this larger context.

Our next postulate concerns the representations of these situational aspects as available at the interfaces.

> P2: The aspects of the total situation at the interfaces are given in terms of schemata and/or state variables.

"Schemata" is used as a generic term to refer to abstract structures. A specific schema delineates a particular structure. A schema could

represent a spatial structure, a temporal structure, or a spatio-temporal structure. We shall consider some examples presently. The distinction between schemata and state variables is pragmatically an important one. Schemata imply structure; state variables refer to unstructured parameters that characterize certain aspects of the situation and, hence, of the behaviour which is a function of these.

To illustrate the ideas implicit in P1 and P2, we might consider some examples of interfaces and the related situational aspects determined as schemata and as state variables.

1. Sensory Interfaces

a. visual : shape schemata.
b. auditory : schemata for speech syllables, say.

2. Motor Interfaces

a. hand movement : schema for writing the letter 'A', say.
b. leg movement : schema for walking.
c. face muscles : schema for 'looking angry', say.

3. State Variable Interfaces

a. color sensors.
b. taste sensors.
c. parameters of internal regulatory processes;
e.g., CO_2 concentration in blood, pulse rate, etc.
d. voice pitch, loudness, etc.

Some of the external interfaces relate to language behaviour and, hence by P2, there must be schemata and state variables associated with these. Let us refer to these schemata as language schemata. Our principal aim in the rest of this section is to discuss the nature of language schemata and consider how they are related to the non-linguistic schemata and state variables which define specific situational aspects.

Normally, the primary interface associated with language behaviour is the motor interface relating to the speech mechanisms. However, there are also several secondary outputs (like facial expressions, gesture, etc.) that play a more or less determining role in language behaviour. Thus, apart from the language expressions proper, these secondary outputs, as well as other prosodic aspects of speech such as intonation, stress, pauses, and so on, should be considered as forming part of the complete language schemata. In our subsequent discussions, however, we shall restrict our considerations to the linguistic expression part of language schemata for reasons of simplicity.

We have already emphasized that speech is not indispensable to language behaviour. "Language" behaviour in such non-standard cases must be appropriately interpreted. It would presumably be found in these cases that what we have characterized above as secondary outputs, as also schemata associated with some of the other modalities, come to be used as substitutes for speech and hearing.

P1 and P2 have been concerned with the manner in which the situational aspects are made available to the organism and how the organism is enabled to act. We need a last postulate to characterize from a behavioural point of view these acts.

P3: The universals of behaviour are (a) describing situations, (b) manipulating situations, and (c) exploring situations.

Describing, manipulating and exploring are meta-behavioural categories. That is, they apply equally to behaviour in any modality. One can

explore with the eye as well as with the ear. Aspects of some situations can be described with facial expressions as well as with hand gestures. But, quite obviously, some modalities are much more appropriate for certain categories of actions than for others.

To proceed further with our attempt to develop a framework for discussing behaviour, we would have to specify what is the nature of the acts which we have categorized as describing, manipulating and exploring. Of what does describing consist? In what circumstances would we say an organism is manipulating and in what circumstances, exploring? Before we can answer these questions we need to develop a more adequate structural description of the notion 'situation'. We shall attempt this task a little later while discussing language behaviour in greater detail. The richness and variety of language expressions would seem to be essential to talk about aspects of situations adequately.

But before we do this it may be useful to add a few more comments to complete our meta-level characterization of an organism as a behavioural system. Notice, first of all, that when we refer to 'situations' in P3, it is the <u>total</u> situation we are referring to. A particular behavioural act of an organism could describe its own internal situation, that is, its own state. In the context of language behaviour, this description could be in the form of statements about the self. Similarly, manipulation could very well be manipulation (and/or control) of the self (i.e., the internal situation) and not

merely aspects of the external environment. Examples of these are: speech as therapy, protocols in problem-solving, therapeutic play, and so on.

Next, it is clear that a complete meta-theory of behaviour must also take into account the dynamics of behaviour. There are two broad aspects to dynamics: (1) learning the behavioural schemata in terms of which situations could be described, manipulated and explored; and (2) using these learnt schemata appropriately to describe, manipulate and explore specific (given) situations. We must specify what the universals of learning mechanisms are and how they function. Learning essentially consists in: (1) learning new schemata, (2) learning new compositions of available schemata (i.e., learning new structures made up of constituents which are available structures), and (3) relating these to aspects of new situations encountered. Elsewhere we have discussed at length the current status of learning theories in psychology and their general inadequacies: (see, Narasimhan 1978)

We shall return to this problem of learning and make some specific comments when we discuss later the developmental stages of language learning. But, referring to universal principles of learning, we might note in passing, now, that learning from examples would really seem to be one of the primitive modes of learning. Analogizing based on learned paradigms, it is possible to argue, is the fundamental behavioural principle of transfer and generalization. An animal tends to extrapolate to a new situation behaviour it has learnt in an old situation to the extent to which the new situation bears a resemblance to

the old one. The conditioning principle of psychology can readily be reinterpreted along these lines. Analogizing principles based on the concept of similarity would thus seem to play a fundamental role in behaviour modelling. Giving a computational interpretation to the notions 'similarity' and 'analogizing' is perhaps the most central open problem to be tackled in this context.

2.2. Language behaviour as a Second-signalling System

We asserted earlier that the universals of behaviour are 'describing','manipulating', and 'exploring'. We shall now try to characterize the substantive nature of these behavioural categories with specific reference to language behaviour. We should then be in a position to exhibit the relationship between language behaviour and behaviour in other modalities, and discuss in what sense language expressions function as second-signals.

The pragmatics of language behaviour is concerned with a delimited totality of situations which may be referred to as the world to which the (particular) language relates. A given language, in other words, relates to some given world. Natural language behaviour at the naive level relates to the situational aspects of the natural physical world available at the (unaided) input-output interfaces of human beings: (we consider later the non-naive usage of language, for instance in scientific theory construction). We shall now consider in a somewhat formal manner the categories embedded in natural language in its naive mode of functioning.

Primitively given are sets of agents, objects and actions. Agents are distinguished from objects by the fact that actions are performed by agents, but not by objects. Every agent, thus, is characterized by an action repertoire that that agent is capable of performing.

Among the totality of actions two subclasses are distinguished and referred to, respectively, as computing (evaluating, measuring, finding, determining) values of attributes, and values of relations. Attributes are, primitively, partially computable functions defined over the sets of agents and objects, and assume values from well-defined ranges. Having a specified value in a particular attribute is called a property of the object or agent under consideration. As illustrations of these concepts consider the following.

Length is an attribute applicable to the object, this stick. Let length (this stick) = 5 inches. Then, 5 inches in length is a property of this stick.

Using attributes, objects can be classified into object types as follows: (analogous remarks apply to agents). Objects O1 and O2 belong to the same type if and only if all attributes applicable to O1 are applicable to O2 and vice-versa. Notice that this classification into object types defines an equivalence relation. This classification should not be confused with other kinds of classifications of objects and agents: e.g., classification according to properties (all things red in color); classification according to performable actions (all things that can walk); classification according to specified relationships (all things greater in length than that object); and so on.

The state of an object (or agent) is completely specified if the values of all its attributes are completely specified. Since the totality of attributes applicable to an object (or agent) may be a very long list (or even not completely known at any given time), it is customary to restrict attention to delimited subsets of attributes only at any given moment. Thus, normally, only partial states are specified. Let us use the term 'state' to refer to 'partial state', to simplify terminology, and use 'total state' to refer to 'state' whenever required.

Relations are partially computable predicates defined over two or more states of one or more objects or agents. Notice that, in particular, relations are defined over values of individual attributes. As an illustration consider this: greater than is a relation defined over values of the attribute length. Length is applicable to the objects, this stick and that stick. Hence, length (this stick). greater than. length (that stick) is either true or false.

Agents perform actions. A consequence of an action is a change of state of one or more objects and/or agents. An elementary event is an agent in action, or the change of state of an object or agent. An event is a structured complex (i.e., a network) in time of elementary events.

A situation is a structured complex of agents, objects and events. The totality of situations constitute a world.

In terms of the structure that we have thus assigned to a situation, we can now discuss the nature of the universal behavioural categories, describing, manipulating and exploring.

Describing a situation consists in specifying what objects and/or agents are present (i.e., are aspects of the situation being described), what their states are, what relationships, if any, exist between these states, what events are happening (i.e., are aspects of the situation being described), what relationships, if any, exist between these events, and so on.

Manipulating consists in causing events to happen.

Exploring consists in determining what descriptions apply to the situation under consideration.

In the language modality, these meta-behavioural categories are identified by a variety of names. We list a sample of these below for each category.

Describing	describing, asserting, stating, informing, ...
Manipulating	manipulating, commanding, controlling, ordering, permitting, requesting, persuading, instructing, coercing, ...
Exploring	exploring, probing, querying, asking, demanding, verifying, evaluating, comparing, solving, puzzling-out, experimenting, ...

Let us refer to a language expression that relates to (refers to) some specific aspect of a particular situation as a <u>language behaviour token</u> (lb-token). The unit of behaviour in the language modality is an <u>utterance</u>. An utterance is either an lb-token, or a language expression representing a language schema, or obtained from

a language schema through the substitution of specific lb-tokens for the proforms occurring in the former. The utterances in a natural language describe, primitively, the states and relationships as computed by the sensory-motor mechanisms, and command and control actions performable by the motor mechanisms. Explorations, again, relate to aspects of situations arising in these contexts.

Natural language interaction between two human beings, then, relates, to discourse about, and manipulations of, some class of situations of the naive physical world. The interaction consists in making assertions about the states of objects and agents in a given situation and about the relationship between the states, commanding and controlling actions that cause events relating to the objects and agents in the situation, and asking questions about the objects and agents, their states, relationships between the states, and so on.

We can now elaborate our thesis concerning the second-signalling (i.e., mediating) role that language behaviour plays and how it plays this role. Our assertion is that in any language there exist only a limited number of different schemata of descriptions, commands, controls and questions. In studying a language we study what these schemata are and what classes of situations they relate to.

Learning or acquiring a language consists in acquiring (or, more precisely, building up) the schemata provided by the language to generate descriptions, commands, controls and questions, and in using them to describe, manipulate and explore particular situations. The

interpretational system that gets built up as a child acquires linguistic competence consists of lb-tokens and their structured relationships in terms of associations between:

(a) lb-tokens among themselves,
(b) lb-tokens and sensory-schemata,
(c) lb-tokens and effector (motor) schemata,
(d) lb-tokens and state variables.

Thus, the problem of interpretation of descriptive utterances (i.e., the problem of relating them explicitly to the structured aspects of situations) consists in analyzing the utterances into lb-tokens and their interrelationships and, thus, apprehending the situational aspects and their interrelationships. Similarly, the interpretation problem for command/control, and query utterances consists in performing the appropriate action commanded in the first case, and generating the appropriate response in the second case. Analogous remarks apply to generation of utterances which are descriptions, commands/controls, or queries.

It is to be noted that an interpretational system as we have described it above is a characteristic of an individual. The details of the interpretational system of a given individual could be inferred only through careful studies of the individual's behaviour in a variety of well-circumscribed and well-articulated situations, and by trying to establish correspondences between the lb-tokens in the elicited behaviour, other observed non-linguistic aspects of behaviour, and the several situational aspects.

However, it is clear that the aspects of the situations as determined at the external (i.e., sensory-motor) interfaces should be

comparable, by and large, among the individuals of a language community. Hence, to make communication through language possible at all, the correspondences between the lb-tokens and the situational aspects at the external interfaces should also be, by and large, comparable among all the individuals of a language community. Thus, among these members the details of their interpretational system should agree to a large extent. These are just the aspects that show up as the common aspects of the language behaviour of that community. This is just another way of saying that a child builds up its interpretational system by interacting with a language community and, hence, in conformity, by and large, with the interpretational systems of the individuals of that community.

Before concluding this sub-section, it may be worth pointing out that the language categories and the pragmatics of language behaviour that we have been considering so far can be extended in a natural way to language behaviour that relates to situations not part of the naive physical world. Artificial languages are, thus, those constructed to cope with (i.e., describe, manipulate and explore) artificially constructed worlds. In scientific theory construction, for example, these artificially constructed worlds are (considered to be) formalized abstractions of aspects of the phenomenology of the natural physical world. Such languages, in general, are constructed formally by defining sets of objects with attributes, and action schemata which determine attribute values of given objects, transform one set of objects into another, and so forth.

Artificial languages designed for computer work define worlds whose situations are problem situations. Describing and

manipulating these situations are treated as problem-solving activities. In computer languages, as they are in use at present, in general manipulations play a much more dominant role than descriptions.

In story-telling what presumably one does is to use a natural language to construct descriptions of an artificial world, i.e., a complex of fictive or imaginary situations. We 'people' them with agents and objects with fictitiously assigned attributes, states, and action repertoires. The affective connotations of the lb-tokens available in the interpretational systems of the story-teller and the listner, clearly, determine the affective status of the situations described in the story. These affective connotations mirror the associations, either direct or indirect, between the lb-tokens and the internal state variables.

2.3. The language acquisition process

So far we have been discussing the thesis that acquiring a language consists in acquiring certain classes of lb-tokens and schemata, and relating them among themselves and with the situational aspects in specific ways. We have not said anything upto this stage about the actual acquisition process. That is, we have not said anything about the kinds of primitive processes that must be postulated as being available to the child so that it can build up these specific schemata and associations by interacting with the language community.

From the point of learning theories as formulated and studied by psychologists, one could ask whether language acquisition could be accounted for by invoking only the classical and instrumental

conditioning processes.Skinner takes the view that it is unnecessary to postulate any new kinds of processes to account for language learning. Chomsky, on the other hand, argues that language acquisition is a process that is sui generis, and that it is dependent on unspecified (unspecifiable?) innate endowments. Clearly, both are extreme and untenable views.

The classical and instrumental conditioning processes require careful and systematic tutoring involving the use of reinforcements explicitly administered by the tutor. The Gardners in teaching sign language behaviour to Washoe had to go through such involved and laborious training procedures. These,more or less,correspond to the Skinnerian paradigm. Children, however, acquire language with great ease and spontaneity requiring hardly any tutoring or reinforcement in the normally understood sense. It is, hence, difficult to agree with Skinner that the conditioning processes (as the psychologists currently understand them) are sufficient to account for child language acquisition. Nevertheless, in view of the well-established roles these processes play in animal learning, it would indeed be appropriate to assume that they do play a significant role. But additional processes have to be postulated which substitute for the role of tutors and deliberately administered reinforcements. The problem consists in determining what these processes can be. It is quite evident that many of these must form part of the built-in capabilities of the child considered as a behavioural system and play a central role.in child development in general, and not merely in language acquisition.

It seems plausible to argue that imitation, rehearsal, and analogizing are three closely related and interdependent processes that form the behavioural substrate of the developing child and play a significant role in language acquisition. It is well-known to psychologists familiar with child development that children tend to imitate all aspects of the behaviour of others and this is especially apparent in motor and verbal areas.

Till recently there was a tendency in psycholinguistic studies to dismiss somewhat casually the importance of the role of imitation in language acquisition. This was based on the argument that the child's and the adult's utterances are not identical and, hence, the child cannot be said to be imitating the adult. Also it was assumed that learning through imitation could not teach the child how to be productive.

However, in the last five years or so, psycholinguists have increasingly begun to veer back to the classical view that a child's utterances cannot be related directly to an adult's at the purely verbal level, since the former is partially verbalized and partially 'acted-out'. These body-action schemata really signify the relational structure connecting the one or more words verbalized. The adult's utterance nevertheless serves as a <u>model</u> for schematization, and the child's behaviour is imitative in the sense that just this schema is associated with the apprehended situational aspects and is made use of again when the same or similar situational aspects are encountered. Imitation and analogizing together can be shown to

be capable of realizing a productive process. (For recent psycho-linguistic views on imitation see, for example, Clark (1977)).

In order to determine with much greater definiteness what kinds of underlying mechanisms and processes have to be postulated to account for child language acquisition, there is an urgent need to analyze and systematize from a computational viewpoint the vast amount of very diverse and rich field data relating to child language that is beginning to be accumulated.

3. Computational Modelling of Language Behaviour

3.1. Modelling Language Usage

We shall restrict our discussions here to language usage in conversation at the naive level, since our primary interest is with naive language behaviour. Consider what is involved in conversation at the most elementary level. The conversing partners talk alternately, but there is an internal coherence to this alternating sequence of individual behaviour. If A and B are conversing and A makes a remark, he expects B to respond to it. An important technical issue here consists in being able to articulate what A's expectation really amounts to and how he verifies whether B's response is in consonance with his expectation. (Parenthetically one may note here that very early in the language acquisition process children engage in 'Social Play' or 'Pretend Play' the central aspect of which is 'role-playing'. The verificational ability that A displays above may be viewed as an instance of 'role-playing'.)

The response verification and acceptance takes place within a delimited context. The contextual clues form part of the background information that A has; these are the presuppositions that he brings to bear on the conversation. It must be noted that this contextual background is continuously being modified and augmented as the conversation proceeds. B's answer must not only be in keeping with A's presuppositions of the immediate context of the conversation but also with his general background knowledge about the type of world being discussed.

A conversation relates to some specific situation. The utterances relate to various aspects of this situation. As the conversation proceeds, the conversing partners accumulate more and more information about this specific situation under discussion. But this specific situation is an instance of a whole class of similar situations that could potentially occur. One's general knowledge of the world is built up of characteristics of these classes of situations. This knowledge is acquired through one's personal experience in interacting with the world, through one's studies, from stories, and from a variety of other sources. This knowledge serves as a framework within which the particulars of the specific situation under discussion are tested. These particulars are expected to be self-consistent as the conversation progresses.

Notice that it is precisely this background knowledge that serves as a general framework enabling one to ask relevant questions to probe. One knows what details to expect and, hence, one knows

what details are missing in a given account of a situation. It is not essential that all aspects of a situation have to be explicitly stated. It may be possible to deduce some of the missing details from other available details. Conversational language behaviour, thus, requires problem-solving competence at a naive level. One's conversational capability is also seen to be delimited implicitly by one's familiarity with the world of situations being discussed.

Earlier we pointed out that a child, as it acquires its language, builds up an interpretational system. This interpretational system is precisely the one that is involved in the understanding of utterances as we have been discussing this process so far. Clearly, then, in modelling conversational language behaviour the crux of the problem consists in modelling this interpretation assignment process. Computer scientists, of course, have always been aware of this in designing computational (i.e., programming) languages. The formalization of the interpretation assignment process in this context is accomplished in a certain standard manner as follows.

1. First, one defines a set of primitives or atoms with assigned interpretations.

2. Then, one gives rules for constructing larger language entities, i.e., expressions, phrases, statements, etc., out of these atoms and other already constructed entities. These rules, in general, could involve recursive procedures.

3. One, then, defines an analysis procedure for parsing a given expression, or other higher level entity.

4. The interpretation to be assigned to an expression (or some other higher level entity) is then defined by a certain set of fixed processes which are dependent on the parsed output as well as the interpreted atoms occurring in the expression (or higher level entity) in question.

It is easily seen that this way of structuring the interpretation assignment process assigns a natural structure to a computational language. One can refer to the atoms (vocabulary), the formation rules, and the parsing procedures as constituting the syntax of the language, and the interpretations assigned to the atoms (dictionary?) and the set of fixed processes for assigning interpretations to the higher level entities, as constituting the semantics of the language. It is also evident that syntactic considerations play an intrinsically fundamental role in this way of formalizing the interpretation assignment process.

A translator for a computational language effectively has to make use of a grammar of that language. Parsing procedures must be explicitly given to analyze any given input string. And these procedures must have incorporated in them the vocabulary and the rules of formation either explicitly or implicitly. In this sense, the interpretation assigning mechanism must have the grammar of the language built into it.

This is the view that computer scientists have adopted all along as regards interaction with computers in the natural language mode also. Perhaps the most impressive natural language interaction program that has been constructed up to now is the one due to Winograd (1972). This system is set up to cope with situations in a toy world consisting of colored blocks of several shapes which can be configured in various ways. The system can move these blocks around as instructed, build new configurations, and talk about what it is doing and what it has done. This system has, possibly, one of the most completely articulated grammars of English built into it.

Linguists, as well as psychologists interested in natural language behaviour, would find it well worth their effort to study carefully and in detail Winograd's implementation. If they do so, they would find that the essential strength, as well as the principal weakness, of Winograd's system consists precisely in the fact that its linguistic capability is delimited explicitly by the grammar of English that has been built into it. For, this grammar defines not only how an input string is to be parsed but also how it is to be interpreted. But, as we discussed earlier in this section, how one interprets an input statement (i.e., one's understanding of it) is delimited by one's knowledge of the world. In order to cope with new situational aspects, appropriate additional knowledge has to be supplied. For this knowledge to become effective in the interpretation assignment process, it has to be integrated with the existing knowledge.

In Winograd's case, new knowledge has to be added to the built-in grammar as the interaction proceeds and new (hither to unencountered) situations arise. Since the system's grammar, as it stands now, has been completely worked out by Winograd and incorporated in the system through the use of a special programming language, there is no way of altering it (or augmenting it) except by reaching into the system and incorporating additional chunks of programs. Only Winograd can do this, or only someone who knows sufficiently well the inside of the existing system and the special programming language used in its implementation. In other words, although the system has ostensibly been designed to understand English, and has a rather massive and efficient grammar of English incorporated into it, there is no way of <u>teaching the system in English</u> new knowledge of the world.

The system, to be sure, can accept a certain limited set of definitional statements in English, but substantially our central criticism remains valid. Winograd himself points this out and remarks there is no simple way of augmenting or modifying its present behaviour repertoire through input statements in English. One cannot tell the system, for example, "when you want to pick up a block, first take everything off from the top of it", and expect the system to incorporate this as the initial segment of its 'picking-up-a-block' procedure. Analogous weaknesses are to be found in the response generation part of the pr gram.

In the usual context of using programming languages(in computing activity) such problems are not encountered because one is all the time dealing with a completely closed world of situations.

The question of augmenting the interpretational capacity of the system does not arise. The programmer learns what the system can understand and writes his programs accordingly.

This, then, is the essential difference between interacting in a computational language, as computer scientists normally do, and interacting in a natural language, as children do. In the first case, the language, as well as the interaction, relates to a strictly closed world of situations. In the second case, the language, as well as the interaction, relates to an open-ended world of situations. It would be meaningless to argue that one could take into account all possible contingencies and build their implications into the grammar to begin with. In principle, one cannot deal with an open-ended world in this manner. Natural language behaviour must, hence, be necessarily based on teachability, teachibility making use of that very language.

3.2. PLAS, a paradigmatic language acquisition system

We can summarize our criticisms of syntagmatic (i.e., explicitly grammar-based) approaches to behaviour modelling as follows: (1) there is no natural evaluation procedure for choosing between different grammatical frameworks as biological evolution would demand; (2) there is no way of growing such frameworks or modifying them step-by-step (incrementally) as developmental considerations would demand; (3) there is no way of modifying and/or augmenting such frameworks through experience (i.e., through "particulars").

To satisfy the above three criteria what we need is a framework for behaviour that can be grown (augmented/modified) step-by-step through examples (i.e., paradigms). As we saw earlier in discussing children's language acquisition, a learning principle that has this feature is analogizing based on learned paradigms. Behaviour acquired in one particular situation is extrapolated to a new particular situation to the extent to which the new situation resembles the old one. The primary computation schemes in the paradigmatic approach to behaviour modelling are analogizing principles based on the concept of similarity; (see Narasimhan (1978)).

To test the viability of the paradigmatic approach, a preliminary version of a system, PLAS, that is capable of being taught through examples to function in the language modality has been implemented in TIFR, Bombay (Sembugamoorthy (1978)). The language behaviour that PLAS tries to simulate is somewhat similar to the language understanding and usage behaviour that a student exhibits while going through a 'self-teaching' language manual, say. The manual is typically broken up into 'lessons', each lesson being concerned with a limited set of linguistic concepts and rules which are taught through illustrative examples. Every lesson usually ends in a set of 'exercises' or 'tests' which help to assess whether the student has been able to absorb successfully the fundamentals of that lesson. See for example Figure 1.

It is worth explicitly noting some points about the class of task environments illustrated in Figure 1. A lesson is a coherent text consisting of several interrelated sentences which together

describe a complex situation; often such a text is supported by a visual illustration. 'Understanding', the text amounts to understanding what this complex situation is, i.e., what its several aspects are and how they are interrelated. The questions probe the student's understanding of the text, primarily. At a secondary level, in answering the questions the student also exhibits his linguistic command over the language. For, understanding a question requires sentence comprehension capability, and answering a question requires sentence generation capability. The generated sentence must be grammatically well-formed and also be factually correct (relative to the complex situation described in the text). The 'sentence completion' and 'sentence construction' exercises, on the other hand, test the creative, language-using capability of the student. The answers to these exercises are essentially open-ended and are not delimited by the situational aspects discussed in the lesson. However, these answers cannot be arbitrary. They must relate to potentially realizable situational aspects (even if not to the specific ones discussed in the lesson).

The essential design feature of PLAS is that it is teachable and that it functions in the paradigmatic mode. No part of a grammar of English is built into the system. Nor does the teaching mode involve teaching the system particular grammatical facts about English in a formal manner. The system does not construct for itself a grammar of English (in the linguist's sense) from the examples to which it is exposed in the teaching mode. What the system actually does is to analyze (on the basis of its currently

available language behaviour competence) a complex situation into plausible aspects by converting it into constant parts (schemata) and variable parts (fillers or variables). It is capable of relating newly analyzed aspects of a situation to available, already-analyzed situational aspects. It is capable of synthesizing answers to questions about this situation, or construct new sentences 'creatively'. The system accomplishes all these essentially operating through analogizing principles based on similarity considerations. Figure 2 illustrates some aspects of schematization and similarity grouping that underlie the functioning of PLAS. Finally, Figure 3 gives some idea of the kind of texts the current version of PLAS can cope with. It would take us too far outside the scope of this paper to go into the details of the behavioural mechanisms of PLAS. Sembugamoorthy's thesis should be consulted for this purpose.

The present implementation of PLAS, although quite rudimentary, clearly demonstrates the viability of the paradigmatic approach to language behaviour modelling. By incorporating in an essential way, as part of the structure of the model, analogues of the verbal environments and feedback processes that children are exposed to in the early stages of language acquisition, the paradigmatic approach enables a systematic study of the extent and manner in which these environmental features affect the developmental process. For example, before one can come to grips with the modelling of the understanding of <u>events</u> (as opposed to static world views which is all that PLAS is capable of handling at present) we would have to learn to model the sensory-motor space more adequately. What kinds

of primitive action schemes and primitive integrating processes should we postulate so that using these more complex action schemes can be built up paradigmatically? How can more complex action schemes be built up through instructions (i.e., description) in the language modality? What additional primitive machinery is required to interpret language expressions belonging to the time modality? It seems plausible to argue that primitively the time dimension should be interpreted in terms of the system's own on-going activities. Terms such as 'before', 'after', 'again', 'first', 'next', 'now', should be capable of being interpreted in this way to begin with. It would then seem to be possible to teach the system how to assign interpretations to other time expressions and schemata involving tense-markers.

The pragmatics of language usage in talking about one's own behaviour (or, equivalently, that of a conversational partner) raise several important issues. In modelling such usage of language it would seem to be essential to incorporate in the model 'motivational states' or internal control parameters that essentially play this role. In order to be able to interpret and act appropriately on the basis of statements of the type, "When you are in doubt/difficulty do x", or "If you want to accomplish y, do z", etc., the system must know <u>when</u> it is in doubt/difficulty, or <u>when</u> it is trying to accomplish something, etc.

The second-signalling role of language behaviour can be appreciated most clearly when one considers the methodological aspects of teaching an organism to do something when in some internal state.

In the absence of language, this teaching can be carried out only when the organism is in the corresponding state. The organism must be experimentally prepared to be in that particular state, and then be made to carry out the specific act so that the desired outcome results. This is the well-known operant conditioning technique. With the availability of language, on the other hand, instructions could be imparted by referring to the specific states by name without requiring that the organism be in that very state at the time of training. It is only necessary for the organism to be aware of the names of the states it is in so that the appropriate instructions could be put into effect by relating together the names and the instructions. It is this interface between language behaviour and motivational states that needs to be mirrored in the model.

Yet another crucial aspect of modelling that requires careful study concerns the role of language in the enrichment of the teaching mode. This is the central aspect of the use of natural language as a meta-language. In the present version of PLAS the teaching methodology remains fixed and pre-wired, as it were. The use of comments to aid the interpretation assignment and the consolidation processes is of utmost importance in language-acquisition and interpersonal language interaction. In a running discourse, expressions like, "as we have been arguing", "on the contrary", "in exactly the same way", "and so on", "respectively", "analogously", "similarly", "roughly speaking", "in a manner of speaking", "so to speak", and a host of others, relate to the interpretation assignment process and are intended to tell the hearer/reader in what way expressions are to be understood.

Some of the other features that are missing in the present version of PLAS and which have to be modelled within the paradigmatic framework are: naive inferring (going from general statements to particular instances of them), naive theorizing (going from particular statements to general formulations), the use of quantifiers (some, all, none, a few, many, etc.), the use of sentential connectives (and, or, not, therefore, because, for, etc.).

After two decades of hard work, it is only now that computer scientists are beginning to have a reasonably satisfactory theoretical understanding of the issues involved in syntagmatic language processing. It is not unreasonable to predict that a comparable effort would be needed before we achieve a similar articulation and understanding of the theoretical problems that underlie paradigmatic modelling of behaviour, in general, and of language behaviour, in particular.

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PLAS, A Paradigmatic Language Acquisition System

(V. Sembugamoorthy)

A. Task Environment

Ability to be taught situational aspects described by a 'text' and to demonstrate the behavioural competence acquired through (i) answering questions about the text; (ii) understanding a similar new text; (iii) constructing sentences using given language expressions.

Lesson

This is a pencil. This is John's pencil. It is on his desk. It is red. John's book is also on his desk. The book is not red. It is green. It is also heavy. It is heavy because it is large. The girl next to John is Mary. Mary's books are on her desk. Her notebook is inside her desk. There are many class rooms in the school.

Exercises

1. Questions

a) What is the color of John's pencil?
b) Where is it?
c) What is on John's desk?
d) Why is his book heavy?
e) Where is Mary?
f) What are on Mary's desk?
g) Where are Mary's books?
h) What is inside Mary's desk?
i) How many class rooms are there in the school?

2. Complete the following sentences

a) Mary is _____
b) Many class rooms are _____
c) John's pencil is _____

3. Use in sentences of your own

a) (Peter, pencil, table)
b) (Pen, box)
c) (Peter, Jane)

Figure 1

PLAS : Fundamental Principles

Language acquisition is predicated on the availability of sensory-motor structures in terms of which the situational aspects of the world can be apprehended.

The interpretational system that gets built up during language acquisition consists of language-behaviour tokens (lb-tokens) and their structured inter-relationships through associations between

(i) lb-tokens themselves via language schemas
(ii) lb-tokens and sensory-motor schemas
(iii) lb-tokens and sensory-motor tokens.

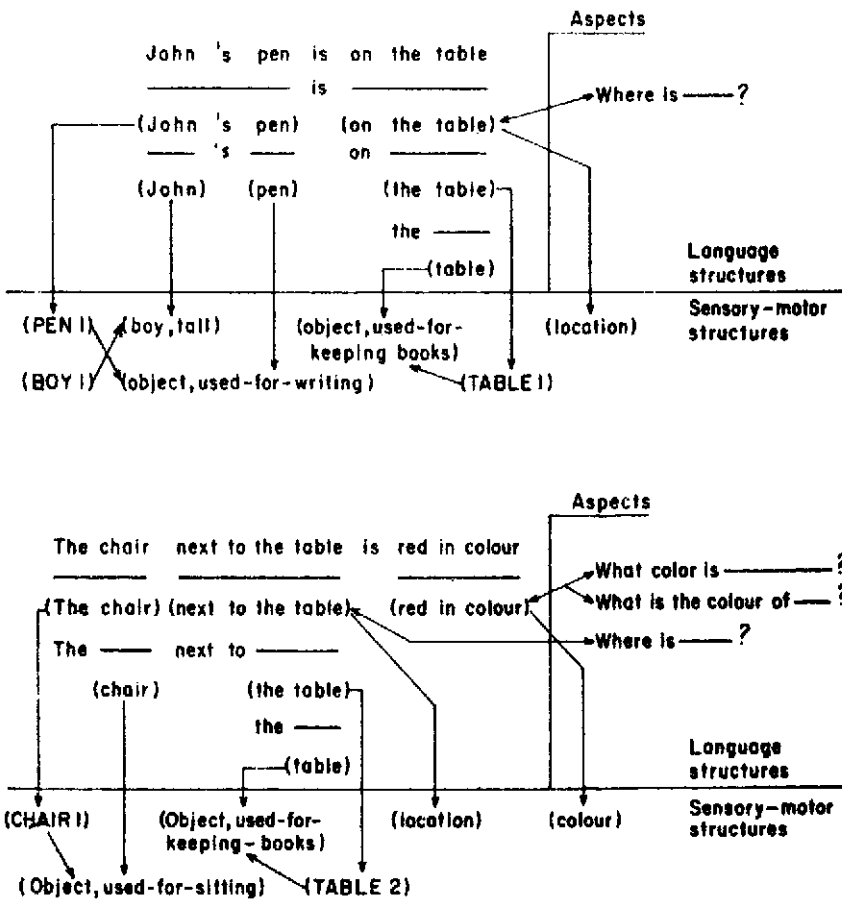


Figure 2

An illustration of the competence of the present version of PLAS

Having been taught 'Text 1' in the teaching mode, PLAS could understand 'Text 2' in the testing mode.

Text 1 : A chair and a table are near the window. The chair is brown in colour. The table is red in colour. A desk and a chair are in the middle of the room. The brown chair is made of wood. The one in the middle of the room is made of plastic. The chair made of wood is heavy.

Text 2 : This is a chair. There is a box on the chair. It is heavy. The box inside the shelf is light. The heavy box is green in colour.

Figure 3

CHAPTER III

THIRD WORKING SESSION

"COMMUNICATION, UNDERSTANDING AND SOCIETY"

Man's curiosity about himself surely dates from his first arrival on earth, equally surely extending yet further into the past in a simultaneous search for an explanation of his origin and for his raison d'être. The third Working Session of the Paris Symposium, looking at the most advanced attempts to analyse and simulate human communication, no less surely marked man's continuing dogged persistence - and growing success - in understanding his own inbuilt secrets and constructing analogous competitors... which (at least in speed and accuracy) have already shown their superiority at some levels of logical evaluation and "thought".

The third Working Session, sub-titled "Communication, Understanding and Society" began with two profound intellectual exercises in the challenging tradition of their alma mater, the Sorbonne University (now known as various numbered units of the University of Paris). In two largely complementary papers, Professor J.F. Le Ny and Professor J.C. Simon provided a high-level introduction to the theory and practice of Communication Mechanics[+].

[+] For the full texts of the two papers, see pages 221 and 276 respectively.

Professor Le Ny's paper, "Communication between Individuals, Classes and Groups", was in fact a treatise on comprehension - an activity fundamental to communication as had already been recognised in the previous sessions[+]. Assuming that human comprehension is (as seemingly it must be) an "algorithmic activity", Professor Le Ny reviewed recent work by a number of specialist teams including his own which essentially suggested :

- that basic comprehension algorithms are stored in the human (and indeed all other animal) brain;
- that the operation (execution) of the algorithms depends on a form of "semantic memory"; and therefore
- that the ability to comprehend a "message" in the way intended by the person transmitting it must depend on equivalence between the receiver's and the transmitter's semantic memory[++].

Applying these ideas to class and group communication, the Professor indicated the importance for communication of social behaviour (a form of communication in itself), and the importance of certain innate or intuitive abilities as opposed to those which might be acquired through (e.g.) learning.

[+] Though not, unfortunately, always recognised elsewhere.

[++] See Professor Le Ny's full text, pages 271 to 274.

Professor Simon carried this basic analysis forward to present a practical demonstration - through diagrams, projections, and a remarkable recording of a totally artificial voice generated in a mini-computer from a typed input message. This most impressive performance, although it seemed still a very long way from "true artificial intelligence"[+] was an invaluable display, for those not frequently or closely in touch with research of this nature, of the tremendous advances which have been made not only in computer programming but also in the computing machines themselves. In particular, the ability to carry out extremely complex (and/or tedious) computations in "on-line" central equipment for, e.g., exploratory satellites investigating the solar system or further afield, is a dazzling tribute to the non-artificial intelligence of Man himself.

It should nevertheless perhaps be noted (as remarked by the mathematician Professor Lions in the first session - second Round Table) that the tremendous advantages offered by modern computers - and by the now extremely sophisticated programs for their use as well as "peripheral" equipment which a few years ago would have been unrealisable even if conceivable[++] - still appear to be no more than very advanced "mechanical" copies of certain human brain functions. The idea that machines can be endowed with the equivalent of mental

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[+] However that might be defined.

[++] It is for reflection (though this was probably outside the scope of the Symposium) that the development of technical equipment and of concepts for its use and further development, generally go hand-in-hand. Modern large-capacity digital computers would surely have been inconceivable without the transistor, whose arrival immediately opened fields of logical simulation which themselves had previously been inconceivable.

initiative ... or even decision-making powers other than those built-in by their human designers, still seemed to most of those present (if not all) difficult to justify either through experience or through logic.

Descending from such heights of cerebral exercise to more earthly intellectual and cultural problems, at least some Symposium participants must have been struck by the contrast between the microscopic analysis of voice patterns displayed on an oscillograph and the macroscopic approximativity of "ordinary" discussion in the afternoon Round Table sessions[+]. These dealt with "Problems of Group Acceptance of Information", and "Cultural Problems of Technology Transfer".

The "Group Acceptance" Session was chaired by Professor Henry Tajfel of Bristol University (UK), and the panel included Professors Louis Dumont (Paris University), Pietro Omodeo (Padua University, Italy), Torgny Segerstedt (Uppsala University, Sweden), and Akira Tsujimura (Tokyo University).

Professor Tajfel directed the attack from two viewpoints :

a) acceptance of information as a function of the (accepting) group's internal composition, structure, function, goals and ecology; and

b) acceptance as a function of the group's relations with other social groups within a wider social structure.

[+] Approximativity emphasised and augmented by the unfortunate coexistence of an unusually high noise background including powerful hammering in a nearby office and occasional disturbances from a rogue telephone bell in one of the conference rooms.

He believed the second issue to be of much greater importance, and much greater potential danger to societal stability, than the first, and was particularly concerned by the possibility of complete communication blockage when conflicts occurred between groups which were basically interdependent. Unfortunately, the causes of conflict frequently included a strong desire by such interdependent groups to represent themselves as independent, an objective clearly irreconcilable with reality.

Other causes of conflict cited by other speakers included those based on the difficulty of admitting "the truth" about some particular development or event which seemed culturally unacceptable. For example Professor Omodeo (a biologist) described the rejection, some centuries ago, by doctors and pharmacists of a new medical discovery which ran contrary to the medical beliefs of the day[+]. Somewhat related was the modern difficulty - perhaps encouraged by many peoples' concept of the mass-media as a type of propaganda machine - of convincing the population of, for example, the real magnitudes of comparative risks associated with different methods of producing electrical power. As Professor Segerstedt remarked : "When we receive a message which is relevant to an old custom we generally ask a person we regard as an authority, but we do not seem to have any 'real' authorities with regard to new fields of information."

[+] Shades of Galileo!

A particularly interesting contribution was that of Professor Tsujimura, one of the few participants in the Symposium to go in any detail into differences between Western and Eastern thought - the bringing together of which is among the objectives of DISCOVERIES. Professor Tsujimura described the influence of Zen on the Japanese way of life and attitudes, making it clear that these attitudes could be of particular assistance when contemplating revolutionary and perhaps unexpected changes in the material world... the environment. The West follows Descartes' "I think therefore I am" in recognising the Ego as a fact of life through which all perceptions are made. Zen, on the other hand, does away with the notion of Ego, this being most obvious in Japanese Zen art. Objects are represented in such a way as to capture their "essence", whilst the personality of the artist is totally bypassed.

The Round Table discussion on the "Cultural Problems of Technology Transfer", which was chaired by Professor Zvonimir Damjanovic, Director of the Multidisciplinary Studies Centre in Belgrade (Yugoslavia) brought together Dr. Jean Cloutier, Director General of the International Institute of Communication in Montreal (Canada), Professor Harold A. Linstone of the Futures Research Institute of Portland, Oregon (USA), Professor Alwyn C. Scott of the University of Wisconsin at Madison (USA) and Professor Donald Ekong, Vice-Chancellor of the University of Port Harcourt in Nigeria.

One of the immediate impressions gained was that technology transfers often (usually?) concerned technology that the advanced countries believed the developing countries ought to have (rather than what the developing countries were themselves seeking), the transfers being frequently favoured because of their indirect commercial profitability for the manufacturing (and other) organisations concerned. Moreover, on occasions when priority was given to evident needs (one example cited was the supply of radio communications equipment to medical posts in Nicaragua, to enable clinical advice to be obtained rapidly from a central control station) there was in fact very little real technology transferred, but rather a series of operating "black boxes" requiring minimal expertise for their use. In these circumstances it was hardly surprising that Professor Ekong should call for greater emphasis on the transfer of basic scientific knowledge and competence rather than "packaged technology". At present, such basic knowledge was, more often than not, acquired without external help and sometimes with very great difficulty.

This led to a second major impression from the Round Table discussion, namely how elementary was a great deal of the technology available in the developing countries. As an example it was said (not by Professor Ekong, although he did not disagree) that automobile servicing in Nigerian cities such as Lagos was extremely poor simply

because very few of the mechanics had undergone any formal training for their jobs, and very few understood the basic principles of a motor car. (Service in the Nigerian countryside however was usually much superior, due to the country garage proprietor being obliged to "generate" his own technology by cannibalising several cars to build one working model.)

The Round Table was in fact disappointing - not in the quality of the contributions but in the realities revealed concerning technology transfer in practice. Whereas the morning's papers by Professors Le Ny and Simon had taken participants to the frontiers of some of the most advanced technologies in the world, this afternoon had shown how enormous was the gap between these and what was being passed on to less-developed nations[+]. The unhappy conclusion, in this highly intellectual Symposium where men made in God's image were busily constructing new gods in their own image, was that the cultural problems of technology transfer could hardly be discussed, for the technology transfer itself was insignificant.

These points were confirmed in the summary session the following morning, when Professor Damjanovic suggested that "technology transfer" could be defined at various levels ranging from sale of new technical equipment (e.g. the communications equipment supplied to the Nicaraguan medical service), through deeper levels of education and training in

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[+] There are of course reasons for this "on both sides" (flowers must bloom before they can be fertilised) and some of these reasons comprise some of the cultural problems of the transfer of technology.

the technical principles of the equipment concerned, to levels of basic knowledge transfer "... with special emphasis on the upgrading of the technical cultural level of the receiving social groups." It had even been proposed, the Professor recalled, that the transfer of technology as such and the transfer of "scientific culture" were sufficiently different to merit their being studied separately, and he felt this proposal might be borne in mind when planning future symposia.

Meanwhile there was no doubt that the transfer of technology could give rise to cultural problems if/when it took place between groups of substantially different educational levels - so much so that there could be active opposition from those intended to benefit from the transfer, in other words a form of "group rejection".

Here Professor Damjanovic saw a close relationship with the questions discussed by the parallel Round Table led by Professor Tajfel, who himself had been quick to remark that his panel had been concerned more with the problems of group rejection of information than with those of acceptance[+].

Professor Tajfel also pointed out (as was evident from Professor Le Ny's paper) that there could be important differences between the mechanisms - and consequences - of individual and group acceptance or rejection of information ... and he cited examples making

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[+] At least some participants, in fact, maintained that the only problem of group acceptance of information as such (i.e. excluding problems which might result from acceptance of "unhelpful" information) occurred when the acceptance did not take place.

it clear that group behaviour was (naturally) dependent on the nature of the group and that (unfortunately) it was by no means always rational, scientifically or logically.

In the case of individuals, however, as Professor Le Ny and others had noted, reactions to received information depended on the individual's previously-established concepts and "semantic memory", and this could also mean that acceptance or rejection could be decided by more or less arbitrary factors.

A most interesting and instructive contribution to the discussion of acceptance or rejection of information came from the Chairman of the summary session, Professor Harry E. Gunning (President of Alberta University, Canada) who reported on some practical experiments which suggested that the human brain will normally and automatically (subconsciously) prepare for the rejection of <u>any</u> information communicated to it because (in the Professor's words) "... attempting to convey information is an act of ego-invasion and, as such, if we attempt to invade the ego of another there is a natural tendency to resist."[+] This must mean that the acceptance of information normally involves a conscious effort, doubtless accompanied by a tendency to select and perhaps modify what is accepted. A further conclusion must be that attempts to <u>force</u> information on to others are virtually certain to fail, and

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[+] The practical evidence cited by Professor Gunning was the discovery that, when a person A attempts to talk to a person B, the vocal chords of person B immediately begin vibrating in subsonic patterns apparently opposed to the patterns stimulated by person A.

that the most effective communication is likely to result from "working together and sharing information", so taking advantage of the backgrounds (concepts, semantic memories) of both, or all, the persons involved.+

Professor Tajfel, returning to the distinctions suggested by Professor Tsujimura between the Eastern and Western approaches to communication, reminded his colleagues that the foregoing arguments based on ego-importance, ego-invasion and ego-resistance were difficult to reconcile with Eastern thinking (such as Zen) from which the notion of Ego is excluded. Citing again Descartes' "I think therefore I am" as fundamental in Western approaches, Professor Tajfel arrived - via "I am therefore I think" which he believed was more appropriate for some of the great civilisations of the past - at "we think; we are, and therefore I think" which was at once more humble and more contemplative and therefore perhaps not incompatible with Zen. This route also provided a rational linkage between individual and group attitudes whether in accepting or rejecting the communication of information. It clearly showed that a group was more than the sum of the individuals therein, and could possibly explain (in a tentative manner) the creation of new groups in an evolving society even though individual members might have strong homeostatic tendencies.

+ Could this be the reason for the success of the Socratic method of instruction, described by Plato as "midwifery" because Socrates tried to convince his students that the information he was communicating already existed within them, having only to be "brought out"?

Endeavouring to summarise the causes of group non-acceptance of information, Professor Tajfel concluded that four main factors were involved :

- clash of interests (i.e. clash with the interests of the group);
- clash of values (i.e. clash with the values of the group);
- conflicts between values and structural "predicaments" (situations), where the predicaments were over-riding and could not be altered to resolve the conflicts;
- clash with "new ignorance" (inability to understand evolving developments - particularly those of advanced technology).

Unfortunately, the identification of these factors was by no means a guarantee that the conflicts involved were resolvable : however the Professor believed such resolution might be achieved by a combination of assimilation (the modification of new information in already existing cognitive structures according to the nature of these structures) and accommodation (the modification of the cognitive structures according to the nature of the new information received). Both these processes were large-scale and in competition, and it was necessary to establish a balance between them if the new information was not to be automatically rejected... or lost. For if assimilation predominated over accommodation, the information was likely to be distorted beyond recognition, while if accommodation was predominant, then the previously existing structures would be destroyed and would disappear.

And if there seemed to some to be a hint of tautology here, it was doubtless because the group concerned was tending to reject both.

It was left to Professor Simon to bring this somewhat self-prolonging excursion into mental esotericism back to what might have been called a practical level. Professor Simon had tried to make computer models which could receive information and learn, and had found this extraordinarily difficult. In particular, unless "incoming" information could be subjected to an important degree of selection and "filtration", instead of learning the model fell into a state equivalent to either epilepsy or catalepsy. This suggested that human beings, who suffered such effects comparatively rarely, were equipped with remarkable protection against incoming information. Thus rejection of a great deal of information, whether by individual or by groups, was probably essential for the maintenance of social stability, and could probably set a limit to the rate of advance of "communal knowledge" beyond which the community would most likely be destroyed.

Professor Simon had discussed these questions in detail with Professor Narasimhan (whose analytical approach to understanding, in his paper two days earlier, had in many ways complemented the paper of Professor Le Ny) and the two Professors now wished to propose the organisation of a "workshop" to investigate more profoundly the mechanisms of information transfer, acceptance and rejection, and learning. The proposed workshop would give particular attention to

these processes in children, who probably offered the best practical examples of the processes to be investigated.

"Starting from the pre-linguistic period" said Professor Simon, "and passing through the early language stage, the ultimate aim would be to articulate the language acquisition process and the development of the stages through which this acquisition was accomplished." He continued "We want to determine explicitly what are the pre-conditions for this accomplishment, what are the necessary environmental supports, what is the nature of the behavioural machinery that serves as an infrastructure for language acquisition."

Commenting on this proposal, and particularly on Professor Simon's concept of information selection as part of the human protective and stabilising mechanism, Professor Barrington Nevitt was convinced that some such filtration was essential to enable the human mind "to make sense of the environment". The mechanism probably had a partly cultural, partly intuitive basis, and the Professor believed most people, on reflection, could discern such a mechanism operating within themselves to arrange all received information in order of precedence (and then allowing that with least precedence to disappear).

Professor Nevitt questioned whether a project based only on western scientific method (which was how he saw Professor Simon's proposal) would be adequate to bring understanding of the rich variety of communication processes which had evolved with the evolution of man. He therefore hoped attention would also be given to the eastern processes

of perception through contemplation, such as Zen, and to the "contemplation of space" as in the Japanese Ma, on which he hoped Professor Tsujimura might be persuaded to speak.

Professor Tsujimura did indeed then endeavour to explain Ma to his western colleagues, saying that its nature could be found in the Japanese No theatre, where the actors moved extremely slowly so giving emphasis to any action taking place.+

Coming back to Professor Simon's practical proposals, it seemed that what was needed was not just a "workshop", but a major research programme.

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+ This explanation may well have been useful to those familiar with No (which to at least one observer has seemed an approximation to Professor Nevitt's "acoustic space") but for others it must surely have been the representation of one unknown in terms of a second.

Text of paper by Professor Jean-François Le Ny

COMMUNICATION BETWEEN INDIVIDUALS, CLASSES AND GROUPS

Communication problems have been for a fairly long time, and sometimes still are, studied independently from their semantic aspects. The legitimate distinction between that which can be approached in a scientific manner and may thus fall within the competence of the communication science(s), and that which remains the private and exclusive realm of each individual, with unique characteristics and highly individual related feelings as well as, finally, literally inexpressible aspects of a number of actual experiences, has led to a deep practical and theoretical schism.

Several of our contemporaries have thus come to the conclusion that we cannot speak of communication in the full sense of the term, that is to say of successful communication and therefore comprehension, other than in terms of its non-existence. An uncompromising and provocative idea which, as Wittgenstein has clearly shown, can and must lead only to silence.

However, the situation has changed to the extent that the spirit of scientific research has recently penetrated this area also. Almost simultaneously linguists,

information specialists and psychologists, following perhaps a little behind the logicians, have begun to tackle the problems of comprehension with new concepts and various though convergent methodologies, all of which make systematic use of experiment or at least empirical verification. Thus a whole new field of study has been opened around semantic problems.

We can never, of course, be certain in advance whether or not a difficult problem can be resolved (except when in all innocence, we are seeking financial backing for research); however, although history can offer counter-evidence against being too dogmatic in the following assertion, we may conclude that there is a greater chance of solving a problem if it is formulated systematically, in accordance with an existing framework of knowledge and a proven methodology.

Within the vast field covered by semantics, the present paper will deal only with a number of questions related to comprehension phenomena, and will cite some experimental illustrations from research programmes devoted to these phenomena.

The paper's initial approach will be from the angle of individual psychology, examining the basic mechanisms

of comprehension and the conditions that make comprehension possible. Only then will attention be turned to questions concerning class or group relationships in this matter. As we shall see, this approach does not underestimate the social aspects; it merely presupposes that an analysis of the psychological functioning of individuals will enable us to form a clearer and more precise concept of communication, or failure of communication, between classes and between groups.

For simplicity's sake, the following discussion will be limited to analysis of communication by means of natural language, and of the purely semantic aspects of the latter. As we all know, the ways in which we dress, cut (or do not cut) our hair or beards, drive our motor-cars or behave generally, are also means of social communication; in addition certain phonetic characteristics of language itself - what we call an "accent" - or syntactic, lexical or idiomatic characteristics, which cause an individual to be identified as hailing from Belleville or Berry, Quebec or Belgium, as being a labourer or a teacher, an old crank or a trendy youngster, are all significant in some respect. These many aspects will be deliberately ignored, in order to concentrate on some other

questions which appear to be more fundamental.

Taking this approach, there are two main categories of problems of interest to the general psychologist. The first can be formulated concretely as follows : what happens in a man's mind when he understands a fragment of speech, perhaps a single phrase or sentence? I have used the words "in the mind" rather than "in the brain" - although this last term expresses more exactly the same idea - to emphasise that I am not adopting a physiological or even neurological point of view; this means that this first category of problems may be re-formulated by saying that they concern the psychological processes of comprehension activity; a different formulation will be found further on.

The second category of problems originates in the conditions governing comprehension, and essentially in the background information that is necessary for any "speaker" - from now on we may agree to call him a "comprehender" - to be able to extract the meaning from a sentence. The corresponding research is then devoted to the cognitive structures of the comprehender; as these depend, to a large extent at least, on what the individual has previously learned, they will frequently be referred to under the heading of semantic memory.

A third type of enquiry, which tends to cut across the two others, consists in finding out where the exact demarcation lies, within these processes and structures, between that which is innate - or more precisely endogenous, even though it may develop only at the time of acquiring language in later years - and that which is learned, acquired through the individual's interaction with the world about him. This demarcation is not, at present, identifiable with any degree of precision, and we know the problem is a highly controversial one. Rather than examining it here, however, I propose to attack the same problem from another angle : by asking what, in the activity of comprehension, is universal, common to all mankind : and what, on the other hand, differentiates and sometimes divides the various social communities and notably different groups and classes?

UNDERSTANDING

Let us tackle the first problem : what, in the eyes of scientific psychology, is understanding?

I have noted elsewhere (Le Ny, 1978) the different meanings of this question, and I shall limit myself here to that indicated above : namely, what are the psychological processes of comprehension?

Most if not all experimental psychologists would doubtless agree that the activity of speech comprehension in mankind can be described in terms of general concepts relating to information theory. To understand a sentence or a text is, in these terms, to absorb and process coded data in such a manner as to transform the visual or auditory message, in the form in which it physcially reaches the sensory organs, into a particular sort of transitory mental structure, which forms "in the mind" of the individual and remains there for a short instant. This is what we call the meaning of the sentence.

Each of us has experienced this phenomenon subjectively, particularly when, confronted by a rather difficult, ambiguous or comical sentence, we have the feeling of "having understood".

Usually, this meaning-of-the-sentence-in-the-mind-of-the-comprehender is, as soon as it has been elaborated, displaced from its owner's mind to make room for understanding the following sentences of a discourse or text, or alternatively to allow the mind to act according to the content of the received sentence, if this contains directions. The meaning of the sentence then passes into a less transitory memory register, where its future can

vary considerably : sometimes - let us be frank and say "often" - it is rapidly forgotten, or altered to a more or less important degree; sometimes it is integrated into the more general meaning of the discourse or text; and sometimes, though perhaps rarely, it subsists in its entirety in a lasting fashion.

It is of course impossible to observe directly what happens in the comprehender's psychological activity during the few seconds he needs to grasp and process received information. The task of experimental psychology is to discover and put into practice indirect means of studying what until quite recently was considered to be unfathomable. I shall refer to some concrete examples of the way in which this has been done.

However, I should first point out that, seen in this light, a certain amount of research in the field of artificial intelligence and more especially in the field of what might well be called artificial comprehension, is convergent with the work of experimental psychology; this is the case even when the research is not explicitly inspired by psychology, or further when it is explicitly non-psychological in inspiration.

In this last case we are sometimes obliged to recode what is said, or the way in which it is said, but this search for a common conceptualisation is nearly always worthwhile. We do in fact sometimes come across the idea that research in the field of artificial intelligence - and, by extension, in that of artificial comprehension - the explicit objective of which is to simulate mental processes, is of a different nature from that which merely attempts to carry out by artificial means (informatique) certain tasks identical with some of those carried out by man, but without any special intention on the part of the scientist to create a true psychological simulation. In fact, when designing a robot capable of carrying out certain human activities of a material nature, for example moving about or manipulating objects, we can imagine that to obtain the same result - that is, the same displayed physical behaviour - the artificial processes of informatique would differ considerably from the corresponding internal human processes.

However, the position is different in the case of semantics, where sense or meaning have no intrinsic reality beyond that deriving from man. This is why it seems

probable that, as we try to simulate human performances in the comprehension of natural speech, we must necessarily also simulate the corresponding human mental processes. This is, of course, a long-term epistemological prediction; it should not lead us to underestimate present differences, in each concrete case and at each stage, between the programs and models of informatique and psychological facts.

WHERE "COMPREHENDERS" COPY COMPUTERS

One of the most fruitful general questions to be explored over the last few years is that of the extent and modalities of serial processing in human comprehension.

The fundamental idea behind the research is that human comprehension, like that which we are trying to simulate by computer, is based on a series of distinct elementary processes; the problem is to identify them.

This problem is already difficult even when dealing with psychological activities involving an observable element. Thus comprehension which necessarily involves a series of successive perceptions, can be observed in the case of reading by studying eye movements, or more precisely the pauses in eye movements. But it is certain that each of these mini-pauses, which constitutes in itself a distinct

and complete act; is also occupied by a more elementary series of micro-activities : the reader must, for example, correctly divide the sentence he is reading into segments (and in some cases, as with a pun or an ambiguous discourse, he must perceive the alternative segmentations possible); simultaneously he must recognise the phonemes of syllables which constitute a word, identify this latter both as a "unit" (for example, the French word "courant") and as a specific lexical form (in the case of the word "courant", either as a form of the verb "courir" - "to run" - or as the noun or the adjective "courant" - a "trend" or "current"). In addition, this identification must frequently take place - in contrast to what has so far been achieved in artificial comprehnsion - following a more or less probable anticipation of its nature. These phenomena of perception - defined by identification - that is to say the phenomena of active acquisition of information in its physical form, of course exist also in the comprehension of oral speech; however for the moment the techniques at our disposal for their recognition are very indirect and complex, as will be seen from an illustration later in this paper.

Phenomena of perception are however only a part of comprehension, and to limit oneself to their particular

sequences would clearly be to miss much of the essential basis of semantic processes. For we have every reason to believe that "what takes place inside" is also a composition of elementary operations which, in a number of cases, are additive in form. A few more details of some research will, I believe, illustrate this.

A type of experiment which has been fairly widely used during the last few years (for example by Carpenter and Just in 1975; Chase and Clark in 1972; Dubois and Weil-Barais in 1977) is based on the principle of verification tasks. These usually consist in presenting subjects, either simultaneously or successively, with two "packets" of information : a drawing on the one hand and on the other a simple written sentence. The task of the subject is to say whether the sentence correctly describes the drawing, and to answer this question by "true" or "false". One could, for instance, show a superimposed star and cross, with sentences such as : "the star is above (or below) the cross" or "the cross is above (or below) the star", or with corresponding negative sentences such as "the star is not above (or below) the cross". The coupling of the drawings and sentences is always arranged in such a way that 50% of the latter are true and 50% false, the order of presentation

being random and each couple being presented several times in this random repetition.

The subjects respond by pressing any one of two buttons labelled "true" and "false". Mistakes are highly unlikely in this extremely simple situation : those making more than a small percentage of mistakes are eliminated.

The experiment is essentially carried out as follows : the subjects are asked always to answer as quickly as possible. The times taken to answer are recorded, and from these times inferences are drawn as to "what is going on inside". Using a sometimes fairly sophisticated form of variance analysis, coupled with efforts to adjust theoretical models statistically, attempts are then made to reconstitute step by step the mechanisms of comprehension, working on the basic assumption that during the interval between the initial presentation of the material and the subject's response (which is generally less than a second) a series of cognitive processes takes place which a well conducted analysis should be able to isolate.

We may examine as examples some experimental results obtained by Hoffmann and Klix (1977). These are taken from a series of nine experiments based on a drawings/

sentences verification task of the type described. The simplest of these were of the type "the door is (is not) open (closed)"; others were of the type "the x is a and (or) b". From these series I have chosen some experiments where the sentences comprised a grammatical subject ("the boy" or "the girl"), a verb ("throws" or "catches") and a direct object ("the ball" or "the ring"). All the possible combinations of these three pairs of terms were used, together with their corresponding schematic drawings. In the cases of "false" sentences, there was never more than one of the three elements that was incorrect.

One of the points of interest in the experiment was that it was conducted in German, a language with declensions which therefore allows a much greater freedom in word order than do, for example, English or French. The authors were therefore able to interchange the subject and the object, which as will be seen is a very favourable experimental circumstance. Thus we obtain :

"Der Junge fängt den Ball")
) ("The boy catches the ball")
or "Den Ball fängt der Junge")

Let us consider the results concerning the mean time taken to respond in the following four cases :

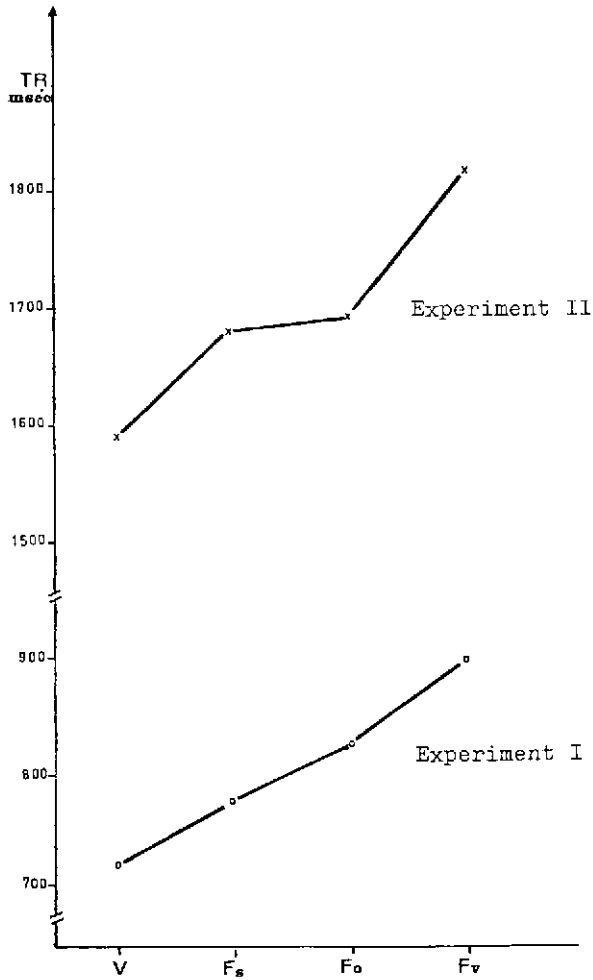


Figure 1

Response times in the case of successive presentation (Experiment I) or simultaneous presentation (Experiment II) of the sentence and the drawing.

V (vrai) = "True" response

F_S = "False" response where the subject is wrong

F_O = "False" response where the object is wrong

F_V = "False" response where the verb is wrong.

(1) "true" response (t); "false" responses : (2) when the subject is incorrect (Fs), (3) when the object is incorrect (Fo), and (4) when the verb is incorrect (Fv). Figure 1 shows that the response times follow this order. Why?

Several control experiments, in which the drawings and sentences were presented simultaneously or successively, or where the orientation of the drawings was varied - for example with the person facing left and the ball on his left, or vice versa - or finally (as already noted) where the order of subject and object in the sentence was varied, demonstrated the stability of the results in Figure 1. Figure 2, for example, shows the effects of altering the relative positions of subject and object in the sentence.

The authors interpret these results by means of a model which implies the following processes : after "encoding" the sentence (for reasons that are too elaborate to go into here, psychologists generally use the term "encoding" where earlier and more classical communications phraseology would say "decoding") the comprehender mentally compares each of the significations of the words with the corresponding representative elements in the drawing : person, object, action, and these comparisons are successive.[+] In a quantitative model which adds precision to this interpretation, it is supposed that an elementary process of comparison will take approximately 60 milliseconds, and that the emission of a "false" response will "cost" 175 milliseconds more than a "true" response; I shall return later to this matter of "time cost" and falsity.

[+] Figure 3A

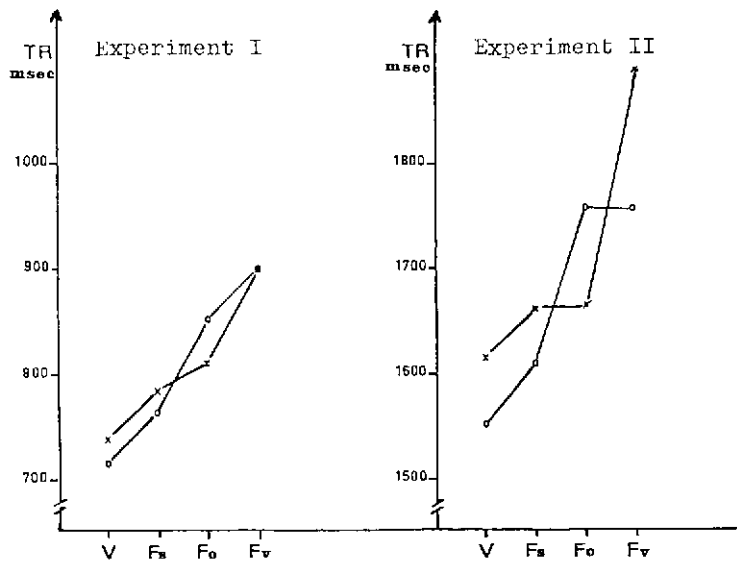


Figure 2

Response times in the case of successive presentation (Experiment I) or simultaneous presentation (Experiment II) according to whether sentences are in subject-verb-object order (circles) or object-verb-subject order (crosses).

The agreement between empirical and computed factors on the basis of this model is very satisfactory as can be seen from Figure 3B.

It is not my intention here to comment on the general validity of this model of Hoffmann and Klix; however, I wish to insist on two points as follows : firstly, it seems that a serial additive model, which assumes that the subject's response follows a series of successive elementary operations, is in this instance well matched to the experimental observations. There is another series of different experiments which leads to the same conclusion, though this does not mean that comprehension processes always take place serially - on the contrary, other situations have been found where comprehension appears to "work" by means of parallel processes, including loops. However, the notion of elementary operations - that is to say the notion which justifies this type of analytical study of the mechanisms of comprehension, is confirmed by this additional evidence.

The second point I should like to emphasise is this : the comprehender's examination of the agreement between the significations of the principal words in the

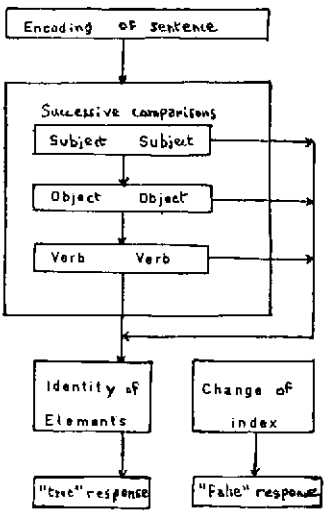


Figure 3A

Hoffmann and Klix model

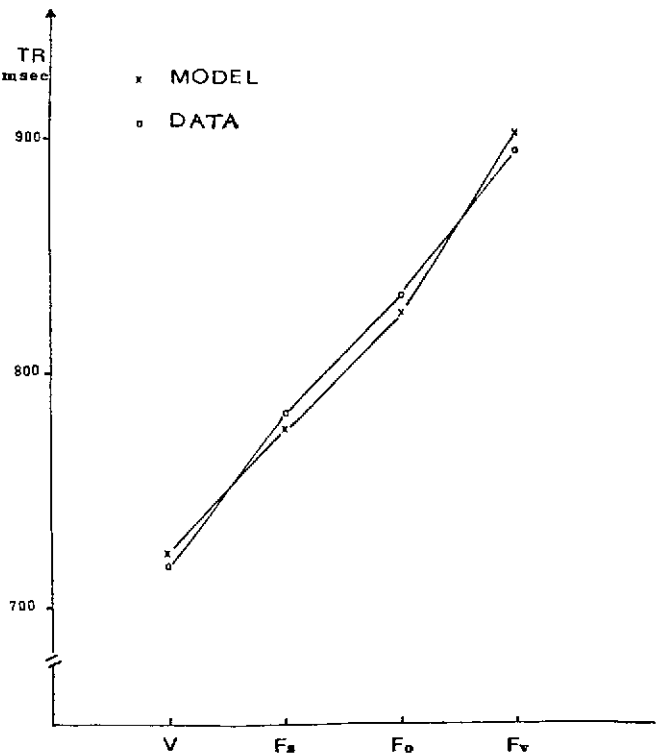


Figure 38

Agreement between experimental values (empirical data), and values computed from the model.

sentence and the principal elements of the drawing is in no way based on a linguistic, and more particularly a syntactic order (subject - verb - object, or object - verb - subject), but rather according to a semantic or cognitive order. The comprehender examines first that which concerns the human individual who acts (the agent), then the inanimate object involved in the action (sometimes known as the "patient"), and thirdly the nature of the action itself.

Without going into details of the possible explanatory hypotheses, we can make the concrete assertion that the psychological mechanisms involved in this type of comprehension register certain semantic characteristics of the sentence or drawing, then organise the necessary processing including its temporal sequence according to the nature of these characteristics and their relevance to the comprehender. This selective role of human semantic activities, and particularly their extremely flexible nature (their change-ability according to time, situations, and the comprehender's motivation) is doubtless the greatest difference between natural and artificial comprehension, at least in its present form.

MENTAL DICTIONARIES AND HIDDEN NEGATIONS

In the preceding paragraphs I have emphasised certain aspects of the processing mechanisms and the strategies, or as some might say the procedures, involved in comprehension. As mentioned in my introduction, comprehension also depends on the use of a system of knowledge, stored in the memories of individuals and linked with their language.

The simplest form one could give to this notion, is to say that everyone of us possesses a mental dictionary, that is to say a more or less extensive collection of "words" each associated with a particular meaning or, technically speaking, a "significate". The second fundamental problem we face is thus that of discovering the nature of this mental dictionary and how it is organised.

Certain logicians and also certain computer scientists, linguists and even psychologists tackling this problem, have a tendency to believe that an individual's vocabulary is organised like a system of concepts; this leads us to give undue importance to relationships such as those of superordination/hyponymia (or more simply inclusion) and transitivity (like tree/branch structures) all of which do indeed exist, but are often highly localised;

or else we tend to make a too universal and simplistic use of operators such as negation, "and","or" or of implications, or presuppositions, (currently very popular), of calculated primary predicates, etc.

It is far from my intention to underestimate the contribution of both traditional and contemporary logic to semantics in general and to psychological semantics in particular; on the contrary I consider it to be both fundamental and essential. It is nevertheless necessary to situate it adequately within the totality constituted by the thought process.

What in fact becomes apparent from empirical study of individuals' natural mental dictionaries is that not one of them is organised completely according to logical rules, although again there is none totally devoid of a partly logical organisation. We may say that there exist variable degrees of "logicisation" of semantic structures; furthermore it is this situation which justifies the existence of conceptualisation (or more precisely, re-conceptualisation) in science and in the advanced part of the educational field known as didactics.

As an illustration of the role in the semantic memory of what appears elsewhere as a logical operator,

we may take the example, quite widely studied over the past few years, of negation and more especially of "inherent negation" in the mental dictionary. This last expression designates the following type of relationship : given a pair of adjectives A and B of contrary meaning, we could say that B equals Non-A, or that A equals Non-B : that which is small is not large, and that which is large is not small. But it would seem that this is not entirely true in the semantic memory of the vast majority of individuals : in general, the other is the negative of the one, but the one is not in the same degree the negative of the other; there is not, in fact, a perfect lexical symmetry.

Thus, for example, "small" seems to be recorded in the memory as "not large", but "large" is not recorded as "not small". Thus in a way, and psychologically "small" is more completely the opposite of "large" than "large" is of "small". To my knowledge, the experiments that I shall now describe have never been carried out with professional logicians as subjects: if this could be done, it could lead to fascinating results.

We may note that symmetry is readily recognised, at least superficially, in couples where one element contains an explicit negation, as with possible/impossible, direct/indirect, potent/impotent, pleased/displeased, etc.

The notion of inherent negation extends the application of this surface structure to the deeper semantic structure of couples which contain no explicit negation; it shows that negation, although hidden is nevertheless present in the semantic memory of the speaker. This applies to couples such as large/small, long/short, high/low, thick/thin, fast/slow, good/bad, and even much/little, more/less, etc.

There are several linguistic facts which favour this notion of asymmetry in relation to negation and the correlated inherent negation. There are also several psychological facts. But since I have already introduced the experimental paradigm of verification, I shall illustrate my proposition by referring to an experiment on comprehension carried out along the same lines. This example comes from H. Clark (1974).

The basic hypothesis derives from the well-established observation that the presence of an explicit negation always lengthens the time taken to comprehend, or, more generally, the time required to process a sentence. It could however be argued that this lengthening is due to the physical presence of one (or two) additional word(s) - in English "not", in French "ne.....pas".

But if there really exists an invisible negation within one of the two elements of a couple of opposites, and if this negation possesses psychological reality, it should produce - when this element is used - a lengthening of the time required for comprehension as compared to the time required for the use of another element.

In the experiment quoted next, the chosen couple is "present/absent"; a control element in the form of "is not present" is also used. The drawing comprises no more than either a circle or a square. Supposing a square is presented; we must then test the four possible sentences :

True-present : "the square is present."

False-present : "the circle is present."

False-absent : "the square is absent".

True-absent : "the circle is absent".

An equivalent (symmetrical) table is obtained for the drawing representing a circle. The problem in reality is made more complex than previously indicated by the fact that "true" and "false", which constitute the responses of the subjects, on the one hand are by no means ordinary adjectives, either from the logical point of view (as we have long known), or from the cognitive point of view; but on the other hand they nevertheless seem to behave in

exactly the same way as other adjectives with regard to asymmetry. All things being otherwise equal, "true" generally gives rise to a faster response than "false" in cases of this sort.[+] As we saw earlier, Hoffmann and Klix have estimated the extra "temporal cost" of the "false" judgment as being of the order of 175 milliseconds.

It is nonetheless possible to abstract this truth/falsity variable from the experimental results as a whole; we then find that the sentences containing the word "present" are always recognised as true or false more quickly than the corresponding sentences containing the word "absent"; the same applies to the comparison of sentences with "present" and "not present"; yet the word "absent", physically, is no longer than "present". In other words the results of this experiment are entirely compatible with the hypothetical existence of an asymmetry between "present" and "absent", and of an inherent negation within the signification of the latter term.

This is not an isolated conclusion and the converging results of a series of other experiments also point to the validity of the notion of inherent negation. Furthermore,

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[+] The picture is not clarified by the fact that, in a well-defined category of cases, the opposite is observed.

similar conclusions are reached when sentences containing comparative adjectives, or the words "more" or "less" are presented. This second asymmetry can combine with the other : "plus petit" (smaller) is slightly different from "moins grand" (less large) but "moins petit" (less small) is very different from "plus grand" (larger). This can be seen easily, and without resort to any laboratory experiment, by quickly drawing some simple inferences from the statements : "John is taller than Peter; Peter is taller than Louis". From this decide whether it is "true" or "false" to say "John is taller than Louis" and similarly for all the possible combinations of comparisons.

Of course, systematic experiments of this type have been made, with detailed planning of each experiment followed by sophisticated statistical analysis. These have, as they were bound to do, added to the complexity of the problem, but have not disproved the foregoing reasoning.

What general conclusions are we to draw from all this? Firstly, that the psychological status of negation is extremely complex and often quite different from its logical status (without however invalidating the latter) and that very little is known about it.

Beyond this, that in the semantic memory of man the psychological structure of an attribute or a dimension (i.e. of that which is more or less adequately expressed in the language of polar adjectives such as "big/small") is also extremely complex. A more detailed description of this complex structure is given elsewhere (Le Ny, 1979). Similar phenomena would be found in the case of opposing prepositions such as "before/behind", "above/below", etc.

IMPERFECTIONS IN TREE/BRANCH STRUCTURES

I should now mention another type of structure in semantic memory. I propose to consider briefly tree and branch structures, which occur frequently in theoretical semantics. It is easy to see, from an abstract point of view, that such structures can be used to describe the relationships that exist in several semantic fields.

We must first note that, although these fields are frequently referred to by many authors, they are in fact very rare in natural language. Beyond the fields of zoology, botany, and blood relationships, we soon find ourselves short of further examples. However, let us examine more closely one of these fields, for example the first of those just mentioned (Figure 4).

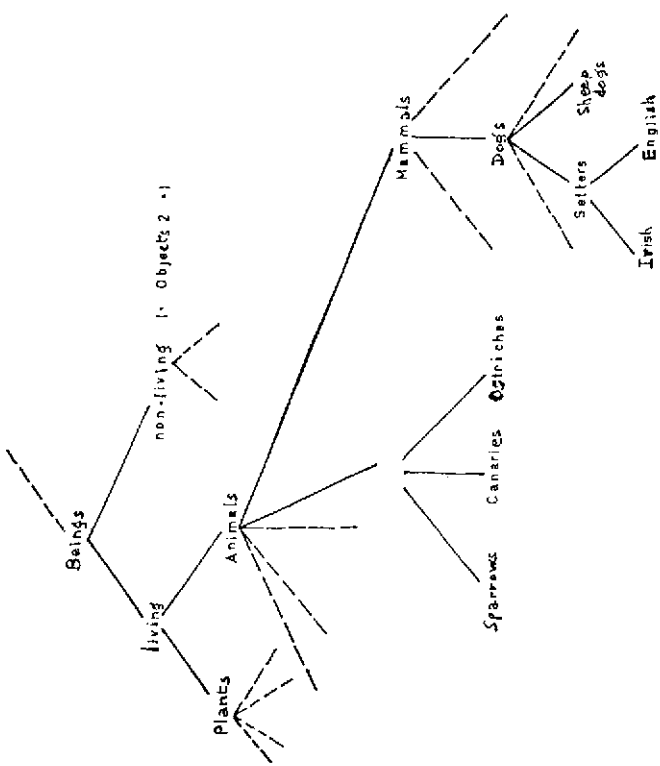


Figure 4

Example of a semantic (taxonomic) tree/branch structure.

A series of inclusions evidently makes it possible to describe the relationships between, for example "animal", "mammal", "dog" and "greyhound". Furthermore, and particularly in the cases of the higher classes, we can also carry out subdivision in such a way that sub-categories of a category have "equal status" (dogs, cats, horses and bovine cattle are all equally mammals). On closer examination however, shortcomings from a psychological viewpoint are quickly apparent. If we ask someone "quickly and at random to give the name of an animal", or "the name of a mammal", we are confronted with the statistical appearance of preferences which in fact are far from random; a subject will only give "cheese-mite" as an answer to the first question, or "balaena mysticetus" to the second if he thinks he has to show off his brilliance in the intelligence test he has been set. However, it is a simple matter to take precautions against these attitudes.

The statistical regularities observed in this type of test have been conceptualised in the notion of "prototype" or "typicality", which has been developed notably by E. Rosch (for example, 1976) : certain mammals are, as we say, more mammal than others. Note (sociologists will have

done so already) the profound theoretical relationship between this notion and that of an Ideal-type, which could wrongly be seen as typically social. Typicality is evidently also at the root of many social prejudices, but we see here that it has an absolutely general character.

It is easy (and Rosch has done this) to obtain judgments on an opinion scale as to whether and to what extent a particular bird is typical of birds; doubtless, for example, the robin will get more votes than the chicken or the ostrich. Here are quantified value-judgments.

But if we now apply the helpful techniques of verification, we find that the reply "true" to "a robin is a bird" is given somewhat more quickly than it is to "a chicken is a bird" (Rosch, 1973; Rips, Shoben and Smith, 1973) : and overall we find a highly significant correlation between the verification times for these statements and the degree of typicality of the words they contain. This result is found throughout a very wide range of categories and sub-categories.

Here again, we find a semantic structure rooted at an (at first sight) unexpected psychological depth : who would have thought that so many questions would arise in deciding whether a chicken is a bird? In actual fact,

of course, the experimental subjects do not ask them, or do not report that they have done so, and we cannot reasonably believe that, in a few extra tens of milliseconds, they would have the time to do so. Perhaps even a psychoanalyst - although we should never underestimate the inventive capacity of a psychoanalyst - would be unable to relate this result to the structures within the unconscious thought of his patients (or of the experimental researcher).

On the other hand, we can see that this psychological organisation of semantic memory differs from the purely logical structure that we might at first sight have supposed; nevertheless, it follows stable and well-defined psychological laws. Selective characteristics are again seen to affect this organisation.

There are several theories which attempt to account for this : it is not possible to go into their details here, but for my part (Le Ny, 1978, 1979) I am most attracted to the class of analytical theories which are otherwise known as componential theories. In essence these suppose that neither words nor their significations are the most elementary entities in an individual's mental dictionary, but rather that there are "atomic components" of these significations. It is a stimulating hypothesis that in the act of

comprehension it should be these components that are identified, through audio or visual perception of words, by the appropriate mechanisms of the comprehender, and that these mechanisms then combine them in order to give meaning to the sentence and the text containing it. But this is a controversial issue.

Restricting ourselves to the examples of isolated words cited earlier, we can say that the inherent negation in the word "small" can be considered as an "atomic component" of this kind. In the same way a particularly significant component of the signification "bird" is, for most individuals, "can fly" : that is to say it has a strong psychological importance, even if its zoological pertinence is weak. There is every reason to believe that this component acts as a major influence in determining how a subject will evaluate to what degree the various types of birds fit into the general category.

It is probable that factors relating to the acquisition of language, and more precisely to semantic development throughout childhood and thereafter, will lead to a better understanding of the formation and organisation of the mental dictionary of individuals. Again, this is not the place for a detailed treatment of this field of research : nevertheless I shall come back later to one aspect.

CONTEXTS AND TEXTS

It would obviously be incorrect to suppose, as the way in which these problems have been tackled might erroneously suggest, that study of the mental dictionary alone comprises adequate semantic research. Significations are always modulated or modified by contexts, and this even influences the way in which we should conceive the mental dictionary and the significations of words : these are not fixed and static realities, but rather ranges of potentialities, sentences and texts being actualisations of those which are appropriate. The flexibility of these significations of words is thus an essential characteristic of natural semantics; it is generally agreed that this has until now constituted what is probably the greatest stumbling block for all attempts to simulate comprehension by computer.

One of the simplest examples of flexibility and modulation by context is that of homonymy; this can be regarded as a particular instance of polysemia, understood in this case to be the existence of several meanings of the same word in the mind of a single speaker. We shall examine later the disparity of meanings between different speakers.

In languages such as English, French and some others which contain non-negligible proportions of homophones and

homographs, it is unusual for these to cause difficulties for the comprehender. Indeed, unless he is specially alerted in one way or another to look for them, any significations other than that suggested by the context are hardly ever consciously perceived. If, in the course of a conversation, or in a current news item concerning legal matters, there is a mention of the "Garde des sceaux", (Keeper of the Seals), the comprehender will virtually never - except perhaps if he is one of the small band of pun-enthusiasts - think of "saut" (jump), "seau" (bucket), "sot" (stupid), of the townships of Sceaux or Sault, etc; each one of us may subjectively feel that he would need a special "prod" of mental commutation - even a certain effort - to manage this spontaneously. However, as we all know, a fault of experimentalists is their lack of confidence in subjectivity. It may therefore be asked whether, in spite of everything, a rapid exploration of all the multiple significations of a polysemic word could nevertheless take place in the elementary but non-conscious mental processes that we discussed; this exploration being <u>followed by</u> choice of the appropriate signification suggested by the context. Incidentally, it is in this way that computer programs function.

In fact, however, there are several good reasons to believe that the comprehender's mind does not function in this way. I shall very briefly describe an experiment which confirms this. If the comprehender's mind were to function in the way just described, polysemic words, and particularly homonyms, would require a greater amount of semantic processing than would non-polysemic words.

To find out whether this is the case, the well-tried experimental technique of the multiple task is used : the subject is asked on the one hand to listen to and understand a sentence, and on the other hand simultaneously to recognise a superimposed "bleep" (or a particular phoneme) and to react to this signal be pressing as quickly as possible on a button. In this situation, with attention divided between the sentence and the signal, the two mental activities are in competition. It has been established that, if a light extra mental load is added, performance deteriorates accordingly; a deterioration which can be accurately gauged from the resulting longer reaction time. Here too, an analogy from informatique may be invoked, describing the effect as more or less "blocking of the channel", this being in these circumstances the subject's cognitive activity.

How does this affect the particular case we are examining? It would seem that the question of processing homonymia can now be expressed as follows : does a polysemic word occupy the cognitive channel more completely than a non-polysemic word?

To find out, we can compare reaction times for a signal superimposed on a sentence, in cases where the sentence contains a polysemic word and where it does not. Without looking at the many very arduous precautions designed to guarantee that all other conditions are the same, we may pass immediately to examine the results.

They are in fact negative, no significant difference being observable due to the nature of the word in the sentence (Swinney and Hakes, 1976). It therefore seems that in this case experimentation confirms the subjective impression : during normal (current) comprehension, the comprehender arrives directly and immediately at the signification determined by the context - or, more precisely, at a unique (even though it may be false) signification : he does not, except in unusual situations, examine other possible significations. It is a matter of individual judgment whether this constitutes a superiority or an inferiority of the human mind.

Homonymia and even polysemia by no means account for all cases of language flexibility. An analysis and a much more general theoretical interpretation have been made elsewhere (Le Ny, 1979).

It should be noted, however, that the effects of context are by no means restricted to single words; a further illustration to which we shall return later, will demonstrate this. In the same way that context can modulate the meaning of a word, a word can modulate the meaning of a text, and it is remarkable to observe that this can affect not only the immediate comprehension of a sentence, but also the way in which its content is stored in the memory.

Kozminsky (1977) and Vezin (1978) have analysed from this point of view the effect on semantic processing of the title attributed to a text. At first sight, the processes brought into operation in the course of reading are no different whether the text has title A or title B; in any case the time required to read each individual phrase or sentence is the same. But, judging from the accounts that subjects can give of the content of the text they have read, their modes of processing must differ considerably according to the title.

Figure 5 (borrowed from Kozminsky) shows in a simplified manner how, for different categories of propositions classified according to their level of relevance+ to the general theme of the text, the recalled account is more accurate in cases where an adequate general title has been given than in cases where the title has been relevant only to secondary aspects of the text.

UNIVERSALITY AND THE UNIVERSE(S)

The present paper has so far discussed results which concern (or are supposed to concern) characteristics which are universal in all comprehension; thus the research described has been research in pursuit of process laws and structures valid for all comprehenders and all speakers.

Naturally there is still much to be done to guarantee empirically this universality, most experimental work so far having been undertaken in a very small number of languages, compared with the many that exist in the world. Furthermore, even if universal semantic mechnanisms and structures do exist (and nobody doubts that they do) here again it is not easy to discover the exact demarcation between the universal and the particular.

+ I shall not describe this notion here, nor the analytical technique at the base of its operational use. I should also note that my Figure 5 reproduces only half of the original in Kozminsky's paper.

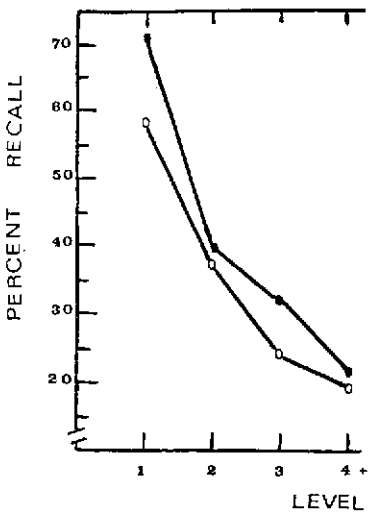


Figure 5

Recall percentages for different categories of proposition, according to whether an appropriate title has been given to the text (black circles) or a slightly less appropriate title (white circles).

This problem is directly related to that mentioned at the beginning of this paper, concerning what is innate and what is acquired, or rather what is endogenous and what is learned. However, it is by no means reducible to it. The universal character of a particular semantic reality, even supposing this should be established, in no way implies that it is innate or that it developed in an endogenous manner. Part of our psychological universality may well result from the fact that all men live, to some extent, in the same universe.

Let us consider the case of prepositions expressing a positional relationship, such as "above"/"below", or "before"/"behind"; in these cases we often observe a dissymmetry of the kind discussed earlier in the case of adjectives (cf, for example, Dubois and Weil, 1978).

A dissymmetry of this kind could be the result of natural biological programming. But it could also result from the fact that, in the physical universe as perceived by man, top is not symmetrical with bottom; in the case of an adult, and even more so in the case of a child, the horizontal eye level view is, in this respect, a particularly important reference level.

Other factors add their effects to this visual structure : firstly movement, and the perceptive and

cognitive analyses it stimulates. Why is it that we find no difficulty in saying "the cat is on the wall", whereas we should find it odd to say "the wall is beneath the cat", which in fact means logically the same thing, if it is not because one of the participant actors often moves, the other only rarely?

To all this must be added the weight of gravity. Let us consider the four prepositions "above", "below", "on" and "under". In analysing the third of these, we can easily discover two semantic components, one of which is roughly equivalent to "above", the other meaning "in contact with". It is only when these two conditions are met that we use or understand "on". On the other hand, "under" is not distinguished in this way from "below". These contrasted relationships are evidence of the way in which gravity, and the distribution of positions that it causes, has left its mark on semantics.

This very brief analysis could similarly be applied to the prepositions "before" (in front of) and "behind", about which child psychology can offer some interesting data. However, it will be more useful at this stage to consider the implications of this analysis in terms of social realities.

Whereas the physical universe, or to be more precise, the "natural physical" universe, is the same for everyone, this is not true of the social universe. It is not even true of the "social physical" world : the modern child in an industrialised country, even before he begins to reflect on his situation, acquires a concrete experience (perceptive and manipulative) of high and low, gravity, movement and causality, of a very different nature to that acquired by children in the past or elsewhere. Moreover, in our own countries, the poor child does not develop the same kind of experience as the rich child : he does not see, touch or manipulate the same things in the same environments.

It will of course be argued that many objects and micro-environments are - in our sometimes strangely - called consumer society - available to everyone everywhere. But seeing an object in a shop or magazine is very different from having the use of it. It will also be argued that indirect experience - through speech, writing, books, television etc. - attenuates these differences. This is probably true in some cases; but in so many others it conceals or exacerbates them.

We saw earlier, with regard to general processes, that it is often the observation of time differences of

the order of tens - or at most hundreds - of milliseconds, which provides the basis for analytical studies. Equivalent differential studies are for the moment very rare : however, we may conjecture, with a reasonable degree of plausibility, that comparison of the modalities of comprehension in individuals belonging to different linguistic communities would disclose many micro-differences in processing modes. It would only be necessary to introduce a few errors, each of some tens of milliseconds, for less competent researchers to arrive rather quickly at a diagnosis of intellectual inferiority.

WORDS AND IDEAS

Do people communicate in the same way in all social classes? It would seem not. What incidence does this have on comprehension, and beyond this, on individual thought?

As is well known, a great debate has recently led to some interesting research programmes in this area. The problem is often tackled from a sociolinguistic angle, the contributions of Bernstein and Labov being the most significant in this field. Despite the interesting nature of these studies, they have added little to our knowledge of semantic and cognitive differences as such, or of their development in children and the conditions under which they appear.

In a comprehensive study of the development of lexical knowledge in primary schools, S. Ehrlich, G. Bramaud du Boucheron and A. Florin (1978) have recently produced an ample series of comparative data, among which we may find some results relevant to our problem.

These authors have compared the verbal repertories of children from the Cours Elementaire 1, Cours Moyen 1, and Cours Moyen 2 (1st, 3rd and 4th years of French Primary Schooling) taking particular account of the childrens' socio-economic backgrounds. The first basic observation is that the size of these repertories increases with the socio-economic level of the environment to which the children belong. As might be expected, the differences particularly concern unusual and less usual words; the well-known words are known by all.

But the qualitative differences are even more interesting. If we study the definitions given by the children to a considerable number of words, we can establish a contrast between those which are categorical (that is to say those which rely on the use of a higher order descriptive word - or a similar or opposite term - thus indicating that their author is approaching a logical type of abstract mental organisation similar to that mentioned earlier) and those which insert the words in empirical constructions

of concrete character. In all cases, preference for the former type of definition increases with age, whereas use of the latter decreases. But we may also notice that categorical definitions are generally more frequent amongst children from the better favoured socio-economic levels. Of course the differences are not very great, and never exceed 18% of the total number of the categorical relations considered; however, we must not forget that, at the ages studied by Ehrlich and his co-workers, the vocabularly of all children is still dominated to a large extent by significations related to the physical universe. Judging from the as yet fragmentary and unpublished observations made by Hiribarren concerning the significations of some abstract terms of economic vocabulary as understood by a group of technology students, differences of socio-economic origin are also to be found later in life.

From this study, Ehrlich, Bramaud du Boucheron and Florin have drawn the general conclusion, with which we may also agree (see Le Ny, 1977) that variations in social origin affect not so much the level of linguistic and cognitive competences as their nature.

We might draw some broader conclusions from this large and wide collection of data, relating to an important question which may well occupy much future discussion,

namely : what is the decisive factor which controls the mode of organisation of contemporary societies, their economy, history and culture, both now and in the future? Or, coming back to the dichotomic choice to which questions of this nature are sometimes reduced : should this factor be sought in the structures of ownership or in those of apportionment of information?

Our preceding analysis, together with other supporting data, clearly indicate a close correlation between both factors; also that, as a general rule, information is concentrated in areas of ownership and wealth.

WHY DO WE NOT ALL UNDERSTAND ONE ANOTHER?

Perhaps, from bases such as those discussed here, it will now be easier to comprehend incomprehension.

Firstly, it is a fact that the meanings of words, sentences or texts are not the same for everyone, that people often do not understand each other, and that conflicts may be correlated with this incomprehension. What of causal relationships in this matter?

Surely we cannot nowadays candidly believe that, if people do not understand one another it is because they do not understand one another's language. The myth of a worldwide semantic code that would reconcile classes,

nations and social groups through a levelling out of meanings has joined the Esperantist dream in the limbo of noble ideas. But if we consider the causes of social conflict between men, and those which lead them to not understanding their respective languages, we soon realise that these causes are often and increasingly the same. Today, it is no longer the language itself in terms of a particular mode of speech, which creates communications problems. The root of the problem lies in the modes of thought which are both at the basis of and hidden by the language. Everybody may well speak with the same idiom in the tower of Babel, but the meaning of what is said will nonetheless vary from floor to floor.

In the perspectives that we have considered, if meanings are not the same for everyone, this is because meanings are dependent on each person's experience of the world, and the world is full of contrasts and contradictions. However much it may be unified and unifying from many points of view, in its social aspect it is no less often tragically multiple and differentiated. Even our most familiar verbal tools, which constitute the small change of our language, hide some dangerous pitfalls in their depths.

"Let them eat cake" was Marie-Antoinette's answer to the semantically simple "they have no more bread". Was this

a prize blunder on her part? No, but it was evidence itself that Marie-Antoinette did not correctly understand the meaning either or "to have" or of "no more". We may well reflect on the social and political abyss shown by this tiny, microscopic linguistic difference between "have no more$_1$", which does not exclude either "having again" or "having something else", and "have no more$_2$", which does indeed imply the exclusion of the other two possibilities. If, using our somewhat derisory laboratory techniques, we were to compare "have no more$_1$" and "have no more$_2$", at how many trivial milliseconds would we estimate the difference?

However, leaving October 1789 to return to our present anagrammatical October 1978, do we not find a recurrence of this difference of understanding in the various responses to "they have no more work"? At least one of these deserves to be enshrined in posterity, just as Marie-Antoinette's answer was; it is that by which the boss, not the dismissed employee, describes as "courageous" the decision which causes men to have no more work. In fact, only a very small semantic variation is involved :

"Courage : spiritual strength enabling one to bear the misfortunes (of others)".

Interindividual polysemia - that which causes meanings to vary from one speaker to another -obviously

leaves particularly wide latitude to the effects of context. Many examples could be found. Social psychologists have studied a specific form of this under the title "source effect". Experiments to demonstrate this effect comprise the presentation of the same text to several groups of subjects, attributing the text to one particular author in the case of some subjects, and to a different author in the case of others. This situation is comparable to that discussed earlier, in which the title of the text is varied. In cases where different authors have been substituted, a series of changes in the interpretation of the text has been observed; studies of this type have been widely used as a means of identifying the ideological factors underlying comprehension.(Pecheux 1975; Poitou 1978).

The ambiguity contained in the notion of "group" - a term which appears in the title of the present paper - has also been studied in this perspective.

It is undeniable that these effects are closely related to affective or imaginative phenomena; this is yet another field of research that we can only mention here, without however denying its considerable importance.

We will examine one last example of experimental research on the cognitive differences of social origin which can affect comprehension. Contrary to the preceding

examples, it occurs on the macroscopic level, i.e. it concerns texts rather than sentences or words.

This type of psychological study has integrated the contributions on textual structures made, following the work of Propp, by researchers such as Roland Barthes, Todorov or Brémond.

Also, Kintsch and Van Dijk (1975) have studied the psychological patterns spontaneously and unconsciously applied by all readers or listeners to the comprehension of all kinds of texts, particularly stories. These patterns are evidently of cultural origin and it is possible to follow their development throughout childhood - as Denhière did in 1978.

If the structure of the story as told does not adequately match the psychological patterns existing in the comprehender's mind, it is observed that important elements, or relationships between the events and characters in the story, are either not understood or quickly forgotten. This constitutes a natural incidence of the process that researchers such as G. Sabah (1978) are attempting to simulate in their work on artificial comprehension.

Kintsch and Greene (1978) have compared in this way the degree of comprehension shown by Colorado students of tales from Boccaccio's Decameron on the one hand, and of

mythical tales of the Alaskan Indians on the other. An analysis[+] of the summaries or sequential accounts of these stories that the subjects were asked to give highlighted the types of deterioration in comprehension which appear when the structure of a story differs from the traditional patterns already known to the students.

FINAL CONSIDERATIONS

Following this brief summary of some typical recent research programmes - a small sample from an exponentially growing field of study - we can perceive something of the multiplicity and complexity of the psychological problems pertaining to comprehension; many of these problems have barely been mentioned here, and some not mentioned at all.

I should like finally to emphasise that, if such research programmes are necessarily pursued at very different levels, their various approaches are complementary and not mutually exclusive.

It can sometimes happen that semanticists fail to understand one another very well. For instance, one whose field of research is that of the microscopic analysis of

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[+] This analysis is based on the separation of a text into its component propositions (and macro-propositions), a process already referred to in this paper.

processing times may well fail to perceive the relevance of research undertaken on the macroscopic level : at the same time, the person responsible for the second type of research programme may well feel that his colleague is too complacently splitting seconds into their thousandths. And there are those for whom the scientific approach is simply foreign or unpleasant.

But, provided we can examine human communication without, in our turn, forcing it into too rigid or too narrow a framework, we shall see that it can be analytically divided into several categories of units or structures which constitute a hierarchy of interrelated organisations.

It is therefore entirely legitimate to adopt a variety of approaches. It is only through a synthetic appreciation of these approaches, integrating them in a theoretically and empirically rigorous manner, that man will be able to establish a reasonable if not exact idea of the modalities by which he communicates with his fellow beings, modalities which are very closely linked to the way in which he conceives the world and society and, therefore, to the way in which he acts on both.

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ON MODELS OF PERCEPTION AND COMPREHENSION

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THE FLOWERING OF COMPUTER SCIENCE (Informatique)

The 1960's saw the arrival on the market of "third generation" computers. The time necessary for the execution of a complex instruction was strikingly reduced, to the order of 10^{-6} second. Memory capacities increased to some one million binary elements (bits) in rapid access (10^{-6} second), and to the order of one hundred million bits on disks (with access times of 10^{-3} second). Important progress has subsequently been achieved in "microinformatique" through integrated circuits. Both the size and cost of a computer is continuously dropping : a "minicomputer" now costs less than a motorcar, and can quite easily be built by an enthusiast "on the kitchen table". At the same time, "software" is developing in a fantastic way : computer networks give access, from inexpensive local terminals, to very elaborate programs in machines thousands of kilometres away.

Thus a vast user community has been created, ranging from the user of the simplest pocket calculator to the most advanced researcher or engineer. Informatique and Telecommunications comprise the nervous system of modern industrial society. The report by S. Nora and A. Minc, "The Informatisation of Society" underlines the importance

of "telematique" in social and industrial organisation.

But in addition - and simultaneously - Informatique is changing scientific thought and language, and by this very action even our way of understanding the world.

The principal object of Science is to represent and verify natural phenomena through models. In practice any modern quantitative theory leads to computable models, consequently to programs able to be carried out by a computer. We see this in the Natural Sciences : quantum physics, plasma physics, atmospheric physics, chemistry, engineering sciences such as control technology, biology, etc... But it is also to be found in the Human Sciences : econometrics, sociology, linguistics, perception, and the present paper will emphasise the interest of computable models of perception, interpretation and understanding, considered under the heads of Artificial Intelligence and Pattern Recognition.

It is no small wonder that the computer, originally conceived for scientific calculation and administrative control, should have proved itself to have a far wider range of applications.

The reason for this versatility is of course that the computer is in fact a universal machine capable of executing any form of "algorithm" - the term which we use to describe a group of "action rules exactly and unambiguously

defined"; these action rules permit the modification of agreed "representations". Thus, starting from the initial representations ("the data") an algorithm permits in a unique way the formation of new representations ("the results"). Within the limits of our capability for measuring and representing information, and for defining exactly the rules of algorithmic processing, a computer is the machine able to execute this process and to supply the sought-after results... if they exist.

The interaction of the programmer with the computer requires a "reciprocal understanding" : on the one hand, the programmer must express the data and the algorithms in a language that the computer can understand, on the other hand the results must be comprehensible to the programmer.

As soon as an algorithm becomes somewhat complex, its translation into a "correct" program becomes very difficult. This is the principal purpose of "programming". In fact, having written a program, the programmer will often examine its characteristics to verify that it will execute correctly the planned algorithm. These examinations lead to a great deal of research on program "semantics".

Other studies are concerned with the "complexity" of algorithms, that is to say the number of operations and the memory capacity needed for their execution.

A big (lengthy) "interactive" program, comprising several thousand instructions in a high level language such as FORTRAN, LISP, PLI, ALGOL, SIMULA, requires long and costly development and checking so as to eliminate the "errors", i.e. functioning different from what the program writer intended.

Most big programs are used despite residual errors. Some have had to be abandoned despite all efforts. Its seems that in such cases we run against a "wall of complexity" (see the author's paper for the previous DISCOVERIES Symposium in Rome).

The translation of a problem into algorithmic terms is often a "delicate" matter : which parameters should be included, and with what accuracy; what simplifications and abstractions may be justified a posteriori? Although it is true that computer science has made possible calculations which were unthinkable before the advent of computers (for instance astronautics calculations in real time) it has also raised problems of fundamental importance, calling for new research in the fields mentioned above, and bringing into question the traditional language and the models of Science.

As already remarked, computer science is also concerned with the Human Sciences, offering models of human perception,

understanding and reasoning. It is a hundred years since the experimental method was introduced in neurophysiology and psychology : we shall see that, with the help of Computer Science, Artificial Intelligence and Pattern Recognition allow us to go further in presenting algorithmic models of perception, understanding and reasoning.

REPRESENTION AND INTERPRETATION

Reflection on natural or artificial signs is as old as human thought, as is recorded in the very interesting historical "Les Mots et Les Choses" written by Michel Foucault. After Plato in Cratylos and the long medieval confusion we shall retain the definitions of the Logique de Port-Royal : 'The sign encloses two ideas, one of the representing "thing", the other of the "thing" being represented, and its nature consists in the excitation of the first by the second',... and for artificial signs 'when one looks at a certain object only as representing another, the idea produced by this object is an idea of sign and this first object may be called the sign'. In 1910, F. de Saussure published his "Cours de Linguistique Générale again drawing attention to the importance of "semantics" - the interpretation of signs.

Today and for the future, the computer is competing with and replacing man in the manipulation of signs. Hence

the principal object of computer science is to specify, define and "execute" algorithms which on the one hand permit a memory storage of the material parts of signs, and on the other hand allow their manipulation and in particular their interpretation.

An initial informatique representation (the "data") corresponds to the material part of the sign, (the "signifiant"). An Informatique interpretation corresponds to the meaning of the signifiant, it is the "signifié" and can be very simple : either the representation will be the result of a measurement by a sensor or it will be already worked out, for instance : the representation will be a letter, a written word, or a phoneme, a syllable or a spoken word.

The interpretations of computer science data in computers involve special "compiler" programs. These usually translate the instructions of a program into algorithmic orders which are then executed by the computer. A program of Pattern Recognition (P.R.) is a particular type of compiler which, on the basis of representations and other data concerning an object, will determine its name and identify it.

It is possible that a data representation will not correspond with a unique identification. A man questioned about the meaning of a complex pattern will answer with a

speech: similarly, if asked one question he will reply in one or several sentences. Artificial Intelligence (A.I.) tries to simulate these mechanisms; and in fact there is a real continuity between identification and comprehension algorithms.

Some general conclusions can be drawn from these computer science researches :

1) The homogeneous nature of the algorithms employed : "linguistic" operations are introduced even at the most elementary levels of recognition.

2) The existence of a hierarchy of languages. On each level the linguistic operations aim at determining "primitive forms" (features). These features become elements of one or several languages of a superior level. At any particular level, a characteristic pattern is the projection of a group of representations which are themselves primitive elements of this level. This pattern corresponds to an important reduction of the volume of information. Patterns and concepts which are abstractions at one level become primitive elements at higher levels.

3) Each particular language has its particular rules. Although each level "nourishes" higher levels with data, the operational functioning of each level is independent of the operations at other levels. The various linguistic levels can largely ignore each other, provided they can communicate; and each can develop its individual existence as its own operations evolve and improve.

Thus the recognition of more and more general patterns, concepts that are more and more abstract, is achieved through a succession of interpretations of representations. We shall look at some examples taken from existing audio and visual recognition programs.

THE ALGORITHMS OF PERCEPTION AND IDENTIFICATION

Because the operations of identification and classification seem "natural", they also seem easy. To distinguish an animal behind a bush, to remember the way home... these were essential for survival. The development of social living has led, in addition, to an immense development of artificial signs, while in parallel human thought has tried to introduce structures bringing order to the apparent natural disorder. As Francis Bacon wrote : "The human

mind is naturally led to suppose more order and resemblance in things than truly exists there; for whereas nature is full of exception and difference, the mind sees harmony, concord and similitude everywhere". Preceded by alchemist thought, which brought signs and objects together, the Naturalists of the 18th century classified the species in an orderly manner : taxonomy is the cradle of scientific thought.

But what do we really know about making these analogies, identifications, classifications in an objective manner? Our own ability, our excellent performances (far better than in mental arithmetic for example) have hardly led us to replace ourselves by machines, nor even to ask ourselves explicit questions about the mechanisms, in order to represent them by models. It is nevertheless conceivable that these diverse operations have an algorithmic nature. Profiting from the new means offered by computers, a group of researchers and engineers endeavours to discover these rules of recognition; for some 15 years this group has been setting up programs permitting the identification and automatic classification of data.

Starting from data supplied by physical sensors, Pattern Recognition algorithms are aimed at finding an interpretation - if possible unique - of these data representations. For example, when shown different pictures

of cats, the result issuing from the machine should be the word "cat". The algorithmic identification of a photograph taken from an aircraft or a satellite should allow the determination of what part of the image is water, an urban area, a forest, or cultivation and of what type : e.g. maize, cereal fields or gardening, etc.

The data representation of a pattern comprises 10^6 elements, each one having 256 possible levels or "states". To be able to represent it in a computer memory, therefore 10^6 octets (1 octet = 8 bits) are necessary. If, as a final result, we wish to take one single decision within 256, 1 octet is sufficient to represent our decision. To distinguish a cat amongst 256 possible objects is the same as carrying out an intelligent compression of information, of 10^{-6}. Recognition therefore implies considerable simplification and abstraction : it must therefore involve the loss of much of the "reality" of the image of the cat.

Three classes of information may be distinguished in Pattern Recognition :

The syntax or nature of the algorithms utilised : algebraic, linguistic, recursive, etc...

The semantic or ensemble of properties and characteristics of the P.R. algorithms.

The pragmatic or ensemble of properties and characteristics of the recognition problem : for instance, invariance of the result despite different geometrical transformations.

Each recognition problem has its own pragmatic, which implies that there will never exist a universal program permitting the recognition of everything. However, syntax and semantic of P.R. programs are often comparable, allowing the unity of the domain to be discerned. We may find our examples in the reading of characters and in speech.

The data provided by the physical sensing are presented as an undifferentiated sequence of elementary measurements; for example one state out of 256, which permits the storage of these samples in a memory in the form of octets. The volume of information given by one pattern is often of the order of one million octets. The same applies to a minute of speech.

A process based on filtering procedures will allow a first level of characteristic patterns to be discerned, so reducing considerably the volume of information.

In a pattern of written characters we therefore look for the lines, the curves, the cusps, the intersections : these will be the "characteristic

patterns". As for speech, it is first separated from silence (or noise), then the speech signs are coded through the amplitude peaks.

The patterns so found become the primitive elements of the next level. For instance the letter "A" comprises lines, has one cusp and 2 intersections : such an ensemble can then be "rewritten" as an "A". It may only be so rewritten if a certain number of relations have been verified, this implying the presence of certain measurable parameters in the characteristic patterns. These relations allow the relative disposition of the patterns, i.e. the context, to be taken into account.

The algorithms by which elemental chains are re-created are known as "formal grammars", codified in their present form by Noam Chomsky. The formalism of P.R. algorithms is a little different : it has been shown that their power is equivalent to that of "contextual" formal grammars.

In his recent thesis on speech recognition Marc Baudry uses no less than seven different programs to achieve the passage from a sign coded by its peaks to the recognition of a "phoneme" (elementary sound component of speech). Each of these recognition programs uses rewriting rules the application of which is controlled by predicates, themselves, dependent on parameters measured within the data . These

elementary programs are organised in a hierarchic structure, the final recognition decision being taken at the "summit".

In 1972, Claude Roche in his thesis had also drawn attention to the efficiency of a hierarchic structure of operators, based on rewriting rules.

Many other works on recognition are based on syntax of the same type, once the level of elementary characteristic patterns has been passed. Examples include the recognition of cardiac, neurophysiological, seismic and underwater acoustic signals. A. Rosenfeld and his team have recently proposed a "recognition through relaxation" technique, to recognise complex real images, such as those produced by airborne teleobservation.

Right from the first (lowest) levels, an interactive process is established involving both cooperation and competition, so as to obtain identifications compatible with the parameters of the logical relations already existing between the primitive identifications. These operators are hierarchically organised : in such a system the information flows both horizontally and upwards.

The use, from the first (lowest) recognition levels, of linguistic and logical procedures has been underlined. Nevertheless it will also be useful to say a few words about procedures based on a different pragmatic,

namely the use of similarity or distance measurements.

Economic or sociological surveys, medical studies, and naturalist measurements provide large quantities of data which should be categorised and classified. Each item of data can be considered as a "point" in a known space the metric of which is provided by the distance in question. Using topological concepts (continuity, proximity, measurements of density) points can be grouped automatically into discrete homogeneous classes or taxons.

"Clustering" algorithms, for instance the Dynamic Clouds Algorithm of E. Diday, are examples of iterative procedures for data structuring. Other techniques, such as the Factorial Analysis of Benzecri, stem from topological concepts, as do also the filter techniques already mentioned for the first level of image recognition.

Concluding this brief review, if procedures based on similarities are used at the first recognition levels; at subsequent levels they are rapidly replaced by logic and linguistic operators whose hierarchical organisation, and simultaneous cooperative and competitive character, must be emphasised.

Let us now review some of the results of these efforts. Although success has come more slowly than the enthusiasts of the 1960's expected, the concrete results are beginning

to be impressive.

Character Reading (printed or typed)

Some instruments can read from 1 000 to 20 000 characters a second with a rate of error of the order of 10^{-4} to 10^{-5}. These optical reading machines, for use with a computer, came on the market at the end of the 1960's. They then cost around one million dollars. Machines of similar performance have now appeared costing 50 times less.

Chromosome and Blood Cell Analysis

Some systems enable blood cell analyses to be made from smears on glass, with results comparable to those obtained by laboratory technicians. The new iterative chromosome analysis systems can reduce by 10 times the cost of such analyses, which are essential for the detection of prenatal malformations and anomalies.

Radar or Sonar Image Analysis

These systems are concerned with automatic look out systems and navigation procedures.

Teledetection

The processing, analysis and recognition of multi-spectral data from aircraft or satellite surveillance is a very active sector with applications in the evaluation

of terrestrial resources, geological, archaeological or military detection, and meteorology.

Speech Recognition

Apparatus has appeared on the market capable of recognising 200 "monospeaker" words with an error less than 10^{-2} per word. "Multipspeaker" systems are being developed, and we may expect in 10 years time to have systems on the market which will understand "continuous" speech; that is to say they will be able to transpose speech into a written text. Already the automatic typist is no longer a dream...

Speech Synthesis

In 1977 Xavier Rodet presented in his thesis a very good speech synthesis system, in real time, using only a multicomputer Multi 20 and a commercial amplifier. A program of 20,000 octets enables the translation of a literal sequence, input via the keyboard of a minicomputer, into a phonetic sequence. This sequence is then converted into signs sampled by another program of 30,000 octets. Different intonations can be introduced with a remarkable flexibility. It is very surprising that this real-time transposition from literal to phonetic sequence should require only a minicomputer and so small a memory capacity.

The "algorithmic understanding" of language has been motivated by the automation of activities such as problem resolution, robotism, automatic diagnosis - more generally, question-and-answer systems and systems for consulting data banks, archives etc. The languages in question are clearly of a precise "scientific" nature, using well defined and non ambiguous word definitions.

However, in every-day life, in politics, the theatre and literature, man more usually expresses himself in other language forms which we may call "natural". In these language forms, no effort is made to be precise : vagueness, indefiniteness, multiple interpretations are even sought. This is what Barthes defines as plural discourse, which may be classified according to the most significant interpretation. Here, too, computer science models have been proposed and are being studied.

It is easy to understand that scientific discourse can be transformed into "computable" discourse. Artificial Intelligence has been successfully used for this purpose for some years : some of the programs used and results obtained are as follows :

Chess Game Programs

The best programs are capable of beating the "masters". It is not unreasonable to suppose that, in 20 years' time,

(if sufficient effort is made), a program may become world chess champion.

It would be wrong to consider these efforts as having only academic significance. At present, the combinatory study of a situation can at most foresee 4 or 5 moves ahead. J. Pitrat has shown the significance of the study of a long-term strategy, of the notion of plans with several possible issues, of learning through the recognition of logically similar situations. This leads naturally to the introduction of an ensemble of more or less hierarchised operators, which cooperate and compete to achieve the best decision and which are capable of adapting and modifying their plans for this purpose.

Problem Resolution

The demonstration of mathematical properties can typically be automated. Much progress has been made recently. As an example we may note the program ALICE, developed by Laurière, which can understand and solve, better than a human specialist, several hundred related problems, e.g. those of travelling salesmen, cryptoarithmetic, planning, permutation, optimum timetable, etc...

Robotism and Strategy

To the extent that it is possible to axiomatise a

problem, and to define the characteristics of the action operators, it is possible to model the problem on a computer. Several examples can be found in Artificial Intelligence, for instance in the efforts of L. Siklossy, who has also demonstrated the difficulty of obtaining a non-contradictory axiomatisation of the real world.

Automatic Diagnosis and Chemical Analysis

Among chemical analysis programs, we may note DENDRAL, developed by B. Buchanan, which reproduces and uses automatically the knowledge of a chemist to analyse a substance through spectrometry. Many automatic diagnosis programs to help doctors have appeared, e.g. M. Terrenoire's program at the anti-poison centre in Lyon.

"Intelligent"Languages

Numerous programming languages have been developed in Artificial Intelligence, in which the compilers understand the terms and execute the submitted problems. We may cite : SAIL, PLANNER, CONNIVER, QLISP,and especially PROLOG, developed by an Anglo-French team. Such languages use first-order logic for their algorithmic framework. The initial and final situations are described, together with the "rules of the game". The program undertakes to find the logical path between the initial and the final situation by following the rules of the game.

The results of these efforts, as yet unknown to the public, are far from being trivial or without consequence : the heuristics of reasoning are clarified and performances are often better than those of a human specialist. The next 30 years will certainly see machines surpassing men in "intellectual" games, in strategy studies, and generally in solving problems that can be expressed in logical and precisely defined terms.

The understanding of a "natural discourse" raises many other problems including the "dimension" of human knowledge and the signification of such discourse in a culture or a society. Truly, and sometimes in a worrying way, the question arises "what is understanding?"

A person will often declare that he has understood something without being in the least able to explain what he claims to have understood. However, in contrast to the exact perception and precise identification discussed above, there may in fact be no unique interpretation possible. It seems therefore to be desirable to approach these problems according to the type of the principal (but not unique) interpretation.

Whatever the framework of the final interpretation, each type of discourse is systematically interpretated on different levels which are organised in cooperative and competitive hierarchies.

1) Syntatic Level

A "grammar" attributes "universal" morphological qualities to the words of a sentence such as : preposition, verb, subject, complement, adjective etc.

2) Semantic Level

Syntactic interpretation alone is not sufficient for the constructive analysis of a sentence. The interpretation of a word depends on the context. Linguists have long hoped to develop grammars which would make possible the universal "syntactic" analysis of natural-language sentences (see for example the work on transformational grammars by Friedman). The new school is much more "semantic", going back to the ancient idea of the grammaire de Port Royal : "A sentence is the affirmation of a quality concerning an object in our mind". Fillmore has introduced the notion of "semantic case" expressing the idea of the link between verb and complement.

The semantic analysis of a sentence leads to its representation in the form of a "profound structure", basically comprising a principal object and the predicate applied to it.

The morphological analysis is no longer just a grammatical analysis, but uses, to define the "meaning" of a word, the recently developed notion of "semantic cases " :

a word is defined through an ensemble of qualities or "cases", each one defining a particular aspect of the meaning of the word. "The signification can be defined as a convergence of simultaneous semantic cases" (Osgood). The concept owes its origin to psychologists (Le Ny) and neurophysiologists (E. Andreewsky) : in France A. Andreewsky has developed a program enabling the automatic learning of a syntactico-semantic morphology.

3) The Pragmatic Levels

In general, a sentence cannot be interpreted in isolation. It is part of a "narrative", probably interpretable within an ensemble of knowledge which may doubtless be very extensive. Concerning discourse interpretable in procedures, J. Pitrat has proposed the concept of "schema" whereas Y. Wilks, Charniak, Shank have proposed "script" or "frame". Many of our actions comprise a stereotyped sequence of events : for example, to travel, to go to a restaurant, to make a purchase, to meet a person. We try to use such (information) structures, on the one hand to expand and improve them with new information (knowledge acquisition), and on the other hand, to use them to answer questions.

In his thesis, G. Sabah proposes an original representation of the meaning of a "narrative" concerning people : a story or a tale. His program achieves a reduction

of the information presented by each sentence, by translating it into one or several summaries which express the links between the people in the story. Five types of summary are envisaged : Desire, Intention, Action, Relation, Perception. For example the sentence "The fox is starving" produces the summary (desire, fox, food). Also, a certain number of people's "behaviour rules" express causality relations possible between the summaries. For example : (Desire; x,y) $\rightarrow$ (Action, x,y). The possible cause of an action by person x towards the object or person y is the desire of x towards y. A simple algebra for the summaries may thus be built up and will enable the deduction of conclusions that are not stated in the narrative. Examples are to be found in the annex to this paper.

It is undoubtedly the introduction of this language of summaries, a supplementary level of abstraction, which has enabled G. Sabah to obtain his interesting results while avoiding a combinatory explosion.

Once again we see several levels of interpretation coming into play, corresponding to memory structures and particular languages : the "words", the "sentences", and the "stories".

However, despite the great interest of these efforts, it is clear that these comprehension models can only handle simple types of natural discourse interpretation : the procedures, the action rules. Thus the program developed by Sabah does not pretend to any other understanding than being capable of showing "why" somebody does something. We may say that we are dealing with an action discourse. This is of course the first discourse, the language of the homo faber. But many discourses of homo sapiens (?) no longer have an action as their principal interpretation; these we may call conceptual discourses. Out of the five interpretative codes proposed by R. Barthes in "S/Z", one single one, behaviour (proairetic code)concerns actions. The others, hermeneutic, connotation, symbolic field, cultural code belong to the conceptual discourse. Clearly this conceptual discourse is destined for the brain of the reader, of "the listener", it is meant to create an impression, a state, modify or reinforce an opinion, act in relation to a cultural background.

It is here that we arrive at the problems of the development by the individual of his mental structures :

1) structures of knowledge representation;
2) procedures acting on these representations;
3) modification of 1) and 2) by external information;
4) formation and modifications of new concepts through 2) and 3).

It is certain that if our present computer science models of understanding (Cognitive Science) or of question-answer (GUS, MYCIN, KRL, HEARSAY, etc.) obtain non trivial results, this is due on the one hand to restrictions of the domain and sometimes the language... to the uniqueness of the interpretation, and on the other hand to the rigidity of the programs. Even if these models can acquire new knowledge, they can neither develop really new concepts, nor improve their performances, which are governed by the existing programs. We may of course imagine a program capable of auto-modification, but clearly the risks of "epilepsy" or "catalepsy" would be considerable. One can never cease marvelling at the remarkable capacity of the human brain to resist the influences and aggressions of external information. Our protective barriers are extremely solid, yet nevertheless we develop our capacity to learn, we are able to learn how to reason, we can invent (sometimes...).

This is why some of the recent studies of computer science are of special importance. Their object is to achieve dynamic systems of concept formation.

As we have seen, there is a group of procedures - a "program" - corresponding to each concept; this is true from the first levels of analysis. It is therefore essential to understand how this program can be automatically developed by the machine.

Let us take the subject of the thesis of Jouannaud : the search for the algorithmic function F which, operating on a list X will transform it into F(X), the data being examples of couples - $\overline{\underline{X}}$, F(X)$\overline{\underline{\ }}$. An outline of this very interesting study is given in annex : the theme may be compared with that of learning to play a game through examples of moves, or learning to count from examples of addition and multiplication.

The essential tools in these studies are the use of recursivity and of generalisation (in the logical sense). Programs such as Jouannaud's SISP really can discover algorithmic functions corresponding to concepts which are far from being trivial (see annex).

Other efforts (the team led by G. Guiho) are directed towards the simultaneous learning of a language and of how to use it. Using a question-and-answer procedure and a number of heuristics, the system is able to extract procedural concepts, also called types or classes, and simultaneously to acquire the language of the "locutor". Such a simulation recalls the simultaneous acquisition of concepts and of language achieved by a young child.

CONCLUSION

It is hoped that this paper will have conveyed and emphasised the interest and value of these important studies. The computer science models of perception, of identification and of automatic comprehension introduce a very powerful experimental tool into the study of mental mechanisms. It is of course fundamental to accept the hypothesis that thought and language processes are algorithmic in nature. Many will protest at the determinism and reductionism implied by these "models". However, understanding the mechanisms of digestion has not killed our appetites... nobody would dream of denying the explicative value of biochemical models of the physiology of the organs of, e.g. reproduction, or even of Life itself, yet opposition persists... In fact, all these explanations, including our models, show the complexity and the richness of the phenomena. We are discovering a world the existence of which we had hardly suspected, and we are led to reflect on the "automatisms" of which we are prisoners and to examine the validity of certain opinions which may be at the origin of some of our political and social difficulties.

We have seen how, from the first levels of perception linguistic and logical procedures appear which lead to elementary concepts of "characteristic patterns".

Real languages correspond to these procedures. Each group forms a viable mini-system which communicates with the other mini-systems in a hierarchical structure, the objective being to obtain one or several interpretations (signifiant) of concrete representations (signifiés).

The nature of semantic operations for understanding discourse is very clearly the same. Once again we see the multiplicity of interpretation levels, of cooperative or competitive hierarchically-organised procedures, of sub-languages intended to extract simplifying concepts transmitted as primitive elements to other levels of knowledge.

It is evident that this type of organisation is the only possible answer to the problems of memory complexity and calculation time posed by the processes of identification and understanding. In a way, it is the necessity of arriving at a result in a time and with means which are physically limited which inevitably demands hierarchical decisions.

It seems worth emphasising that these types of hierarchically-organised linguistic structures have very early been distinguished in the evolution of neurophysiology. We find them in image and sound recognition. The mechanisms of human language understanding are direct heirs to these processes, which we can imagine as first appearing in the

course of evolution of the species. If man endowed with discourse is at the summit of this evolution, we must also admit that there is no fundamental difference of nature between our own perceptive mechanisms and those of other species, particularly those of mamals; furthermore, we must accept that the formation of concepts is a faculty shared by animals even though they cannot speak. The recent education experiments with chimpanzees seem to confirm this point of view.

Civilised man has greatly developed this process of concept-formation through language. Prodigiously manipulated and interpreted by religion and politics, "Ideas" have completely invaded our discourse. And this despite Socrates' warnings, in the fifth century BC, of their dangers, of their chimerical and contradictory interpretations. We may go back to Plato's dialogue "Laches" to see how Socrates ridicules Laches, the military chief and Nicias, the political strategist, about the notion of "courage" : both of them end by admitting "that they are totally ignorant of things which should be known by people who believe they are someone".

The mental processes which have allowed us to disengage ourselves from a chaos of sensations and impressions, and to organise our world, are now dragging us too far

towards the search for "universal principles" : Liberty, Socialism, Equalism, Order, Independence, Justice, Nationalism, Change. Many "conceptual discourses" use them freely, we "understand" them, but how should they be interpreted in the factual universe, in the world of decisions? So agreement is rare indeed...

However, we may wonder if these conceptual discourses may not be the means we provide ourselves with to try to understand apparently inextricable situations. Already our social organisation reflects to some extent the structures we have described : mini-systems equipped with particular languages, communicating through simplified concepts with the outside world. Thus our desire for rationality has brought into being hierarchical structures of decision, in enterprises, in administration, in the State. Faced with complex economic and industrial situations, the "technocrats" simplify the problems and prepare decisions for the politicians. This is how a Head of State is able to call for "growth", "inflation", "deflation" etc., with a sense of assured rationality.

Of course we know that decisions must be taken, that we must avoid certain disasters : wars, pollution, energy shortages, collective madness perhaps. But can we do this without <u>seriously</u> studying all the consequences

of our decisions, and in particular the interpretation of our conceptual discourses in the whole universe of actions?

This is why the author of this paper believes in the great importance of the studies of computer science which he has described. Of course, it is not to take the decisions in our place, but to help us to obtain concrete interpretations of our signs, in a way "to understand". May we hope that the experimental method, applied to our hazy but sometimes danger-laden discourses may, like a new Socrates, deflate them and show us their dangerous emptiness.

From another viewpoint, can we hope that these experimental models of understanding, and therefore also of decision, will allow us to construct the solid bases of a theory of interactive human systems, which we so clearly and desperately need to understand our present world.

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ANNEX

DESCRIPTION OF A SYSTEM FOR UNDERSTANDING STORIES

As indicated in the main paper, the thesis of G. Sabah concerns the understanding of tales and stories, with emphasis on the "personages" responsible for the "actions". We may find examples in the fables of La Fontaine.

The program written in interactive SIMULA (a well-developed language from the ALGOL family) comprises 4,200 instructions and requires a memory volume of 45,000 words. The memory volume necessary for the representation of 300 concepts is 5,000 words. Response times are fairly short : 1/2 to 3 seconds for the analysis of a sentence, the same time to "understand" it. To answer a question takes from 0.7 to 4 seconds.

For the program, understanding a fact means that it is able to define one or several reasons behind the fact. The program is therefore able to respond to questions "why"...

The system's memory comprises 3 information levels each manipulated according to its own language and rules.

i) Words are the basic concepts. They use the notion of semantic cases. In 1963 Osgood declared : "in the same way that a phoneme is defined as being a convergence of simultaneous phonetic properties,

signification may be defined as a group of simultaneous semantic cases. However, regrouping is possible in order to organise a hierarchic vocabulary, in which links are related to properties.

ii) Sentences express relations which link particular occurences of words. A sentence is entered into a memory in the form of a predicate. The surface structure is a chain of characters. It is transformed by analysis of its internal relational structure, built after Fillmore's model of case grammars. Six semantic cases have been chosen : Source, Principal Agent, Theme, Secondary Agent, Objective, Place. In general, the verb defines the predicate.

The case structure of the sentence is included in a recursive structure which defines the principal object of the thought and the predicate applied to it, and which will eventually treat recursively the variations of nominal syntagmas or sub-sentences. Understanding a sentence means being able to break it down into this basic structure (Anderson and Bower). The grammar of accepted sentences is the following :

Sentence	⟶	Nominal group (NG) Predicate
NG	⟶	Determinant adjectival group (AG) inflexion
AG	⟶	Noun/Adjective AG/AG Adjective
Inflexion	⟶	Ø /of NG inflexion/who predicate inflexion/which predicate inflexion/ of which predicate inflexion
Predicate	⟶	be (adverb) circumstance/ Physical process (adverb) (of NG)/ Mental process (adverb) sub-sentence/ Action (NG) complements/Action-process NG Complements
Circumstance	⟶	Adjective/Locative preposition NG/ NG/past participle (by) NG
Complements	⟶	Ø /preposition NG Complements
Sub-sentence	⟶	Ø /which sentence/NG/Complements/ (not) predicate (infinitive tense)

The terminal elements of the grammar are double underlined. The elements underlined once only are those which are re-written in terminal elements.

The recursive character of these grammar rules has to be noted.

Correct analysis applies to sentences such as : "The big gascon fox, from the forest, dying of hunger, whose tail is red brown, sees the grapes that the hunter wants the fox to eat".

Also : "He drank the whole bottle" understood as : "He drank all of X, X was in the bottle", by the use of the semantic cases of to drink and bottle.

iii) The Stories enable the identification of persons (actors), the discovery of their motivations through the "summary" algebra. The links between the different sentences of a story are sought.

The fundamental idea of G. Sabah is the reduction of information provided by the sentence, so producing summaries, relative to the actors.

For example :
"A starving fox sees a crow holding a cheese",
produces the following summaries :

(Desire; fox, food)
(Perception; fox crow)
(Relation; crow, cheese)

If we add the sentence :

"The fox is talking to the crow",

this corresponds to the summary :

(Action; fox, crow)

The system then deduces :

(Desire; fox, cheese)

Thus the system can answer questions which are not explicitly answered in the story, particularly causal questions. It can answer general questions. Here is an example of the mechanism : in a first sentence the system (whose elocution is indicated by ⊕) is told a story :

⊕ HELLO, I AM LISTENING
LISTEN TO A STORY

⊕ NAME OF THE STORY
THE CAT AND THE MICE

⊕ I AM LISTENING
A STARVING CAT COMES INTO THE HOUSE

⊕ UNDERSTOOD
THE HOUSE MICE IMMEDIATELY HIDE

⊕ UNDERSTOOD
THE CAT GOES UP TO THE ATTIC

⊕ UNDERSTOOD
HE GOES DOWN TO THE CELLAR

⊕ UNDERSTOOD
HE DOES NOT SEE ANY MICE

⊕ UNDERSTOOD
HE THEN HIDES

⊕ UNDERSTOOD
THE MICE WHO CANNOT SEE HIM ANY MORE
COME OUT OF THEIR HOLE

⊕ UNDERSTOOD
THE CAT CATCHES THEM

⊕ UNDERSTOOD
THAT'S ALL

Here now is the interrogative part :

⊕ I AM LISTENING
WHERE DOES THE CAT GO?

⊕ INTO A HOUSE
⊕ TO THE ATTIC
⊕ TO THE CELLAR

⊕ I AM LISTENING
WHAT DOES THE CAT WANT?

⊕ THE CAT WANTS TO EAT THE MICE

⊕ I AM LISTENING
WHO DOES NOT SEE THE CAT?

⊕ THE MICE

⊕ I AM LISTENING
WHAT DOES THE CAT SEE?

⊕ I DO NOT KNOW

⊕ I AM LISTENING
WHAT DOES THE CAT NOT SEE?

⊕ THE MICE

⊕ I AM LISTENING
WHO HIDES?

⊕ THE MICE
⊕ THE CAT

⊕ I AM LISTENING
WHY DOES THE CAT GO UP TO THE ATTIC?

⊕ BECAUSE HE WANTS TO ESTABLISH A
RELATION BETWEEN HIMSELF AND THE MICE

⊕ I AM LISTENING
WHY DOES THE CAT HIDE?

⊕ BECAUSE HE WANTS THE MICE TO COME
OUT OF THEIR HOLE

⊕ I AM LISTENING
WHY DO THE MICE HIDE?

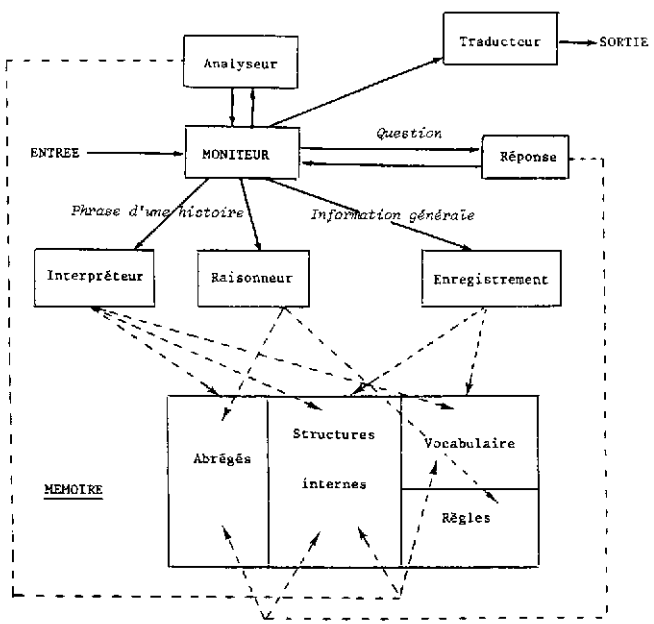
⊕ BECAUSE THEY DO NOT WANT TO BE EATEN
BY THE CAT.

Clearly the system has a certain amount of a priori information about the carnivorous nature of cats for instance, but the dialogue shows that it "understands" the information given by the first sentence, the story.

Finally, here is a diagram showing the general organisation of the program (below).

The "analysing" sub-program accepts sentences in French and interpretes them at the word level in its vocabulary and at the sentence level in its internal relational structure.

The "translation" sub-program transforms an anwser, or a question put to the program, from the internal structure into a "surface structure" : i.e. into sentences.



Structure générale du programme

——→ Appel de procédure

- - - → Consultation de la mémoire

THE SISP PROGRAM

The subject of the thesis by J.P. Jouannaud is "The inference and automatic synthesis of LISP functions from examples". The term "LISP Function" means that these "constructive" functions - the explicit algorithms - are represented in the LISP language, a high-level programming language particularly adapted for the treatment of "Lists". The interest of this work is to show that, starting from relatively simple means, the program produces, by recursive induction, algorithms which are far from being trivial. Starting with only a few examples, the program truly invents and generalises, just as would a human observer.

Here are some examples of problems posed in the program.

Question X	Answer F(X)	Function F
ABCD	BCDA	the first becomes the last
ABCD	DCBA	the list is inverted
ABCD	ABCDDCBA	mirror
ABCD	AABBCCDD	double
ABCD	AABABCABCD	iterative repetition
ABCDEF	AFEDCB	partially invert a list
ABCDEF	AFBECD	mix "the cards" (shuffle)
ABCDEFGHIJK	KBIDGFEHCJA	idem
ABCDEF	ABC	halve the list
ABCD	ABBCCCDDDD	repeat according to position
ABCDEF	CBAFED	invert the lists by halves

The problem is to find a recursive function F which will operate satisfactorily not only for the given example but also for other examples provided by the "teacher". This of course requires that the teacher applies a "general law", and that he does not change this law in the course of his examples. The function F constructed by the program is a LISP representation of this general law.

The "a priori knowledge" of the program is now much more restricted than in the previous program for story understanding. The language is extremely restricted and the capacities very specialised, but the performances are remarkable.

In a few words, a so-called "decomposition model" graph is established by SISP, it enables the passage from X to F(X) to be achieved through a"lattice". The heuristic which permits the establishment of this lattice is simple and very general : it consists in measuring the similarity between two trees by means of the "largest common sub-tree". Starting from this lattice, the possible recursivity is automatically detected, corresponding in normal terms to a "repetitive regularity".

In case of difficulties, SISP is capable of breaking down a problem into a hierarchy of sub-problems. This results in the discovery of complicated functions, built up by composition and recursivity operations from a group of LISP elementary primitive functions. It is not possible here to go into greater technical detail. However, it may be noted that SISP comprises more than 2 000 instructions in interactive LISP, and can synthesise a complicated function F in about one second under the form of a program built up from the elementary LISP functions.

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C H A P T E R I V

FOURTH WORKING SESSION

COMMUNICATION AND SOCIO-ECONOMIC PHENOMENA

If the two opening papers of the Third Working Session of the Symposium (Professors J.F. Le Ny and J.C. Simon) were "largely complementary", those of the Fourth Working Session (Professors Ithiel de Sola Pool and Jean Voge) were even more close to each other, notably in their emphasis on the much increased "information content" of modern production - with a much increased proportion of the workforce engaged in informational activities rather than material production; and in drawing attention to changing structures in information production, treatment and dissemination. Both these changes are fundamental, almost certainly irreversible, and quite certainly changes which nostalgic supporters of "the old order"[+] can be expected to resist for as long as possible.

Professor de Sola Pool, from the Research Program on Communications Policy at the Massachusetts Institute of Technology, in a paper entitled "Development of Communication in the Future Perspective" maintained that these changes resulted mainly from four world developments :

[+] In particular, according to Professor de Sola Pool, nation states, bureaucracies, cities, and a class structure in which manual labour is performed by an underclass and mental labour by an elite.

- growing economic interdependence, leading to a "global economy";
- rapid and efficient (and cheap) transport of persons and things;
- electronic communication; and
- "intelligent" machines.

Of these the most immediately significant were electronic communication, especially via geostationary satellites, and transport... even though the former was likely eventually to make "business" transport less and less necessary. One result would be the inevitable collapse of national frontier controls on information transmission, and on services dependent on this such as news diffusion, interchange of cultural, technical and economic data and, for example, banking (banks anywhere in the world would be accessible "to anyone who can pick up a telephone anywhere").

Professor de Sola Pool had many other penetrating comments on the evolution of a "communications society"[+] as well as some philosophical reflections on mankind's oldest unresolved questions: whence did he come, why is he here, and whither is he going? One might have hoped to hear, during the subsequent discussion, something of the oriental approach to these questions, but those present who might have contributed such information remained silent - a reminder, perhaps, that "non-communication" can be due to non-emission of information no less than to its non-reception or non-acceptance.

[+] For the full text of Professor de Sola Pool's paper, see page 339.

In his paper "Economy and Communication"[+] Professor Voge (French Direction Générale de Télécommunications, Paris) added quantitative data to Professor de Sola Pool's information, in particular developing rules for "optimum" structures in communications networks and showing that a system of exchanges at several levels (subscribers being connected to "primary" exchanges which were themselves interconnected through "higher-order group exchanges" at one or more levels) required less commutable connections and consumed less power than if a single large centralised exchange were used. This demonstration that a degree of decentralisation led to greater efficiency clearly had relevance in other fields, notably that of agglomerations of "population units" in large cities as opposed to their distribution more evenly over much wider areas. The compelling reason of the past for concentrating population in cities (the need for frequent and rapid personal contacts with many other citizens) was disappearing as electronic communication made personal contacts a matter of choice rather than of necessity.

Concerning information content in production, Dr. Voge cited figures, mainly from the United States, indicating that an optimum content (information "quota" or "ratio") was 50%, and that in the US this had now been very nearly achieved. The more advanced countries elsewhere in the world were in pursuit.

Both of these papers pointed to the important benefits - material and "moral" - to be expected from replacing today's concentration in cities

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[+] For the full text of Professor Voge's paper, see page 359.

by the gradual decentralisation of society which modern communications have made possible. One somewhat paradoxical observation, however, was also to be noted, namely that increasing unification of communications structures (e.g. through satellites and even through large though "distributed" computer systems) could not only lead to greater physical decentralisation of much of our currently centralised society; it could equally lead to even further centralisation, which at least initially would probably exhibit increased efficiency. This point was raised in the discussion following the two papers, when it was pointed out that in some circumstances decentralisation could lead to paralysis and disaster. Professor de Sola Pool readily agreed that this might be so, and remarked that there seemed need for a rigorous study of the relationships between technology and decentralisation.

One questioner in the discussion wondered whether Dr Voge's conclusions concerning optimum telephone networks were necessarily valid for the much more complex interconnected networks of a complete society; and another drew attention to the importance of quality (whether of products or of life) which would not necessarily follow the same type of law as Dr. Voge's paper had described. Could it be envisaged, in fact, that if eventually production growth rates became very low or even zero, being perhaps compensated by high information growth rates, a general growth in quality (presumably at least partly dependent on information quota) might also be achieved? These remarks provoked some lively and controversial discussion, notably concerning the "quality

of quality" and the role of happiness in the realisation by man of his destiny. Professor Voge went so far as to ask whether future happiness would be synonymous with survival : Professor de Sola Pool, while not denying that they were related, believed they were fundamentally different in nature and that, in the context of this Symposium, man's survival depended on the use he made of technology while his happiness depended on the use he made of survival.

This prompted a characteristically philosophical concluding remark from Professor Eduardo Caianiello, to the effect that fundamental changes such as more (or less) decentralisation should not be decided only on the results of technical studies and calculated figures. While these should certainly be used as guides towards sound future planning, at some point there should be consideration of human wishes... and human happiness.

For this fourth Working Session, as for its predecessors, two parallel afternoon Round Table discussions had been planned : one, to be chaired by Professor Ilya Prigogine (Free University of Brussels : Nobel Prize for Chemistry, 1976) on "Urban Problems, messages from Town and Politics"; the other on "Social Consequences of Economic and Technological Modifications resulting from Communication", to be chaired by Professor Caianiello. In fact, as a result of many participants wishing to avoid exclusion from one discussion while attending the other, the two were amalgamated... or at least took place serially in a single room rather than simultaneously in two. Although this resulted

in some rather abbreviated presentations, and allowed no time for participation from the floor, most of those present considered these inconveniences preferable to being obliged to choose one Round Table and forego the other.[+]

Professor Prigogine opened the session with a brief exposition of his celebrated "town" model of a complex societal unit, interacting with its environment and at the same time pursuing an internal evolution due to such developments as expanding population or increasing road traffic. Towns in this sense are "dissipative structures", and when some part of the system is disturbed by a "communication", resulting non-linearities in the various inter-related evolutionary paths of the system may provoke unforeseen changes which, in Professor Prigogine's terms, are "bifurcations". Without such non-linearities the system would not of course - and could not - remain a "living system".[++]

This type of analytical approach was mentioned in a case study of the Belgian capital Brussels, presented by Professor P. Laconte (Louvain Catholic University), who described the very substantial changes resulting from the installation of EEC Headquarters in Brussels in 1960, and the subsequent development of the city as an international centre of administration and business. Professor Laconte's account of the present situation of Brussels clearly represented the many and complex problems associated with such a development and amply demonstrated

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[+] Compared with some symposia, where attendance following a good luncheon is often somewhat thin, a notable feature of this DISCOVERIES meeting was the determination of all participants not to miss anything.

[++] Those wishing to pursue Professor Prigogine's theories in greater detail are recommended to his paper "Metamorphoses de la Science : Culture et Science aujourd'hui" (in French) prepared for the previous DISCOVERIES Symposium in Rome, and presented in summary form as recorded in the Proceedings of this Symposium, pages 297-311.

the need for and value of dynamic analyses of this type. It also offered practical confirmation of some of the conclusions of Professors de Sola Pool and Voge concerning the relative merits of concentration and decentralisation in heavily-populated areas.

Two other papers, from Professors P. Allen (Brussels Free University) and M. Castells (French Study Centre for Social Movements, Paris), dealt respectively with some effects of its communications system on the growth or decline of a town (again Professor Prigogine's model was relevant); and with methods for "accommodating" some of the new forms of social movement which modern urban development tended to encourage. This paper gave ample evidence of the very substantial effects which such movements can have on an entire community.

The Chairmanship was then taken over by Professor Caianiello, who delivered some penetrating reflections on such matters as the optimum values of money pieces and notes in a currency, numbers of officers and men in military and other teams, and of participants in discussions (in order to achieve valid conclusions without excessive delays). This introduction to some rather novel uses of "mathematical linguistics", as Professor Caianiello described them, must have set many of those present thinking of new possibilities for the application of their professional training. It must also have stimulated at least some reflections that, in the type of "communications society" to be expected in the future, conflicts could arise between efforts to take account of all viewpoints likely to affect an administrative decision (e.g. on the

siting of an airport or of a motorway) and the need to take the decision without undue delay. Here was a pointer to what is already a severe problem in modern technological society, a problem that is widely manifest through the appearance of so-called "public-interest groups", each claiming to represent a particular aspect of the public interest but without (usually) accepting that other aspects are equally important and inter-related.+

Professor Luigi Mendia (Naples University, Italy) followed this with some remarks on environmental quality and its preservation in face of various attacks such as the unhappy pollution by mercurial compounds of the sea at Minamata in Japan, or the dioxin poisoning in the Seveso region in the north of Italy. Both these events, besides being consequences of "communication" in the sense of the DISCOVERIES Symposium, must surely also be attributed to ineffective or perhaps non-communication in an important measure.

Professor Giuseppe Caglioti (Milan Institute of Nuclear Physics) spoke about "non-resolvable ambiguities" in ordered structures, illustrating his talk with some diagrams (now well-known to his Symposium colleagues) which can exercise the perceptual sensors of the human brain in a manner which - to an engineer - is reminiscent of an electronic "flip-flop" oscillator. The rythmic inversions of Professor Caglioti's ordered structures resemble a model, based on an ideally non-linear decision equation for binary systems, which was originally proposed to schematise the observed behaviour of neurons.

+ cf. Professor Tajfel's observations (third Working Session) concerning interdependent groups wishing (and endeavouring) to represent themselves as independent.

Next Professor Umberto Pelligrini, President of the Federation of Scientific and Technical Associations in Milan (Italy), commented on the major changes in social and economic structures resulting from the evolution of pre-industrial society into industrial society, and from the latter to post-industrial society. These last changes could be particularly well seen in the effects on labour forces of the electronics industry and the growing impact of the manufacture and use of automation equipment.

In a somewhat similar analysis to those of Professors de Sola Pool and Voge (in the morning session) Professor Pelligrini saw three main levels of communications-related activity in post-industrial society, namely :

- informational activity (information being a basic resource which in post-industrial society would play a similar role to that of energy in industrial society);
- "intellectual technology" (based on information, abstract theory and science, these being substituted for the intuition and empiricism characteristic of industrial society);
- a new "working class" of professionals and technicians trained in the applied sciences.

These developments would certainly, as Professor de Sola Pool had indicated, radically reduce the significance of national boundaries,

and would lead to new types of transnational social aggregations and interactions. Such new relationships, dependent on electronic computers and telecommunication systems ("teleinformatique") would allow the operation of many decentralised but highly productive units, every one with individual access to the information resources of the entire world.

Professor Pelligrini was followed by Dr. F. Margulies, of the Austrian Federation of Trade Unions, who was unfortunately obliged to shorten his address but who showed that the gradual evolution of workforces - which a century ago comprised mostly manual labour - to what now comprised a technological elite, had been achieved with remarkable understanding and responsibility. Nevertheless, further progress could still be envisaged, and Dr. Margulies suggested a "guiding code" for continuing successful relations between workers, managers and society in the Age of Electronic Communication.

This code, he believed, should include :

- improved and speedy communications to and among the workforce representatives of details and probable implications of foreseen economic and technological changes;

- participation of workforce representatives in decision-making affecting the future of all;

- recognition by workers and their unions, as well as by managers, that every technological and organisational problem offers

alternatives, that these frequently (usually?) involve conflicting interests, and therefore that the question of who decides what should be done is no less important than what is decided;

- recognition by managers that the greater satisfaction among their workers which would result from more opportunities to take decisions and make their own choices would almost certainly lead to better work while - on the other hand - sophisticated automated systems were unlikely to work satisfactorily if controlled by dissatisfied workers;

- recognition by society that human values cannot be reduced to simple production figures and financial returns : that the most important of all human values, in fact, is human dignity.

Listening to Dr. Margulies' discourse, it was difficult to disagree with any of these suggestions which clearly concerned not only the humane use of human ideas, but the humane use of human beings themselves.

Nevertheless, and by no means for the first time in presentations of this nature, it was not easy to suppress an underlying tendency to believe that "real life" was less simple and straightforward than here suggested. An example, perhaps, of "message refusal" due to conflict with pre-existing understanding?

To end the session of a note of renewed cerebral stimulation, Professor Barrington Nevitt drew together various practical and theoretical

theses of the Round Table discussions to support the proposition that, just as communication was dependent on environment, so was environment dependent on communication. As a result of the virtually instantaneous communication now possible through the "electric media", there was ever-increasing compression of "the sequent into the simultaneous", so eroding "visual and logically-connected order" and replacing it by (returning to) "audile-tactile dialogue".

This led the Professor to a renewed exposition of what might well be described (at least among DISCOVERIES participants) as his "Course on perceptual and conceptual communication". In a short and stimulating discourse, he reminded his listeners of the distinctions between what he termed synchronic (simultaneous) and diachronic (serial) assimilations of image patterns, recalling that these two variants had been discussed in detail in an earlier presentation.[+] The human brain, he recalled, comprised two separate and apparently independent halves, whose apparently independent roles were concerned with these two distinct types of information pattern.

Although the reason for this division might be obscure, its existence was not disputed, and the Professor was convinced it was fundamental to the evident differences between the thought processes of orientals and occidentals. Here could be the origin of eastern Zen, Ma and similar practices - and in the west of "impressionist" poetry,

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[+] H.J. Barrington Nevitt : "Invention is the Mother of Necessities, Old and New". Paper prepared for the previous DISCOVERIES Symposium in Rome, and presented in summary form as recorded in the Proceedings of this Symposium, pages 218-226

music and visual expression. On the other hand (side) were logical philosophy, science, technology and engineering. The two halves were separate yet inseparable, indispensable parts of the human whole yet parts which rarely grew to equal stature in one individual. That, said Professor Nevitt, was why we rarely had poets who were engineers, or engineers who were poets. And why we could benefit from many more such "complete" people.

This fourth Working Session, possibly because it was the fourth and therefore benefited from the "preparation" of the three preceding days (not only in the formal sessions but also in many informal discussions in corridors, over meals etc[+]) was a particularly stimulating exercise towards a combined interdisciplinary approach to the technological, sociological and human problems of "Communication in Human Activity". Opening the following morning's summary session of the papers and Round Table discussions,[++] Professor Prigogine insisted that communication in human activity was inevitable, an intrinsic element of all society which could not be eliminated without eliminating society itself.[+++]

Moreover, communication was in the main irreversible, as was its progress : that was to say there was no way of returning to a society with less communication, less information or less understanding without (again) the elimination of that society.

[+] Despite the well-known attractions of the capital city of France, there were few participants prepared to trade the stimulating intellectual contacts of DISCOVERIES for visual, acoustic or even gastronomic experiences elsewhere. An indication, surely, that intellectuals of whatever disciplines are (contrary to a fairly popular belief) very conscious of their responsibilities towards the world about them, and very ready to give priority to its well-being.

[++] Chaired by Professor Alfred Sauvy of the Collège de France.

[+++] Even in that event, communication outside human activity would continue.

Today, through the combination of many sciences, notably those of physics and mathematics, the overall nature of complex systems such as human society was being seen with a new clarity, as was also being seen the systems' remarkable complexity and the impossibility of breaking them down into simpler systems which could be satisfactorily represented by simplistic models.

Their evolution was continous - yet continuous only in the sense that it comprised a series of sudden, non-linear changes - or in the Professor's terminology, "bifurcations". All progress in fact must depend on these non-linearities... without them the future would be entirely settled and determined by the past - evolution would become a banality.

Professor Caianiello, while not disagreeing with the general direction of these enunciations (i.e. that mankind, with the help of science, was constantly advancing towards a better understanding of his environment, including his own society) clearly believed there was still a very long way to go. "We do not", he said, "really know enough, if we know at all, of the laws that make human societies of various degrees, qualities and so on; nor do we know about many essential facts that still concern the perception by the individual of some message that that may come to him."

The Professor was also unprepared to dismiss simplistic models as without value in studying very complex systems. While recognising

that they could be very crude he believed that this could often be an advantage : indeed, much past progress in investigating the complex processes of nature would have been more difficult or even impossible without the use of crude and simplistic models.[+]

However much more sophisticated models - such as those of Professor Prigogine's "nourished equilibria"[++] (to which Professor Caianiello paid particular tribute) were also more and more necessary as understanding advanced and, as was clear from the papers and discussions in the present Symposium, many such models would not be realisable without the help of modern computer and information-processing systems.

Professor Caianiello also stressed how frequently it was found that a set of mathematical expressions, developed to represent a problem in one particular branch of science, was found to be equally applicable in representing a totally different matter.[+++] That was due to the nature of the model, which was "only a tool for thinking, to be discarded as soon as you may" but nevertheless offering a promising approach "to find ways to do better things".

Surveying some of the other remarks and presentations of the previous day, the Professor discussed the impact of so-called post-industrial society on the labour force which that society had inherited

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[+] The (momentary) assumption that certain variable parameters in a relationship were invariable was a classic way of arriving at crude models which, despite their crudeness, could be of remarkable help in understanding aspects of very complex processes and systems.

[++] For details see reference paper cited in second footnote on page 324.

[+++] It is perhaps for reflection that this might be due to man's habitual methods for representing natural phenomena no less than to characteristic similarities in the phenomena represented.

from the preceding industrial society. Both Professor Pelligrini and Dr. Margulies had drawn attention to the decreasing demand for "elementary" (manual) labour,and the increasing professionalism in the new "intellectual technology". Professors Voge and de Sola Pool had indicated how advanced countries were approaching a situation where 50% of all production would comprise informational activity. Clearly this implied very significant changes for traditional workforces, and there was a developing problem of how, in a world of information and automation, those displaced by machines should occupy their lives. "We have", said Professor Caianiello, "to prepare more students in our highschools, experts in our universities, so that there may be places where these people find the right occupation and a job." He continued : "They will be an essential means for human development provided we are careful enough to take care of such things now", and in this he was echoing the sentiments of all who, seeing the path along which modern society was now set, were apprehensive of the possible consequences for a substantial sector of every community. For despite the encouragements of additional education and more intellectual work, not everyone in that sector would necessarily wish to follow this path, yet they would be unable to avoid its effects and implications. Perhaps we should see a massive return to traditional handicrafts, themselves with a high information content and offering personal satisfaction and fulfilment not to be found on the production line.

Professor de Sola Pool, summarising comments following the presentation of his paper, returned to the question of system modelling (whether on computers or otherwise) with a reminder that the use of a model in decision-making would usually be limited by the over-riding power of human intervention. It was easy, he said, to talk about decisions being made by humans versus decisions being made by computers, but it was improbable that this issue would arise in practice in relation to important decisions, simply because humans would not be willing to have "really important" decisions taken other than by themselves. "If we decide the computer is wrong", said the Professor, "we will exercise that judgment."

Most people would surely agree. For them the computer, data processing and communications technology - in fact the whole of "informatique" - must be regarded as a useful (even invaluable) extension of and aid to human activity, but not a complete substitute for it. For them, although the robots we create to serve us may be theoretically infallible it is still conceivable (perhaps because of our own failures in their design) that they may produce false answers. Our safeguard is the overall monitoring effect of "common sense", which rejects propositions widely at variance with its own assessment of a situation. As Professor de Sola Pool said, "this is a new kind of input, and a new kind of input which will complicate the interaction between human beings and the computer".

Referring to the complex systems models developed by Professor Prigogine, Professor de Sola Pool pointed out that these did not unambiguously favour either centralisation or decentralisation as desirable future policies. Such "simple polarity" was unrealistic : for example did the growth of modern conglomerate organisations in industry or elsewhere represent more centralisation, or less? "The only way they can grow bigger", said the Professor, "is by adding levels into the hierarchy and allowing a much larger degree of decentralistion of components." A conclusion clearly in line with those of Professor Voge concerning telephone systems.

A concluding remark concerned mankind's options for planning, predicting, or simply accepting the future. Here again "black and white" divisions were not realistic, for the future in fact would certainly evolve from a mixture of all three. In communications, it was clear that technical developments were already challenging the authority of nation states, which could respond in a variety of ways... one of which was simply to cut off the facilities offered in a determined refusal of progress.+

Another response could be the creation of new types of organisation - at both national and international levels - and here the choice available was both very wide and very open. The implication, although Professor de Sola Pool did not say so in words, was that man's future destiny - despite his continuing creation of more and more sophisticated

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+ "Technically possible", said the Professor, "at a price."

"attachments" to his life - was still, and could and should remain, firmly in his own hands.

This most interesting session of the Symposium ended with interventions from Professor Voge and Monsieur André Danzin (Director of the French Institut de Recherche d'Informatique et d'Automatique). Like Professor de Sola Pook, both were concerned with the practical effects of the "information explosion", and how society could and should accommodate these effects. Also like Professor de Sola Pool, both stressed that the developing controversy getween centralisation and decentralisation was a false controversy, very dependent on precise definitions of the terms concerned which in any case were no more than crude (very crude) attempts to model future trends. Although they were seen by some as alternatives, further examination showed them in fact to be complementary, and the future search should therefore be to find the optimum combination. Without going into detail (which neither Professor Voge nor M. Danzin did) the general trend of thought seemed to be towards some system of "dispersed hierarchies", leaving matters of no more than local concern to be decided locally, but recognising that others (food supply, raw materials, energy, international informatique, or the problems of pollution) to be regulated at what Professor Voge called "global level"... for (as he said) we can visualise the world as a "global village, made up of a large number of micro-societies". In such a system, he believed, most of the "power" would exist and be exercised at the lower levels,

but some would necessarily remain - and even be further concentrated - in the top echelons of the hierarchical pyramid.

Monsieur Danzin raised one further matter. Recalling the problems expected to develop for many people of how they should occupy their lives when - in the post-industrial society - the "mechanics" of living required only a small part of their daily effort, he believed a quite separate structure could be created in which people participated voluntarily (or at least without immediate material reward) in projects designed to develop and improve their environment, their participation in the world about them, in fact their contribution to society. In this way, important developments of benefit to all could surely be realised without stimulating the (currently common) accusations of small groups exploiting for selfish ends - and often incompetently - the rest of the community.+

To many of those present, it was highly encouraging to hear this idea of service as a principle of life put forward, with such evident sincerity, by one who must rank as a Captain of Industry, if not a Field Marshal.

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+ Although this type of accusation seems today to be a common battle-cry among many varieties of "protesters", it may perhaps be observed that proven examples - at least of incompetence - are rather rare, while the definition of "selfish ends" depends substantially on where that definition originates.

Text of paper by Professor Ithiel de Sola Pool

DEVELOPMENT OF COMMUNICATION IN THE FUTURE PERSPECTIVE

Since the time of Bodin, and certainly since Condorcet's "Esquisse d'un tableau historique des progres de l'esprit humain", men have generally assumed that there is a pattern to human history such that the future will differ from the past. That is a novel thought. Through most of the millenia of human history fundamental change was so slow that men's natural assumption was that their world would not differ greatly from that of their great-grandfathers or of their great-grandsons. There were, of course, changes like famines, wars, floods, and epidemics, but they followed no epochal laws or patterns. History could be conceived as "one damn thing after another." Chronicles there might be, but an epic of man with a plot of intrinsic evolution (and not just some magical creation) could only be conceived when individuals could perceive systematic change taking place within the time frame of their own comprehended experience.

The Jewish and Christian myths were among the earliest perceptions of a plan to history. The plot involved creation, sin and the fall of man, a long struggle of penance, and an ultimate messianic resurrection. History, "the unrolled scroll of prophecy", made sense as such a divine plan. And indeed, when in the 18th Century the idea of progress was secularized by Condorcet and others, it may have been freed from some of its mythological baggage, but it still had a transcendental character that cried out for explanation.

The Darwinian process of selection was one way to account for a phenomenon of infinite perfectability. Any notion of history more complicated than unidirectional progress -- what Shelley called "a cyclic poem written by time upon the memories of man" -- was even harder to explain except by a divine plan. The 19th Century notion that there were scientific laws of history in which "nature" somehow determined the character of society at different stages, mispercelved science, and merely substituted the word "nature" for the word "God". Though such sacro-scientific theories may now fail to satisfy us intellectually, they continue, now that men recognize the fact of change, to appeal to a profound desire to know where we are going. We are haunted by the question of whither!

The Darwinian explanation of progress makes much sense. There is reason to presume that what exists today in the most advanced societies meets some human needs, for it was selected in an evolutionary process. The human institutions that have evolved over millenia of change may help the species to survive. But it would be a profound confusion of evolutionary ideas to assume that the process of natural selection necessarily makes life better in all respects for the individuals in the species. (After all, some species such as bees and ants thrive by their total subordination of individuals.) The pleasure principle may play an important role in mediating the process of selection, but that fact does not guarantee that the conditions of life that get selected for survival are the same as those in which we as

individuals would find our greatest happiness.

Indeed, it would be very surprising if the features of contemporary society, so alien from the natural environment of the species, were not also to a considerable degree distasteful to the human organism and likely to have features that we struggle to change. After all, for the overwhelming majority of the span of man's existence on earth, almost all men lived in tiny tightly knit primary communities, met perhaps 50 people in a lifetime, and talked little and that little, mostly in the context of familiar emotional ties where few words were needed. It would be strange, indeed, if organisms that had lived in such a milieu for a couple of hundred thousand years would be entirely at home living in cities of millions, interacting socially not with 50 people, but with two orders of magnitude as many, and spending all but a few minutes a day of their lives in enclosed boxes called buildings.

The society in which we live today is characterized by four quite unnatural major institutions (among others). These are:

the nation state;

bureaucracies;

cities;

and a class structure in which manual labor is performed by an underclass and mental labor by an elite.

These four institutions all grew up together in the past 500 years. Each had its antecedents. Cities existed in the ancient

world, long before modern manufacturing and commerce made the city the habitat of the majority of the population. There were city states and empires long before the world was partitioned into (now 130) sovereign nation-states. There were Mandarins and Samurai before there were white collar bureaucrats. There were classes and there was class exploitation, but the members of ruling classes in the past often based their power on personal prowess in combat or on physical possession of land and goods, rather than on moving pieces of paper.

The above four institutions of contemporary society are all well adapted to each other and also well adapted to a communication system using printed mass media. The size of a typical nation state is such that print media can be economically distributed around it in a day or at most several. A few of the largest nation states are so large that newspapers are based in many separate cities, but more often the national press is the capital's press, published in the primate city and circulated daily around the whole country. The unifying language in its canonical form is taught in the schools which are also the source of literacy. The state organization functions through the forms of bureaucracy, built (as Max Weber and others have pointed out) on the written document. Thus those who write, rule and organize the manual labor of the large number of others who make and move things. Industrial and bureaucratic activities are centered in great cities (and indeed create such cities). In those cities the densely conglomerated population can be well addressed via

movies, TV, and the press, produced by an intelligencia but enjoyed by all.

As Aristotle recognized, the optimal size of the city-state was set by the ability of people to gather physically together to transact business. One could likewise argue that the optimal size of the nation-state was set by the limits to which printed matter in the vulgate language could be rapidly transported and delivered.

Radio and electronic communication have begun to change that situation. Starting with telegraphy in the 19th Century it became possible to transmit the printed word instantaneously over vast distances. However, that was very expensive. It was so expensive that the early newspapers limited their telegraphed text to a short column of cryptic bulletins, leaving the more expository treatments to wait for the mails. But with the coming of radio the cost of addressing millions of people scattered over large areas dropped drastically. The natural perimeter of communication ballooned outward.

In the United States public policy sought to create a broadcasting system modelled on the newspaper system with local broadcasting stations in every town. "Localism" was the basic philosophy of the legislation. It worked, however, only to a limited degree. While no licenses were given for stations with power enough to blanket the country, networking was used by the broadcasters to turn the local stations for many hours a day into

mere retransmission points. The vast reach of broadcasting could not be totally denied.

In the 1930's short wave broadcasting made radio a global phenomenon. For the first time frontiers became totally permeable. No customs officer could stop subversive material any more. In Stalin's Russia less than 2 per cent of the population had access to short wave; today the majority do. That fact has been a powerful force for change.

Nonetheless, international broadcasting, international telephony, and other forms of transborder electronic communication are still small in scale compared to the communication within nations. We still live in an era of preponderantly national communication systems. So if we look only at the present world, nationalism seems to be as strong or stronger than ever. We are struck by the extent to which the four institutions that we have mentioned as characterizing the modern world -- the nation state, bureaucracies, cities, and the segregation of manual and mental labor -- are well adapted to each other, and also well adapted to the main media of communication of the 19th and first part of the 20th Centuries. They are, however, ill adapted to a number of new developments in the world's economy and particularly to its communication system. We have no crystal ball, but there are a number of trends well under way, of sufficient magnitude that it would indeed be astonishing if they did not continue into the future.

Among these we may mention four: the development of a global economy with transactions having externalities that are felt across borders; rapid and efficient transport of persons and things; electronic communication; and intelligent machines. These trends are fundamentally at odds with the institutions that we have mentioned as characterizing the modern world till now.

There is little reason to doubt the power, or the persistance, or the revolutionary character of these new trends. Trade has existed as a global phenomenon for hundreds of year, but the oil crisis of 1973 was the first time in history that the economy of the whole world was instantly and simultaneously impacted by a single set of transactions; before that the crises or transformations that occurred in one place sent ripples or waves spreading sometimes to the ends of the earth. But the oil crisis was not a wave phenomenon; it was a single crisis everywhere.

That fact is explained by the low cost of modern oil shipment. Before modern means of transportation the cost of bulk goods would double in a hundred miles from their origin. Today the shipping costs of wheat or oil almost vanish in the differences in their costs of production. The same sort of thing is happening to human travel. This year, despite the fall of the dollar and America's continental remoteness, one in ten US citizens vacationed abroad. In this era of the Concorde, Jules Verne's "Around the World in 80 Days" brings a smile of amusement.

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The changes in electronic communication are even more revolutionary. Electronic transmissions, as we have already noted, are no respecters of boundaries. Yet up to now economics has kept international telephony and short wave broadcasting as secondary features of the global communications system, buth that will not long be true. Three technical changes will result in distance becoming a negligible factor in the cost of communication. The most obvious reason for distance insensitivity of communications costs is the use of satellites. When messages travel to and from a satellite on the geostationary orbit at 36,000 kilometers above the equator, it makes no difference how far apart, within the beam, the point of origin and destination may be.

However, the cost of terrestrial transmission is also becoming more and more insensitive to distance. With broadband digital transmissions, whether over microwaves, through light conductors, or cables, the cost of additional kilometers falls to relatively trivial levels. Finally digitital switching and store and forward devices make message processing within a network a complex activity in which distance covered is a minor factor in the cost. In a modern packet network packets travel by random routes, so that on an international network one piece of a message may have travelled through several countries, another piece through several others, and few pieces by the most direct route.

The result of all these technological advances is that global interactions in business, government, science and culture will no longer be merely possible, but also so cheap as to become the usual way of conducting affairs. In that sort of world the nation-state will no longer be able to effectively control communication flows across its borders and therefore no longer be in command of problem solving activities within it.

Increasingly, the important problems in life can only be handled on an international basis. Among the problems that nation states cannot solve individually are pollution, ocean resources, space resources, and spectral resources. For example, Efficient use of the geostationary orbit has to be transnational, for there are, apparently, large economies of scale. The inappropriateness of national allotment of the geostationary orbit was illustrated by the obsolete political outcome of the 1977 World Administrative Radio Conference at which a plan was adopted giving each nation a spot on the orbit and five frequencies in the 12-14 GHz band for direct broadcasting. The fact of the matter is that there is no conceivable way of avoiding massive congestion on the orbit if each nation puts its own small satellite up there for all the different uses for which fixed satellites will serve.

The only sensible solution is one in which nations share large platforms with a variety of antennas and also switching facilities aboard them. Already a dozen nations are turning to Intelsat to provide domestic satellite communications, while only

a few are seriously planning their own national satellites for telecommunications.

The problem of interference between separate facilities will become increasingly acute as high powered beams come to be used to send and receive messages directly from rooftop antennas rather than through each nation's terrestrial communications monopoly. A commercial service of that sort is about to be launched in the United States by Satellite Business Systems. By law, the SBS connections can only be located in the United States, but technically reception is possible anywhere within the beam regardless of boundaries. Satellite interconnections of the future can (and if efficiency is a criterion will) in many instances completely bypass national communications systems as they go from sender to satellite and directly to the receiver.

So the nation state will decreasingly be an effective unit of planning and action in the world that is being created by electronic communication of messages and money, as well as by efficient transport and intelligent machines. Nations will increasingly find that they can no longer effectively control the operations of commerce or the cultural life of their people, as such activities come to be carried on in whatever location is most hospitable, at the will and for the service of people everywhere. Banks (or whatever intermediary financial institutions succeed what we now call banks), will offer their services to anyone who can pick up a telephone anywhere.

Journalism, research, and information activities will be conducted globally on distributed computers and distributed data bases. The physical facilities will be located wherever the local authorities are hospitable.

Let me not overstate the case. Local government and community planning did not disappear with the passing of the city state. So governance over large natural regions like nations will not disappear either; but as those matters that sovereign nations can handle by themselves become fewer and fewer, the absolutism of contemporary notions of nationalism and sovereignty will seem increasingly obsolete, and the power of national governments will begin to decline.

Just as trends in communication threaten to erode the power of the nation state, so too they threaten the institution of bureaucracy. Centralized bureaucracy operates by the hoarding and control of information and of its dissemination. In a bureaucracy there are channels that must be followed. A communication system based upon electronic abundance undercuts such a system of restricted channels. The physical capability will exist for anyone anywhere to communicate and share information with anyone else anywhere else.

That process of breaking of communication hierarchies began with the telephone. If one looks at early journalistic treatments of the telephone one finds concern that a woman picking up the phone may find herself talking to a strange man. In some of those

articles there is advice to subscribers to have their servants answer the phone to avoid finding oneself talking to social inferiors. An early article in praise of the phone notes how a magnate in Wall Street can talk to the foreman in the bowels of a mine that he owns in Pennsylvania, bypassing the layers between them. When President Kennedy took office he caused shivers to go through the bureaucracy by his habit of phoning assistant secretaries and deputy assistant secretaries that he knew from before, instead of phoning their bosses at the Cabinet level. In the American government today most serious business is carried on by telephone across hierarchical lines, violating all the classic descriptions from Max Weber and others about how bureaucracies work by passing pieces of paper up and down the chain of command. Only in American foreign posts does the old description still hold. Numerous technicians have pointed out to the State Department that modern telecommunications makes it possible to give each foreign service officer abroad a terminal at his desk which would permit him to communicate at will with any terminal back in Washington or elsewhere in a foreign post. The gains in efficiency would be enormous over the present reliance on airmail for most things and on telex or telephone through a bottleneck, for priority messages. But the suggestion is always rejected; the foreign service is clinging hard to the notion that the ambassador is head of the country team and everything must pass through him. It will not be long, however, before this fiction dies and every member of the team finds himself able to talk to

anyone back home in the Executive Branch, or for that matter in the Legislative Branch or in the press. Is it any surprise that this prospect evokes alarm?

The statement that anyone will talk to anyone else anywhere should not be confused with the statement that anyone will be able to communicate with everyone everywhere. Time imposes limits; there are only 24 hours in the day. The telephone removed the physical limit on who could talk to whom, but conventions regarding acquaintanceship, appropriateness, and importance evolved and checked phoning beyond certain limits. In the domestic US bureaucracy, phoning cuts across organizational lines, but officials know the limits as to whom to call. However, the choices of interactions, even if limited, are not constrained by the principles that have been applied in the past. New conventions emerge.

The phone has been with us for 100 years and yet bureaucracy is as rampant as ever. What reason is there to believe that communication technology, for all its flexibility, will reduce bureaucracy in the future. The point is that up to now written communication has retained the same canonical form that it had in the 19th Century. A document is a considered and fixed representation of an idea. It places a responsibility on its author. To avoid such crystalization one may use the telephone, but in the end, in a bureaucracy, a document must be produced.

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Computers and electronic mail, however, give to documents the same flexibility which a phone conversation has. A memo entered into a word processor can be edited at will by anyone who receives it at his terminal. It can thus have any number of infinitely varied forms no one of which need necessarily have precedence over any other. There may never be a printed version which is authoritative. The document may remain a retrievable set of bits in memory, edited and restructured and copied into other memories at will. The implications for copyright, for the organization of science and learning, and for bureaucracy are enormous.

In the ancient world versification was introduced to give some fixity of form to oral sagas that would otherwise have varied infinitely. The notion of sacred scripts was also introduced to preserve texts; any deviation in copying them was deemed a sin. With the coming of printing, secular prose acquired a fixity that it did not have before. In the days of manuscripts lawbooks, for example, existed in the royal court and perhaps in a handful of copies in major centers. Local magistrates had to interpret the sense of the law from memory. With the coming of printed law books, every court could have the letter of the law at hand. Hundreds or thousands of copies of the canonical text came off the same press in indistinguishable form.

But now we are moving into an era in which text is displayed on a CRT in its fugitive form, and even printout is produced in single

copies on demand from the dynamic store of an electronic memory.

If we believe that electronic communication is promoting the atrophy of nation-states and the atrophy of bureaucracies, can we believe that despite that there will be a world of great cities. One might imagine a new Hanseatic League tied together by verbal and material commerce, but that seems unlikely. Co-location of people (i.e. cities) loses much of its importance if remote communication is easy. We can anticipate that interaction with people at a distance and interaction with those close at hand will become of much more nearly equal efficiency. Work done by machines, rather than by human hands, will be easily controlled from a distance.

The pattern of densely populated cities with sparce agricultural areas between them is already giving way to complex megalopolitan regions. Cities, before the invention of telephones, streetcars and automobiles, were walking cities. One had to be able to go from one end to the other on foot. To reduce the duration of long walks different activities concentrated in small neighborhoods. A city was a checkerboard of single-activity neighborhoods, still signalled, in old cities, by names such as Market Street or Ironmonger's Lane.

With the coming of public transport, cities spread, and with the coming of the telephone, entrepreneurs moved their businesses to cheaper locations, and also nearer to their customers, without losing contact with their suppliers, bankers, and labor pool. In

FUTURE PERSPECTIVE

the first part of the 20th Century the downtown became a center of offices and department stores, while production moved to the outskirts. To meet the demand for office blocks, skyscrapers were put in the heart of the downtown. Without the telephone, as well as the elevator and steel-frame, these tall buildings would not have been possible. In 1902 someone figured out that if businesses had had to continue using errand boys instead of phones in skyscrapers, the traffic would have required an elevator well of such size as to make such tall buildings uneconomic.

So a dual process was taking place of urban concentration along with spread of both industry and residence to suburban periphery. Instead of cities we now have in regions like Bos-Wash or the Ruhr a network of population concentrations extending over hundreds of miles. There is every reason to expect this process to continue with an ever more complex division of labor among centers of population density.

Urban concentrations will not end any more than will nations or bureaucracies, but they will be transformed perhaps beyond recognition. Population projections for the year 2000 tend to show that virtually all the growth of the worlds population will be in urbanized areas. The rural population of the world may perhaps remain fairly constant, and so there are likely to be then, as there are now, vast areas of forest, desert, fields, and wilderness. But the urbanized areas may be less distingulshable

into finite cities, and very likely there will be vast areas of exurbia in which people will seek an urban way of life in a rural atmosphere. Abundant communication may make that possible. Cities and exurbia each have their attractions, but the balance between them is profoundly changed by telecommunications and the changed structure of work.

The structure of work has already changed in the most advanced societies to the point where the majority of the working population are workers with brain rather than with hand. The documentation of that remarkable trend is found in the work of Mark Porat on the United States. His study is now being replicated under OECD auspices in various other countries. In 1900, according to Porat's figures, 13% of the U.S. labor force were in information occupations as against 27% in industry. By 1950 31% of the labor force were in the information sector, by 1960 42%, and by 1970 46%.

That is a revolution! Stop and think for a moment about those figures. In a quarter of a century, the proportion of the labor force moving paper or other information media instead of things has gone from one fourth to one half of the total labor force.

That extraordinary rate of growth in the information sector will not continue. The large number of white collar workers makes it now economically attractive to develop labor saving devices for intellectual activity, in the same way that in the last century when production required large masses of manual workers, it paid

to invent labor saving devices. Just as large numbers of persons, including many who are no longer manual workers, use machines to do things which used to require manual labor (e.g. a washing machine or a car), so in the future we may expect large numbers of people to use thinking machines, though not necessarily to be themselves employed as white collar workers.

What occupations can we expect to grow in a society in which the agricultural sector has declined to 4% of the labor force, to use the U.S. figure (a figure incidentally for a very productive agricultural country), and in which the industrial working class may be expected to decline to a similarly tiny number as automata take over assembly lines, and in which clerical work too begins to be automated by computers and so comes to require a sharply reduced part of the labor force. The jobs that will remain to be done by human beings are those that require a specifically human kind of interaction. These are service jobs such as those performed by a waiter, or nurse, or counsellor, or teacher. Such person to person services are likely to absorb an increasing portion of the labor force. We now know how to build machines to automate the more routine intellectual as well as manual functions, but we do not know how to automate the experience of a human relationship.

If what we have anticipated as a consequence of electronic communication is even for the most part correct, we are at the edge of a vast transformation of society. We seem to be moving

towards a society in which nation states will lose much of their power, in which bureaucracy gives way in part to more equalitarian and distributed modes of decision making, in which cities are replaced by megalopolitan regions, and in which only a small minority of the population remains engaged in the classic forms of productive toil that have been the lot of most of mankind until now.

These prospects of drastic change have very little in common with most political platforms that advocate drastic change. Most movements that are self-described as radical are highly urbanistic, or nationalistic, or oriented to obsolete class structures, or to central bureaucratic planning. The changes that we can see on the horizon are much more drastic than that. They are changes that arise out of the very nature of electronic communications technologies. They reflect the ease with which electronic communication can operate over global distances, and the abundance of bandwidth that can now be made available to all, without producing any exhaustion of the earths resources. They reflect the ability of digital communications to operate under the control of thinking machines. They reflect the ability of intelligent machines to handle degrees of complexity far beyond anything conceivable with non-electronic devices, and at the speed of light. These technological facts have profound social and political consequences. People who think about social change in traditional political terms cannot begin to imagine the changes that lie ahead. Conventional reformers cast their

programs in terms of national policies, or in terms of laws and central planning. But in the end what will shape the future is a creative potential that inheres in the new technologies of electronic communication and machine intelligence.

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Text of paper by Professor J. Voge

ECONOMY, INFORMATION AND COMMUNICATIONS

> Thus the crisis does not arise from accidental events or human errors. It is inherent in technology's relation to geography on the one hand and to political organization on the other... In the years between now and 1980 the crisis will probably develop far beyond all earlier patterns. When or how it will end -or to what state of affairs it will yield- nobody can say.
>
> John von NEUMANN,
> Can We Survive Technology. Fortune, June 1955.

A close relationship can be observed between the economic development of a country and that of its means of communication. Thus, for example, the number of telephone lines tends to grow in step with the national product (figure 1) : countries which, like France, have for some reason been unable to follow this natural progression are sooner or later forced quite brutally to make good their delays in the shortest possible time. Substitutions are of course possible among communication methods : the telegraph (and more recently the post) have lost ground in favour of the telephone, just as the cinema has lost ground to television. The interaction between economy and communications is not only unidirectional : professional telephones - the most profitable for the telephone companies - are advance investments prior to industrial or commercial expansion, wheras residential lines seem more like consumer goods whose increased use is one of the signs or prosperity.

The fundamental role of communications in an economy

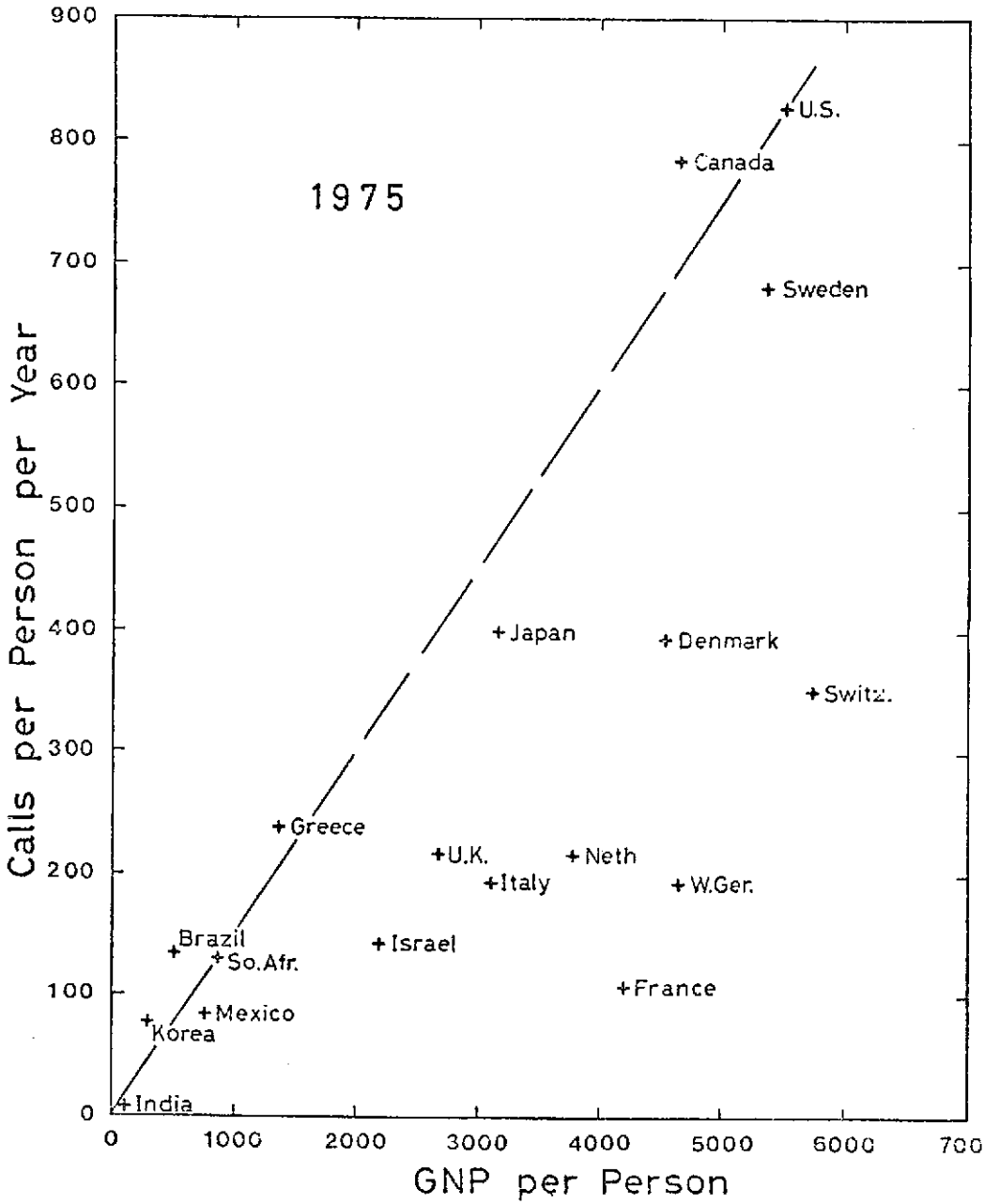

1975
Calls per Person per Year
GNP per Person
900
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
4000
5000
6000
7000
+U.S.
+Canada
+Sweden
+Japan
+Denmark
+Switz.
+Greece
+U.K.
+Neth
+Italy
+W.Ger.
+Brazil
+So.Afr.
+Israel
+France
+Mexico
+Korea
+India

Figure 1

is to collect, transfer and diffuse one of the resources which - together with raw materials and energy - is essential to production, namely information and, in a more developed sense, knowledge.

Fritz Machlup was the first to postulate, in 1962, the division of economic production into physical or material production on the one hand and on the other non-material production of information and knowledge - the last-mentioned being largely reintegrated at either the human or the equipment level, into the material production circuit. The often imprecise border between material and information has been defined with great care, and not without many difficulties, in a 1976 thesis by a young American economist Marc Porat, who divides the information field into two major sectors : a primary sector comprising "merchant information" (education, research, engineering, architecture, counsels and transactions of any nature, certain financial and commerical services, production and exploitation of equipment for use in informatique, the media, etc.) and a secondary sector comprising the bureaucracies of public and private enterprise.

The data provided by Machlup and Porat from the USA - (figure 2), together with some very fragmentary data from Germany, Australia, France and Great Britain - reveal a

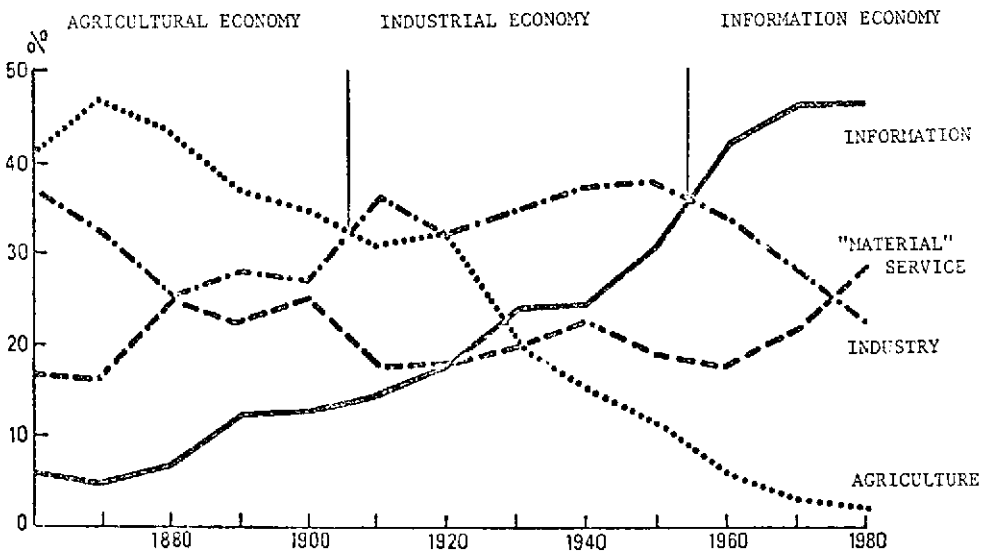


Figure 2 : Distribution of the Working Population in the United States from 1860 to 1980 (from M. Porat, The Information Economy, OT Special Publication 77-12, US Department of Commerce, May 1977)

growth rate in the domain of information much greater than the average for the economy as a whole : in the United States it is about twice as rapid if the production is expressed in added value or national revenue per worker (in constant money). Thus, in 1958 dollars, which will be used for reference throughout the present paper, the gross national product per worker is today in the region of $ 10,000, of which 50% ($ 5,000) comprises information. At the end of the last century it was of the order of $ 2,500, only 12.5% (slightly more than $ 300) being in information (figure 3).

This quadratic law is not surprising. The number of information workers (producers and distributors) has increased proportionally to the national product : their apparent productivity has thus remained constant for nearly a century[1], although it has given rise to very

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(1) It was of the order of $ 20,000 (1958) per information worker, dropping however to $ 15,000 during the 1929 crisis. It is important not to confuse this productivity, determined as a function of natioanl production, with that which might be measured in information quantity or the number of messages processed or diffused. This latter kind of productivity has, thanks to electromechanical and electronic techniques, grown spectacularly. But despite the hopes (or the fears of unemployment - see Nora-Minc Report on "Informatised Society", Paris 1978) which have resulted from these performances, the overall volume of information continues to increase in such a manner that bureaucracy has yet to show any noticeable reflux, even in telephone exchange enterprises with entirely automatic networks.

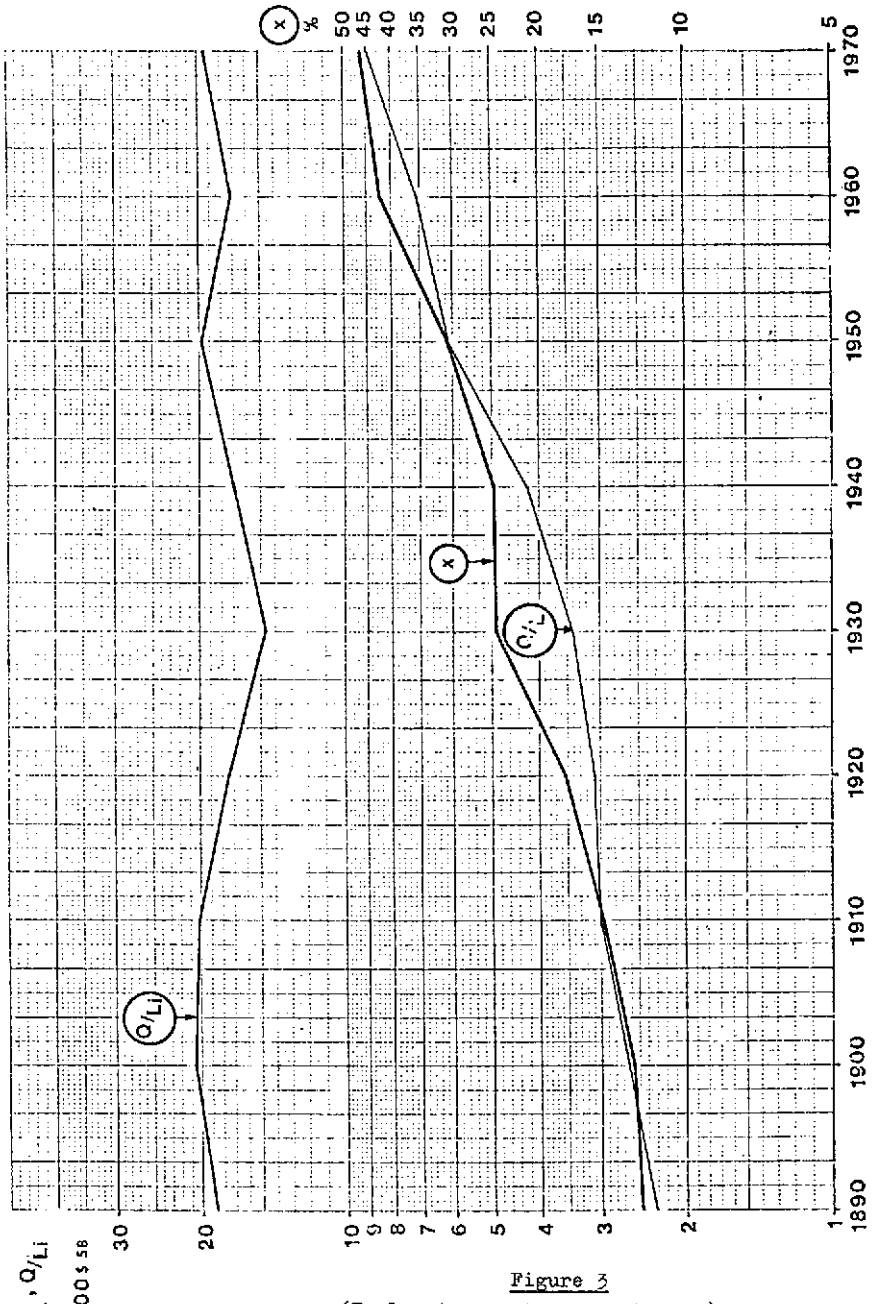


Figure 3

(Explanatory note on next page)

Figure 3 : Explanatory note

The figure shows variations between 1890 and 1970 in the United States

1) of work productivity (national product Q, in thousands of 1958 dollars, per worker L and per information worker Li)

2) of the information quota x = Li/L (percentage of information workers in the working population).

The data concerning labour are from M. Porat (cf. figure 2); the data on American gross national product are from the Historical Abstracts of the US, Colonial Times to 1970, Bi-Centennial Edition, Part 1, US Department of Commerce, 1976.

important productivity gains for the "material" workers, enabling them to become both better equipped and better educated. It is normal that the volume of information circulating in the form of messages exchanged through divers means of bilateral communication (dialogue, post, telephone) or collective communication (conferences, press, radio) between those who produce or process information, tends to grow, as the square of the number of interlocutors. We may recognise here a manifestation of C. Northcote Parkinson's famous law of bureaucracy, which would seem to be applicable to the whole domain of informatique.

The growth of the complementary domain of material production has, on the contrary, been progressively restrained. It is easy to show, by extrapolation of the above results, that it should theoretically reach, as an average per worker, an upper limit of "economic maturity" when the proportion of information in the national product or the active population, which may be termed the information quota, itself reaches 50%, that is to say very soon in the United States and some years later in other industrialised countries. It would in fact be necessary, in order to raise the American national product per worker from $10,000 (1958) to $ 12,000 or $ 16,000, to increase the information quotas to 60% and 80% respectively : the material part of the

product would thus be reduced from $ 5,000 to $ 4,800 and $ 3,200. It seems difficult to admit that a society should accept a decrease in material wealth in exchange for more information already judged to be excessive.

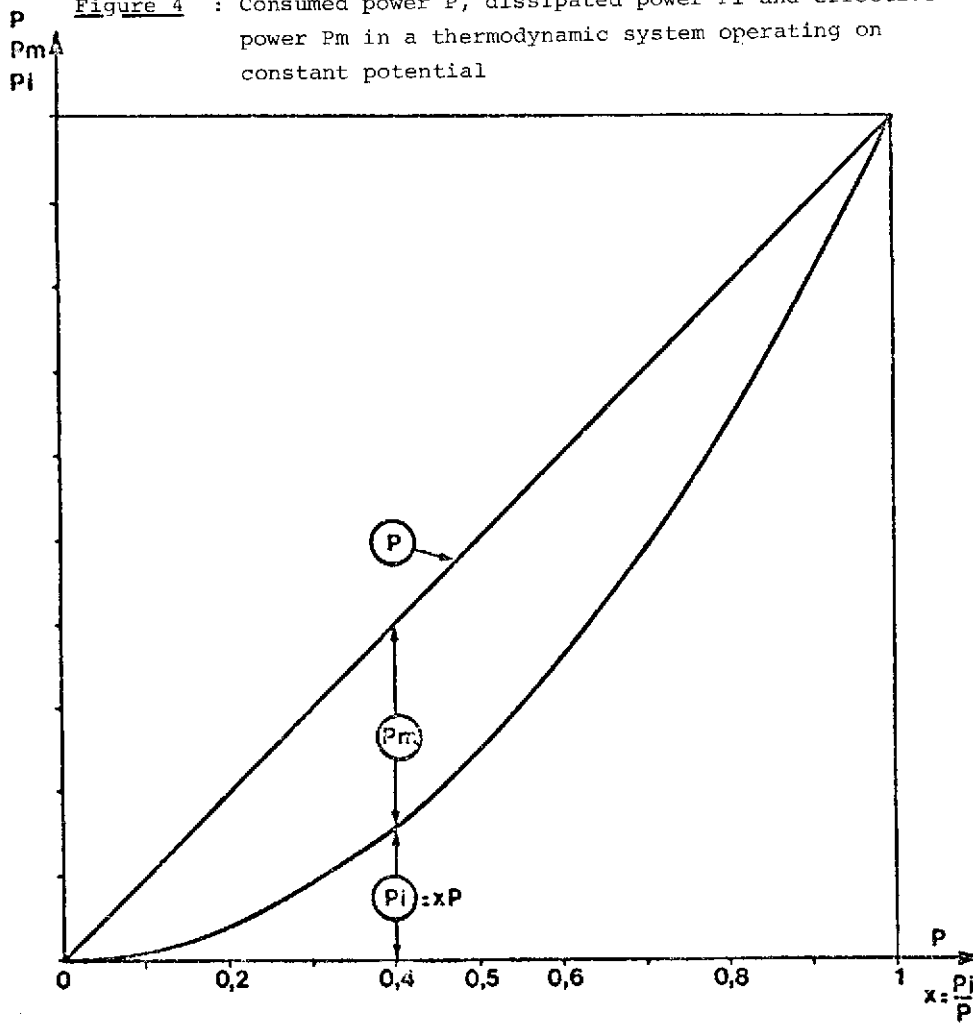
Various justifications - which seem to be convergent - can be offered for this rather disquieting interpretation of available data. The first is provided by Porat, who has drawn attention to a stagnation in recent years of the American information quota at 50% : this stagnation has been particularly noticeable in research since 1965, and in education since 1970. The second derives from the observation of annual growth rates in hourly productivity of work in the private sector in the US : reaching 3% between 1940 and 1966, they dropped to an average value of 1,6% between 1968 and 1977, and since then have fallen practically to zero in recent months, a change which has been accompanied by a spectacular reduction in unemployment.

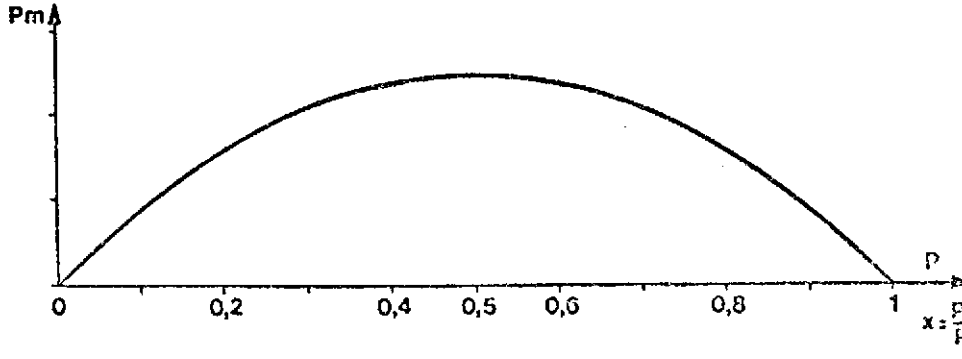
It seems possible to see a last justification in the very striking agreement between the foregoing results and the laws - whose bases are the great principles of thermodynamics - which govern the growth of a great variety of physical and biological systems. Frequently, when the power supplied to such a system is increased, the power dissipated in the form of heat (or, in more scientific terms,

in an entropic thermal flux) similarly increases as the square of the power supplied. The residual power, delivered in the form of effective work on material production, then reaches its maximum as before when the dissipation rises to half the total consumed power (figure 4). Thus an electric equipment operating at constant voltage, dissipating 200 W, when consuming 2 kW, will dissipate respectively 5 kW and 12.8 kW for total consumtions of 10 and 16 kW. The corresponding effective or "material" powers would be 1.8, 5 and 3.2 kW. The analogy with an economic system is even more striking in that the great information theoreticians, Claude Shannon and Leon Brillouin, have shown the existence of a very close relationship between the entropy dissipated and the information which must be fed to a system so as to ensure the maintenance of its functional organisation.

The problem thus confronting more advanced economies is to know if their production of information will be inexorably submitted to this quadratic "Parkinson-type" growth which will lead them rapidly to stagnation. It is perhaps symptomatic that one of the world's major companies concerned with informatique has publicised an "information crisis" which, in contrast to the scarcities in material domains, comprises an overabundance and an anarchic proliferation (see figure 5). Yet may we nevertheless hope

Figure 4 : Consumed power P, dissipated power Pi and effective power Pm in a thermodynamic system operating on constant potential





THE INFORMATION CRISIS.

If you pick up a newspaper these days, it's easy to walk away with the impression that there's a world-wide shortage of everything.

There is an energy crisis and a food crisis and any number of other crises, all caused by vanishing resources.

But there is one that involves not a shortage, but an excess. A crisis where the resource isn't dwindling, but growing almost uncontrollably.

That resource is information.

Consider: Seventy-five percent of all the information available to mankind has been developed within the last two decades. Millions of pieces of information are created daily. And the total amount is doubling every ten years.

The problem, as with any crisis, is one of management. With fuel, it's a question of making proper use of too little. With information, it's making proper use of too much.

With 72 billion new pieces of information arriving yearly, how do you cope with it all? How do you gather it, edit it, disseminate it, store it and retrieve it?

At Xerox, our business is solving problems like these.

With electronic input systems that let you quickly create, edit, and store information.

Copiers and duplicators that reproduce it. Telecommunicators and communicating typewriters that disseminate it.

Even electronic printers that let you retrieve information directly from computers, and print it out with laser beams.

You see, Xerox doesn't just copy information anymore. We help you manage it.

The purpose of it all is simple: to help you make good use of information, instead of being overwhelmed by it.

And to help reduce, if only by one, the number of crises in the world.

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Figure 5

one day - with the help of informatique and telecommunications technologies - to improve productivity of the informational domain?

Two different approaches - which are doubtless fundamentally identical - offer a tentative answer to this crucial question.

The first is related to information science and to the economically optimal structure of telephone networks. The number of commutable connections or contacts necessary in a telephone exchange to connect N subscribers, without risk of blockage, varies quadratically as N^2. If however, instead of connecting these subscribers through one single exchange, they are distributed among a number of primary exchanges of reduced capacity, themselves interconnected through a structure of higher-order group exchanges (secondary, tertiary, etc.) it can be shown that the number of contacts, and the power necessary to interconnect them, does not increase so rapidly. Shannon has determined a theoretical minimum for this increase following an ideal law in N log N : without reaching this limit, existing networks - and even more those which will systematically use electronic commutation, already allow or will allow in future very appreciable economies (figure 6). But it is important to notice that these more economical structures,

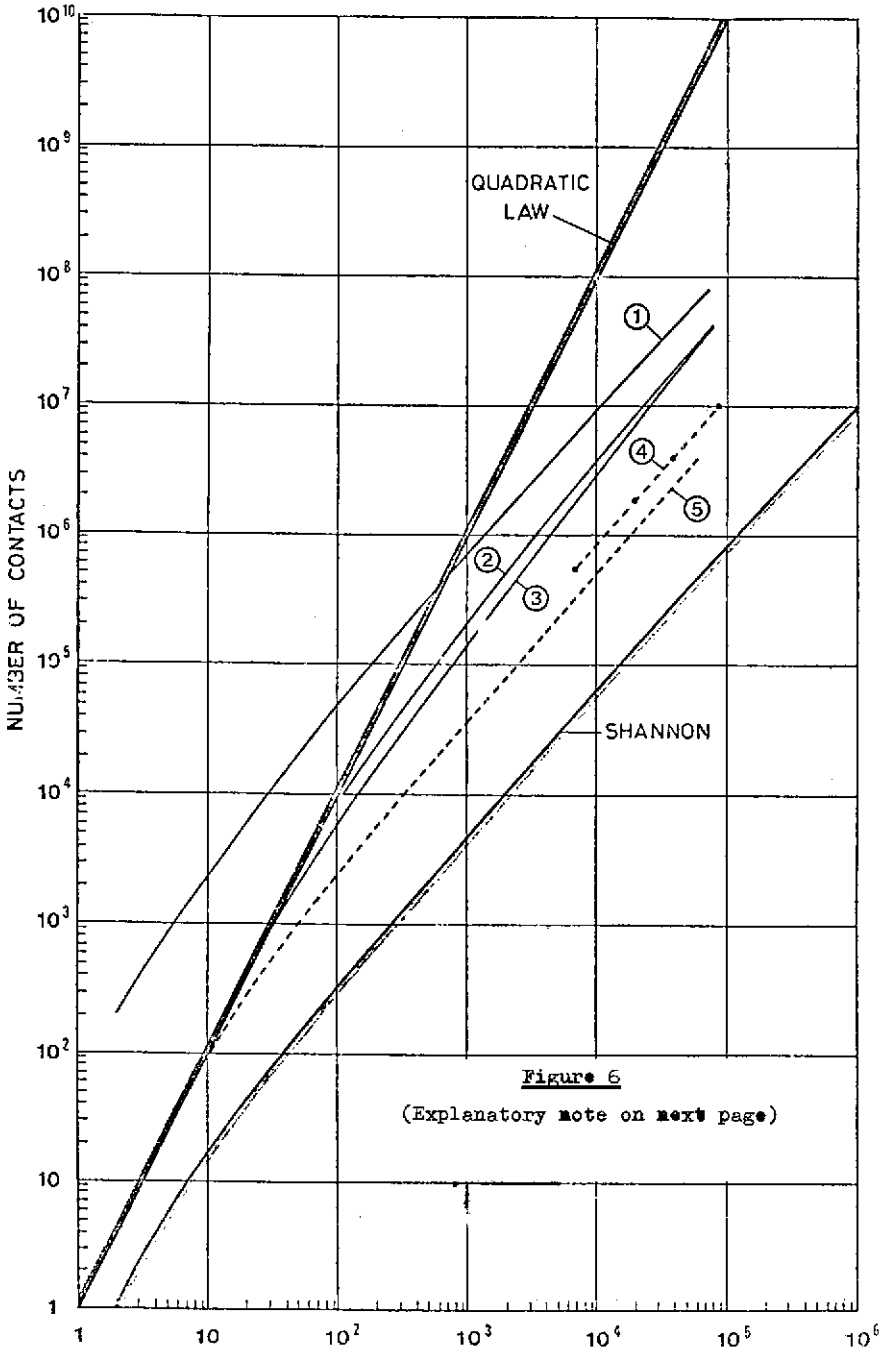


Figure 6

(Explanatory note on next page)

Figure 6 : Explanatory note

The figure shows relationships between number of contacts and number of entries (or subscribers) in various types of telephone networks:

1. BASSALYGO-PINSKER network, non-saturable (without blockage)
2. CANTOR network, non-saturable
3. CLOS, optimal network, non-saturable
4. KAPPEL network, quasi non-saturable (blockage probability of 10^{-3} for a 70% time usage on every line)
5. CLOS network with adaptable structure (from M.J. Marcus, Proc. IEEE, Vol. 65, pp 1263-1271, September 1977).

if comprising several exchange levels, are essentially decentralised and non-hierarchic (figure 7); any unitary organisation comprising a star-type centralised hierarchy tends ineluctably towards the quadratic variation of a single exchange.

The other approach to the problem is based on the science of thermodynamics - probably the most fundamental of all ways for study in natural phenomena whether physical, biological or sociological. Thermodynamics is known particularly for its two great conservation principles, but also for that of entropic degradation of energy, a degradation from which neither a human being nor a society can escape... whether for decades or for centuries - if they cannot furnish a continuous supply of information. Thermodynamics, born from the study of the economic output of heat engines, is the science of systems formed by a great number of interactive elements, whether molecules or individual people. When such a system is displaced from its state of rest or equilibrium, being fed increasing energy, the entropic dissipation will at first follow a quadratic law. But if both the power and the level of growth are increased, then non-linearities and instabilities can appear and, beyond a critical threshold, can cause the system to evolve - more or less abruptly according to

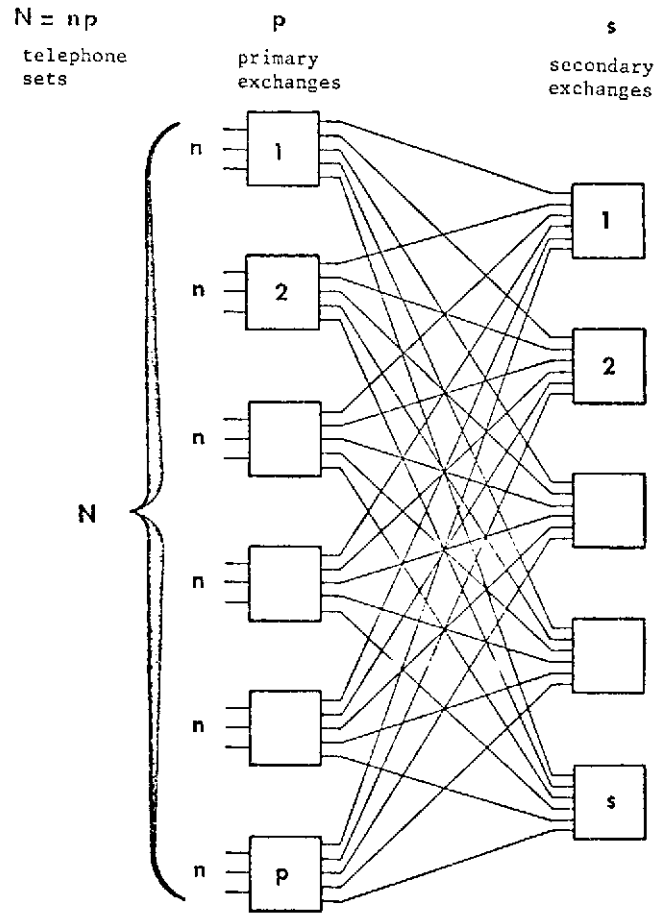


FIGURE 7 : Interconnexion pattern for a two-stage telephone network. The most economic structure for a non-blocking network (non-saturable) corresponds to the formula :

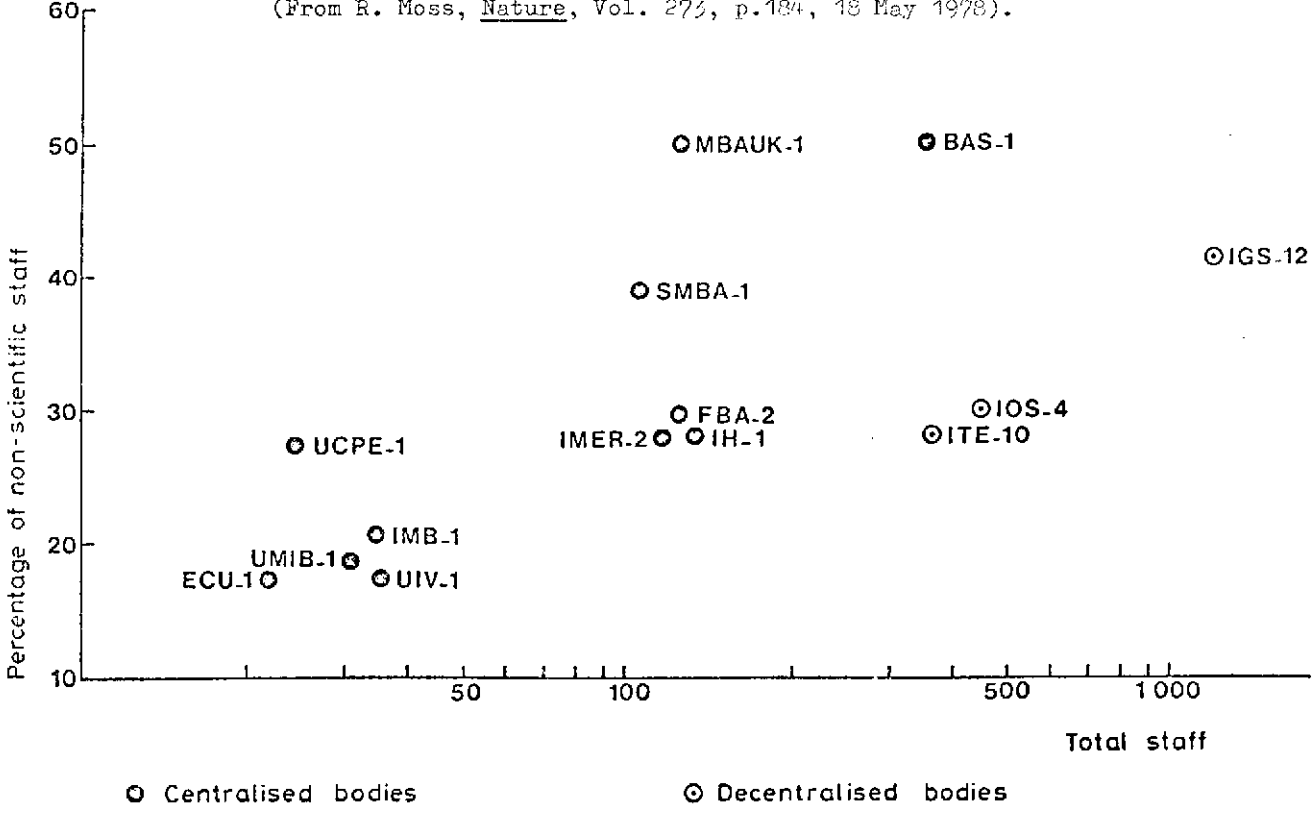
$$2n = p = s = \sqrt{2N}$$

its constraints - towards new structures, which Ilya Prigogine (Nobel Prize 1976) and his collaborators have termed "dissipative". They can in fact only exist in a regime of dynamic organisation which, even without any activity or useful external production, would consume and dissipate power. Despite this "structural" dissipation, the total entropic dissipation (structural and functional) can however, because of a better interaction organisation between elements of the system, be less than what it would be if the initial state near to equilibrium were maintained. Thus, for the same consumption of energy, the useful power and the productivity can be increased. Prigogine has shown that these dissipative structures are characterised by a certain spatial or spatio-temporal periodicity, very often materialising in a cellular organisation which can be observed in hydrodynamics, chemistry and electronics, as in biology. The evolution of a system can take place spontaneously through auto-organisation from an initial state, which is usually rather amorphous, uniform or unitary, towards more and more complex cellular structures - capable also of being more and more productive - reflecting the aleatory circumstances of instability which preceded their appearance.

A letter recently published in the Journal Nature concerns a case which seems to characterise very well this type of evolution (figure 8). The author observed that the production of groups for scientific research - evaluated in terms of the percentage of productive elements (in this case researchers) dropped fairly rapidly, in accordance with Parkinson's law, as the total number in the group increased : for a group of about one hundred people, the percentage was about 50%, i.e. equal numbers of administrative agents and researchers. But it was to be noted that many still larger organisms (comprising in practice from 350 to 1100 persons) were decentralised into a number (4 to 12) of geographically dispersed centres, for which the percentage rose again to values around 60% or 70%.

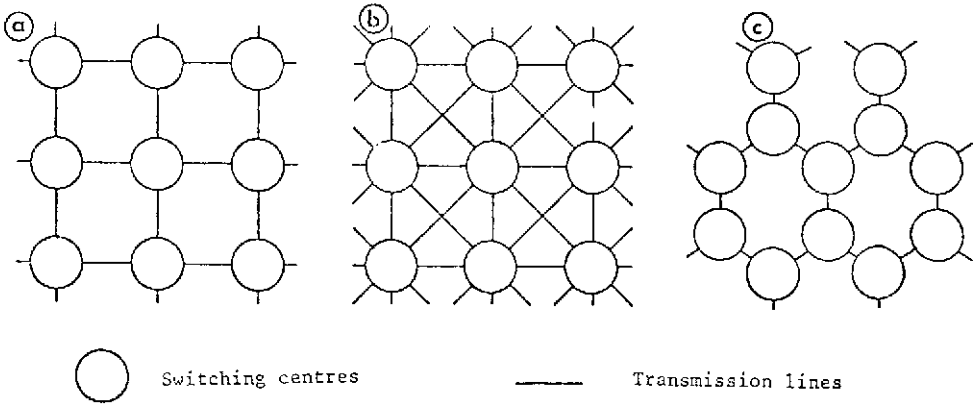
Taking account of the foregoing, it is to be hoped that our modern societies, despite the weight of social customs and centralising tendances which have appeared in more and more rigid forms over the last decades, will some day also be able to follow this natural evolution towards a decentralised cellular organisation. As can be seen from the quadratic law, a unitary structure does not lead to an economy of scale in information production, but rather to a diseconomy : the basic reason for this is that such a structure does not provide for any filtering of parasitic or ineffective information ("noise") from information of real

Figure 8 : Relation between the percentage of non-scientific staff and the total staff in British scientific research organisations. The initials correspond to the organisations' initials, and the following number to the number of groups (in different locations) in each of them. (From R. Moss, Nature, Vol. 275, p.184, 18 May 1978).



value and use to an individual or given group : also to be noted is the all too frequent reaction of certain central powers which, in order to maintain their authority, feel obliged to limit and control the diffusion of the most essential information. For these reasons we must welcome with great satisfaction the substantial changes in orientations and tendancies which have recently appeared quite spontaneously in telecommunications and information processing networks. Here we can see the beginnings of a growing decentralisation and a distributed sharing, without reference to hierarchical structure, in communication links, telelphone exchanges and data processing centres (figure 9). Mini-calculators, microprocessors, dispersed informatique, local radios and interactive community networks are no doubt the precursors, as well as indispensable instruments, of the information and communications decentralisation process - which should lead, despite reticence and opposition, to a similar decentralisation of decision and power in economic and social structures. The choice between centralisation and decentralisation is, I believe, no longer a political one, but rather a hardly questionable choice between a crisis of stagnation and recession, and a new economic growth.

I fully agree with Jacques de Bourbon-Busset who



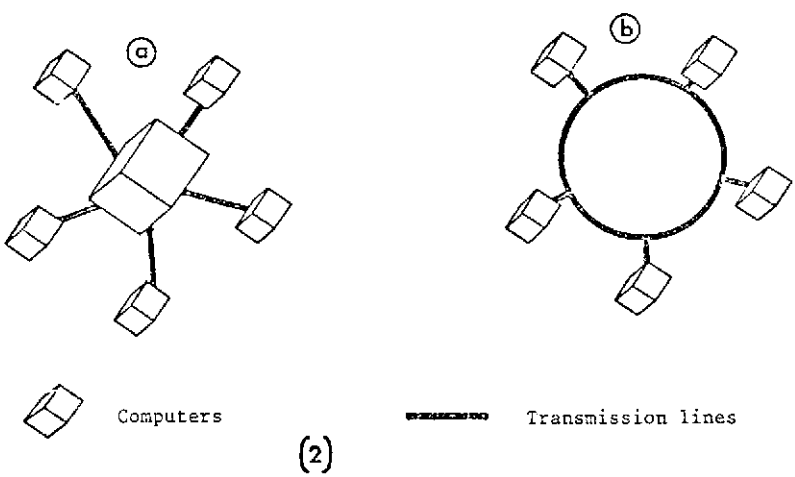


FIGURE 9 : (1) Distributed and non-hierarchical structures in telecommunication networks
ⓐ grid ⓑ multigrid ⓒ honeycomb (from H. INOSE, Scientific American 9/72)
Such structures are already commonplace in military networks.

(2) Distributed structures in data processing networks.
ⓐ hierarchical (star-net) ⓑ non-hierarchical (ring-net).

recently wrote : "I believe it is essential that we should never forget that tomorrow's society must avoid, at all costs, becoming a new unitary society. The new society will be one of micro-societies or it will not be a society at all".

However, a very important point seems still to remain totally unforseeable: will the basic cellular constitution of future society retain a local and geographical character, with links oriented towards specialised or particular interests intervening only on the second (intercellular) level of coordination and association, but not on the level of internal decision? Or will the elementary communities themselves be, through the use of electronics, non-geographical communities whose existence would mark the decline of nations and the multiplication of multi- or transnational entities. Modern telecommunications techniques could lead to either of these types of society : it is still the responsibility, though perhaps not for much longer, of governmental authorities responsible for communication policies to help one or the other of them to develop.

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C H A P T E R V

CONCLUDING SESSION OF THE SYMPOSIUM

The Concluding Session of the Symposium was "concluding" only in the sense of being the last session of the Paris meeting. From the viewpoint of the on-going work of DISCOVERIES, the session was a moment for taking stock - not only of the past week's work but of overall progress towards the objectives of the Honda Foundation and of Dr. Soichiro Honda when he created it, in establishing a combined oriental/occidental and multidisciplinary approach to the problems of a world rushing ever faster into the future : a future which is neither well understood nor even well defined.

What in fact are the objectives of DISCOVERIES? "The Humane Use of Human Ideas" is emotive and immediately appealing (especially to human beings) but needs qualification to become practically significant. What is meant by "humane use", and how may it be achieved? It is precisely these questions which the series of DISCOVERIES symposia (Tokyo 1976, Rome 1977, Paris 1978, Stockholm 1979...) is trying to answer, and in this sense the Paris meeting was only one contributor - albeit a most important one - to the on-going movement. Dealing specifically with Communications and Information (the former has no practical significance without

the latter) the meeting was itself an exercise in both.

The Concluding Session was in the form of a very high level panel discussion.+ Chaired by Professor Jean-Claude Simon (Université Pierre et Marie Curie, Paris, and Chairman of the Symposium's Scientific Committee), it included Dr. Takeso Shimoda, President of the Honda Foundation, Professor Eduardo Caianiello (Salerno University and Vice Chairman of the Symposium's Scientific Committee), Professor Ilya Prigogine (Free University of Brussels; Nobel Prize for Chemistry, 1976), Professor Torgny Segerstedt (Uppsala University) and Professor Alfred Sauvy (Collège de France, Paris, who had chaired the preceding working session summary). In addition, the Concluding Session was honoured by the presence of Monsieur M. Turpin of the French Ministry for Industry, who had followed some of the previous day's work and who presented a message of congratulation and encouragement from the Minister, Monsieur André Giraud.

In reply to an introductory remark by Professor Simon, Dr. Shimoda pronounced the Honda Foundation extremely satisfied with the Paris Symposium, and paid tribute to all those who had contributed to its success. He emphasised that the Foundation had not expected "instant answers" or

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+ Given the eminence of all the participants in the Symposium, the level of the panel could not have been otherwise whatever its composition.

concrete conclusions, but rather guidance for its future work. "You", he said, with the humility typical of the oriental approach[+], "you will decide what direction you want to take."

It was Professor Prigogine who, in taking this invitation further, echoed the thoughts of most (if not all) present by asking how the sought-after "concrete action" might eventually be distinguished and launched. He believed there was wide agreement that communications and "informatique" must necessarily be involved, for they were essential to any societal structure. Furthermore, in a properly functioning democracy they must be fully and recognisably "open". This was where difficulties could arise, for communication on technical matters with non-technicians raised many formidable problems - whose non-resolution was at least partly the cause of the present "crisis in science".[++] It was of course essential that those of the intellectual disciplines, as represented in the Paris meeting, should communicate successfully among themselves, but it was not enough : communication with "the public" was no less important ... and indeed with governmental authorities and parliamentarians, who were usually

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[+] Even had DISCOVERIES done no more than introduce the Western participants to this attitude, at the basis of the contemplative approach in what Professor Barrington Nevitt has termed "acoustic space", it would surely have thereby registered a highly significant success.

[++] Opposition to technological or indeed any other progress is probably as old as humanity, and those who suffer from it today might occasionally reflect that at least their professional careers and lives are rarely threatened. Considering the possible practical consequences of some modern developments, this is surely a triumph for tolerance if not for understanding.

the source of the investments without which scientific work would die. "The Government which pays big research bills", said Professor Prigogine, "has a right to the results."

Professor Sauvy, reflecting on the very esoteric nature of some of the papers and discussions during the meeting, drew an analogy between present-day society and Baudelaire's Albatross, soaring to ever greater heights in the air, yet being unable to walk on the ground because of the encumbrance of its great wings. While he was certainly not against progress in the most sophisticated realms of research, he entered a plea that more elementary but practically very important questions should not be neglected. He was a little suspicious that the Paris meeting had tended to forget this.

Professor Caianiello, while agreeing with Professor Sauvy defended the sophistication of the Paris approach by pointing out that, following the very general nature of the preceding meeting in Rome, the next step must logically have been devoted to communication, which was vital even to the future of the DISCOVERIES Project itself. Many other meetings around the world were devoted to "immediate aspects of futurology" (if that was not a paradoxical statement) and Professor Caianiello paid tribute to the Club of Rome and similar study enterprises.

Where he believed DISCOVERIES differed from these was in its proclaimed objective of trying to pool oriental and occidental knowledge, wisdom and "philosophy" for the benefit of world civilisation as a whole. To a large degree, DISCOVERIES was concerned with the means towards the ends that were sought, and it was to be noted that history had shown the results of undertakings to be very often far removed from those envisaged. DISCOVERIES must try to avoid this, and communication was an essential tool not only for forward progress but, and in particular, for providing the feedback loops necessary for maintaining stability without losing direction.

Professor Segerstedt reminded the meeting that communication was in fact both a means and an end - though he agreed that the two should be recognised as separate. He reiterated the need, now that the validity of the multi-disciplinary approach was proven, for efforts to bring more uniformity into scientific language, so avoiding misunderstandings due to non-standarised "vocabularies" (and grammars). He also stressed the vital need to keep in communication with (and keep the confidence of) the younger generations of intellectuals, who would soon be shouldering the immense responsibilities of decision making in fields non-existent in their parents' youth.

The discussion being then opened to the floor, Dr. Jean Cloutier (International Institute of Communication, Montreal) performed a brilliant analysis of the Paris Symposium itself - analysing the use of the time available (despite extra hours, he found the time for discussion, as opposed to listening to papers, too limited); the success of communication at the two (quite distinct) levels of intellectual exchange and language exchange;[+] and the intervention, whether intentional or not, of many other factors such as individual speakers' intuitions, psychologies etc. In particular Dr. Cloutier remarked on the distortions of information which inevitably took place as speeches were recorded, translated, retransmitted and published... and he saw these various stages as giving rise to "noise" in which meanings of insufficient amplitudes could be lost. He believed there was a need for a profound and extensive study of all the phenomena of "communication", even those which at first sight seemed elementary.

Professor Barrington Nevitt (Toronto University) agreed with the "noise" analogy but believed that, in addition to the sources mentioned, some noise was due to differences in cultures, notably between those of east and west. He

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[+] The translation services, incidentally, had been particularly good.

called for greater efforts by representatives of each to understand the other "without" as he said "reducing one to the other". Professor Prigogine appeared to be unsure of this, saying that differences between some eastern cultures were at least as great as those between eastern and western : he believed an important contribution of science to intercultural understanding was precisly that the language of science - at least for the present - was more rigorously defined and more universal.+

Professor Alwyn Scott (Wisconsin University,USA) while not disagreeing with this general thesis, seemed unconvinced that the language of science retained its precision unimpaired when it was applied, for example, in psychosociological fields by psychosociologists. Professor Scott further questioned Professor Prigogine concerning the applications of his own terminologies (and theories) in the realm of pure physics, suggesting that these might in some instances represent an unnecessarily complicated approach. This was not the first time during the Symposium that a participant with basic training in physics or engineering had implicitly championed use of the simplest possible explanation or model of a phenomenon; and those who had

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+ In fact, these two professorial opinions must surely be complementary rather than mutually exclusive.

been in Rome for the previous Symposium were reminded of a remark by Professor Simon questioning the necessary validity of "Occam's Razor".[+] Professor Prigogine, while not denying the value of "simplistic models" without which much scientific understanding could not have evolved, believed that today physicists (and others) were recognising that "reality" was usually extremely complex, and that much effort could be lost in seeking a simplistic "general pattern" which did not exist. A further comment (from Professor Marcello Siniscalco, Sloan Kettering Institute, New York) lent support to a thought which - though not publicly aired during the Symposium - had not been absent from some of the private discussions : it was at least not unimaginable that some aspects of nature might be so complex as to be beyond the comprehension of man, even man equipped with all his panoply of "peripherals" including these of informatique in its fullest sense.

In contrast to this, and certainly encouraging for anyone beginning to sense incipient intellectual indigestion, Professor Harold Linstone (Futures Research Institute, Portland, Oregon) drew attention to a typical case - an exercise in urban planning in Athens - where the application of "common sense" had produced greater efficiency in energy use than had a highly intellectual "first principles" study.

[+] "Entities must not be multiplied unnecessarily" - i.e. the simplest explanation compatible with observed phenomena should always be adopted. The dictum is due to the English Franciscan monk William of Occam (1300 - 1350).

However, the Professor recognised that this was not a condemnation of "the scientific method" but rather a demonstration that a problem could often prove a great deal more complex than it might seem on first view. Was this not, after all, support for Professor Prigogine?

Throughout the Paris Symposium, there had been a general tendency to discuss communication in human activity on the assumption that it was a beneficial instrument normally used beneficially (i.e. for the "best good"). It was left to Professor Luigi Mendia of Naples University to point out that modern communications systems offered important possibilities for "manipulating" information made available to the public, and in some cases even to those with intellectual and/or public authority. This aspect - the deliberate misuse of science and technology - had certainly been in the minds of many participants, particularly during the discussions of "high-level" machine handling of information.

At least for the moment, however, there was no suggestion that the manipulation could result from any but human stimulation. The idea that a Deus ex Machina might itself engage in such an activity was not considered.

Concluding the Concluding Session, Professor Simon believed a synthesis of the work done was not possible - certainly not within the few minutes still remaining. Although no "concrete conclusions" had been reached (and, as Dr. Shimoda had said, none had been expected), Professor Simon was convinced that everyone present had benefited greatly from the week's intellectual exchanges across both geographical and academic frontiers. He was sure he was expressing the thoughts of all his colleagues in conveying once more, to the Honda Foundation, to its founder Dr. Honda, and to Dr. Shimoda and all others associated with its work, a deep feeling of gratitude for the organisation of the meeting.

It is certain that no one can have gone home without many new thoughts and ideas to reflect upon. It is just as well they will have had a whole year ahead of them before having to come together again for a new exercise in Stockholm.

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APPENDIX I

LIST OF PARTICIPANTS IN

DISCOVERIES

THIRD INTERNATIONAL SYMPOSIUM

Under the high patronage of Professor Pierre Aigrain
French Secretary of State for Scientific Research

Honda Foundation

Dr. Takeso Shimoda
President

SCIENTIFIC COMMITTEE

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Prof. J-C. Simon
Université Pierre et Marie Curie, Paris

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Prof. Eduardo R. Caianiello
University of Salerno (Italy)

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Institut de Sociologie des
Communications de Masse,
Université de Lausanne (Suisse)

[+] Unable, at last moment, to be present.

A P P E N D I X II

PROGRAMME OF THE SYMPOSIUM

1ST DAY : WHAT IS COMMUNICATION ?

1. Morning

Lecture I — From exchange to communication
Lecturer : A. TOURAINE, Directeur d'Etudes à l'Ecole des Hautes Etudes en Sciences Sociales

Lecture II — Communication between cultures
Lecturer : L. DUMONT, Directeur d'Etudes à l'Ecole des Hautes Etudes en Sciences Sociales

2. Afternoon

Round Table 1 — The impossible transfer, misunderstanding
Chairman : Y. JAIGU, Directeur de France Culture

Round Table 2 — Evolution of expression : interactions with computers
Chairman : A. DANZIN, Directeur de l'IRIA

3. Next day

Joint session

Chairman : M. MAROIS, Professeur à la Faculté de Médecine (Paris VI)

Panel : A. DANZIN, L. DUMONT, Y. JAIGU, A. TOURAINE

2ND DAY : THE DEVELOPMENT OF COMMUNICATION

1. Morning

Lecture III — Consequences of technology for communication

Lecturer : M. EDEN, Professor, Chief biomedical engineering and instrumentation branch, National Institutes of Health, BETHESDA

Lecture IV — Communication and understanding, a competitional approach to language behaviour

Lecturer : R. NARASIMHAN, Director at the Tata Institute of fundamental research, BOMBAY

2. Afternoon

Round Table 3 — Communication between human beings

Chairman : T. ISHII, Professor at the University of TOKYO

Round Table 4 — Communication and the media

Chairman : J. VIDAL BENEYTO, Professeur à la Faculté des Sciences Politiques et de Sociologie, MADRID

3. Next day

Joint session

Chairman : Y. NOVOZHILOV, Deputy Assistant Director-General for Science, UNESCO - PARIS

Panel : T. ISHII, J. VIDAL BENEYTO, M. EDEN, R. NARASIMHAN

3RD DAY : COMMUNICATION, UNDERSTANDING AND SOCIETY

1. Morning

Lecture V — Communication between individuals, classes and groups

Lecturer : J.F. LE NY, Professeur à l'Université Paris VIII

Lecture VI — Machines as models of perception and comprehension

Lecturer : J.C. SIMON, Professeur à l'Université Pierre et Marie Curie (Paris VI)

2. Afternoon

Round Table 5 — Problems of group acceptance of information

Chairman : H. TAJFEL, Professeur à l'Université de Bristol

Round Table 6 — Cultural problems of technology transfer

Chairman : Z. DAMJANOVIC, Professeur à l'Université des Sciences de Belgrade

3. Next day

Joint session

Chairman : H.E. GUNNING, Professeur et Président de l'Université d'Alberta,

Panel : H. TAJFEL, Z. DAMJANOVIC, J.F. LE NY, J.C. SIMON

4TH DAY : COMMUNICATION AND SOCIO-ECONOMIC PHENOMENA

1. Morning

Lecture VII — Development of communication in the future perspective

Lecturer : I. de SOLA POOL, Professor, M.I.T. CAMBRIDGE

Lecture VIII — Economy and communication

Lecturer : J. VOGE, Directeur délégué pour les Relations Internationales à la Direction des Affaires Industrielles et Internationales - Direction Générale des Télécommunications - PARIS

2. Afternoon

Round Table 7 — Urban problems, messages from town and politics

Chairman : I. PRIGOGINE, Prix Nobel, Professeur à l'Université Libre de Bruxelles

Round Table 8 — Social consequences of economic and technological modifications resulting from communication

Chairman : E. CAIANIELLO, Professeur à l'Université de Salerne

3. Next day

Joint session

Chairman : A. SAUVY, Professeur, Collège de France PARIS

Panel : 1.de SOLA POOL, E. CAIANIELLO, I. PRIGOGINE, J. VOGE

C O N C L U D I N G S E S S I O N

Chairman : J-C. SIMON, Professeur, Université Pierre et Marie Curie, Paris

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