本田財団レポートNo.39
「ディスカバリーズ国際シンポジウム
ロンドン1983」の報告

このレポートは、1983年4月25日～28日に英国ロンドン市で本田財団が開催した第6回ディスカバリース国際シンポジウムの会議内容をもとにまとめたものです。

DISCOVERIES international symposium

The Social and Cultural Challenge of Modern Technology

The Fellowship of Engineering
London
25–28 April, 1983

Opening Ceremony

Schedule

スケジュール

Opening Ceremony

Tuesday 26 April, 1983

10:00-10:30 HRH The Prince Philip, Duke of Edinburgh
The Senior Fellow, The Fellowship of Engineering
Mr. Takeso Shimoda
Presidet, Honda Foundation
Chairman: The Rt. Hon Viscount Caldecote DSC FEng
President, The Fellowship of Engineering

Opening Session

Tuesday, April 26, 1983

10:30-12:00 Chairman: Sir Denis Rooke CBE FEng FRS
Senior Vice-President, The Fellowship of Engineering
Viscount Caldectoe
Technology-Master or Servant?
Mr. Moeen Qureshi
Senior Vice-Presient, Finance, The World Bank
Technology in a Developing World

Modern Technology in the Context of Western Europe

Tuesday 26 April, 1983

14:15-17:30 Chairman: Professor Sir Hugh Ford FEng FRS
Vice-Presient, The Fellowship of Engineering
Mr. Umberto Agnelli
Managing Technological Change in Western Europe-Challenges and Possibilities
Dr. Günter Schuster
National and International collaboration in the development of Science and Technology: a European view
Discussion
Break
Professor Gunnar Hambraeus
Modern Technology in Western Europe: Problems and Options
Sir Peter Gadsden GBE FEng
The Perspective of the Past: Indications from the history of the Industiral Revolution in Britain
Discussion

Advanced Technology in North America

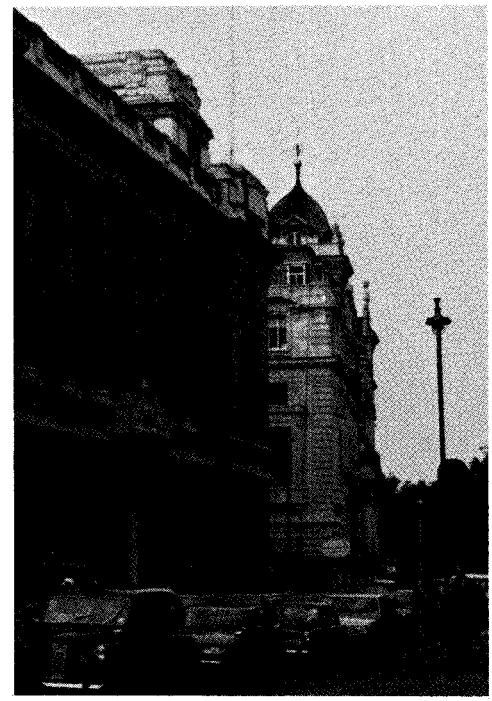
Wednesday 27 April, 1983

9:30-12:30 Chairman: Sir Robert Clayton CBE FEng
Formerly Vice-President, The Fellowship of Engineering
Professor Herman Feshbach
Social and Cultural Effects in the USA of Recent Technological Developments:
A Physicist's Viewpoint
Dr. Robert A Frosch
On Tap But Not on Top:
Technology in a Pluralistic Society
Discussion
Break
Professor Ithiel de Sola Pool
Changing Technology-Its Social Impact
Dr. Roger E. Levien
Interactive Information in the Office and Home-Technological Evolution, Societal Revolution
Professor Harold W Lawson Jr.
Some Consequences of Tomorrow's Electronics CAD Systems
Discussion

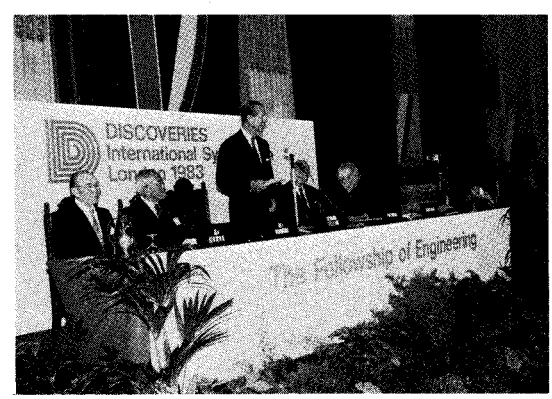
Technology and Cultures in Developing Countries

Wednesday 17 April, 1983

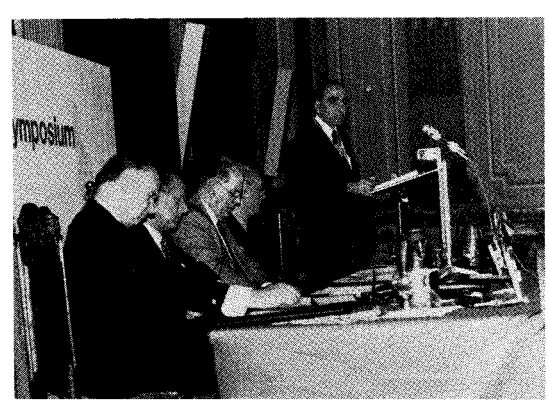
14:15-17:00 Chairman: The Rt. Hon The Lord Nelson of Stafford FEng
His Excellency Sheikh Yamani
The Potential for Industiral Technology in Developing Countries
Mr. Surendra J. Patel
Technological distance between the North and the South
Discussion
Break
Mr. B.M. Grime FEng
The Potential for National Resources with Reference to International Trade
Professor Brian A May
Effective use of Agricultural Technology in the Developing Countries
Discussion



An external view of the Institution of Civil Engineers (front) and the Institution of Mechanical Engineers (rear), meeting place of the symposium.



HRH the Prince Philip, Duke of Edinburgh, addressing at the opening ceremony.



Mr. M. Qureshi, Senior Vie-President of the World Bank, giving his Keynote speech at the opening session.

Social Aspects of Technology in South-East Asia and Japan

Thurday 28 April , 1983

9:30-12:30 Chairman: The Rt. Hon the Lord Sherfield GCB GCMG
Dr. Shinroku Saito
The Clashes between Society, Culture and Technology
Professor Ungku A. Aziz
The impact on Culture and Society of Changing Patterns of Employment
Break
Professor Shuhei Aida
Future possibilities in Telecommunications and their impact on Society in South-East Asia and Japan
Professor Kazuhiko Atsumi
Medical Co-operation Programmes for Asian countries
Professor Toshiyuki Furukawa
A comment on the Relationship between Medical Progress and Social Development
Professor Reikichi Shirane
The Challenge of the New Media Age to Communication
Professor Toru Yoshimura
Policy Making for Technology in Japan
Discussion

Session scene

General Discussion and Formulation of Conclusions

Thursday 28 April , 1983

14:30-16:30 Chairman: Viscount Caldecote led by a panel of speakers including:
Professor S. Aida
Dr. R. Frosch
Professor G. Hambraeus
With a summing-up by Sir Francis Tombs FEng Vice-President, Fellowship of Engineering


Session scene

Closing Ceremony

Thursday, April 28, 1983

16:30-17:00 Mr. Hiromori Kawashima
Vice-President, Honda Foundation
Viscount Caldecote

Closing session chaired by Viscount Caldecote, President of the Fellowship of Engineering.

Social Rogram

Monday 25 April
18:30 HM Government Reception for participants at Lancaster House, London SW1
Host: The Rt. Hon Patrick Jenkin PC MP, Secretary of State for Industry
His Excellency Mr. Tsuyoshi Hirahara
The Japanese Ambassador

Tuesday 26 April
18:30 Reception given by Mr. and Mrs. Soichiro Honda at The Institution of Civil Engineers

Wednesday 27 April
19:00 Reception by the Fellowship of Engineering at the Science Museum, London SW7

Thursday 28 April
19:30 Dinner given by Mr. and Mrs. Takeso Shimoda at The Inn on The Park

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現代技術の社会的・文化的課題

—ディスカバリーズ国際シンポジウム　ロンドン1983の報告—

電気通信大学教授　合田周平

1．MANTECHの意味するもの

ディスカバリーズ国際シンポジウムは、昨年のアメリカについで、今年は1983年4月26日より4日間にわたり、前記のスケジュールでロンドンで開催された。英国の理工学アカデミーに相当するThe Fellowship of Engineeringとの共催によるロンドン・シンポジウムは、工学の分野に於て歴史的にも伝統あるCivil Engineers 協会とMechanical Engineers協会の2つのビルで行なわれ盛況であった。

開会式には、エジンバラ公フィリップ殿下が臨席され、あとで要約するようなスピーチをされ、それにつづく政府の迎賓館ランカスター・ハウスで行なわれたレセプションでは、日英両国の首相からのメッセージが伝達され、国際会議にふさわしく、はなやいだ雰囲気のうちに開幕した。開会式での司会は、The Fellowship of Engineeringの会長、コールドコート子爵が担当され、女王陛下が社会の発展に英国の技術者が多く貢献されていることを認められ、The Fellowship of Engineeringに王立憲章の栄誉を下賜されたとの報告がなされ、出席者一同の喝采をあびた。

現代社会のなかで、技術は絶え間なくその威力を増大し、プラス面での社会効果とともに、公害や人間疎外など、マイナス面での影響も見逃すことが出来なくなっている。つまり、文明社会のなかで人類は、こうした相反する問題をいかに解決するか、という課題をつきつけられているのである。生活の質的向上に、科学技術は人間との絆をより強くしたとともに、その可能性はいまなお強力であるが、マイナス要因となる絆も大きく、そのなかで現代文明は進展しつつある。そこにManとTechnologyの課題を総合的な立場から論じることの意義が大きいのである。つまりMANTECHは、われわれ本田財団の基本的な活動理念である“エコ・テクノロジー”（Eco-Technology）を実現するための具体論であり、今回のシンポジウムで、そのためのいくつかのシナリオについての提言がなされた。

現代社会のなかで、日常生活に欠くことのできない食糧、エネルギー供給、住居等にかかわる問題の解決や、生活水準の維持とその向上のために、より高度で技術的な取り組み方が増してきている。またそれと並行して社会の一部に、そうした技術は将来、社会のなかに深刻な危険性を生むものである、という不安も高まってきている。たとえば、原子力の研究開発と利用は、その顕著な例である。原子力によるエネルギー開発は、社会的に大きな意義をもつものであるが、一方ではその研究開発が、直接間接的に核兵器のそれと関連があり、さらに原子力発電そのものについての信頼性と廃棄物処理などに問題があり、欧米諸国においても当初の利用計画から大きく後退している現状である。

先進国においても、100年足らず前には、自動車も冷蔵庫もテレビもなく、結核、ジフテリア、コレラ等の病気についても、ごく初歩的な医療措置しかなかった。この事を思い起こしても、現代文明は多くの恩恵をわれわれにもたらしたが、その一方では、平和維持の名のもとに科学技術が、人類の殺傷や破壊活動を目的に利用される可能性も、きわめて大きいのである。しかし、現在科学技術の開発を悔む者はきわめて少数である。

と言っても、この問題は見過ごすことができないほど、人類の未来に大きくかかわっている。したがって、技術開発に反対する人々がよく引き合いに出す数字、たとえば核爆発による有害物質の汚染量を考慮するにあたっては、同時にその数字に匹敵する各種の汚染が自然界に存在することをも考えなければならない。たとえば、世界の自然の湿地帯からは、年間1万5千トンのメタンが放出されている現実を重視すべきである。

もうひとつのマイナス面として、今後ともますます高まる工業技術の発達が、雇用に及ぼす社会的影響があり、このことを憂えている人々に対し、説得力のある論理を展開する必要性は極めて大きい。世界市場でそれぞれの業界が、競争力を維持していくためには、この様な技術的進歩が不可欠である。技術開発の遅れは、活力のない企業に転落する。また企業内においても、とり残されてしまった部門の技術能力を増大させねば、健全な目的を推し進めること

はできない。したがって、経済的に生き残っていくためには、再教育、再訓練が必要不可欠であり、技術進歩に反対することは、単に将来により大きな問題を残すだけである。このことが、われわれがいまMANTECHを考えるにあたっての出発点である。

こうした観点から、発展途上国への財政援助の提供について、厳しい問題提起が行なわれた。具体的には、援助が受け入れ国側の国内構造を、混乱させる可能性がある場合である。“単純な援助”は決して単純なものではなく、さらに“複雑な援助”は拠出国においても、受け入れ国においても、歓迎しかねる波紋を引き起こすことが多い。先進国から途上国への技術移転の増大は、将来の世界の繁栄にとっても、欠く事のできないものであるが、同時にその処理に窮する様々な問題も発生させる。

オープニング・セッションの最後に、議長の招請でエジンバラ公が再び立たれ、それまでの発言について、ごく簡潔にコメントされた。

第一に、新規な職に要する再教育についての強い反対論はよく理解できない。時代の流れにより熟練工が他の職種に移り、もはや弓矢を製造する産業は成り立たなくなった。

第二に、生活水準の向上は大いに望ましいが、これ以上の人口増加は回避しなければならない。さもなければ、人口増加によって生活水準は忽ち昔のレベルに戻ってしまうことになろう。

第三に、世界の限りある資源の消費ペースが、早過ぎることに警告を発したい。また先端技術が資源の効率的利用を促進する上で、貴重な貢献を果たしている。しかし現実には限界があり、いわゆる再生可能な資源でさえも、消費率が再生率を大きく上回われば、再生可能な資源といっても有限である。要するに支出は収入の範囲内にとどめるべきである。

第四に、情報社会の向上に大きな感銘を受けている。技術によってこれがさらに向上することは間違いない。しかし一方では、多量に伝達される取るに足らない情報が、技術によって改善されるという徴候はいまだない。

最後に、前世紀の馬車による輸送手段では、1マイル当たり平均150グラムの“汚染物”（馬フン）が排出されたが、今日の自動車の場合にはわずか1グラム程度である。しかし、前者の排出物が少なくとも、土地を肥沃にし、マッシュルームを成長させたのに対し、現代の輸送手段から排出される汚染物質（二酸化炭素、鉛、しばしば硫黄系物質）には、そうした有益な面はなく、エコロジーに害を与えるのみである。ここにも、エコロジーとの調和をめざした“エコ・テクノロジー”研究の意義がある。

MANTECHの意味するものは、非現実的な“古き良き時代”への回帰を呼びかけるのでは全くない。今日の文明社会の問題は、その規模が極めて大きく、想像を起えるものである。したがって、その解決には、先端的な科学技術の粋を可能な限り駆使することが必要となろう。

2．　西欧における現代技術

現代文明がもつ社会的かつ文化的問題を克服するために、先端技術がどのような役割を演じるか、ということは極めて大きな課題であるが、ここでは先端技術そのものが、西欧社会にどのような影響を与えているかについて論じてみよう。

たとえば、自動車産業についてみると、僅か10年前の自動車そのものと、生産工程の技術を考えるとその革新的な技術進歩は驚くべきものがあり、社会の誰もが何の確証もなく、こうした技術革新はすばらしいものであり、社会によい結果をもたらすものと考えていた。欧州諸国の多くの国々で、広野に〝保管〟されている売れ残りの自動車の膨大な在庫は、明らかに欧州産による自動車の需要と供給のギャップを示している。ここに日本車の問題があるにせよ、技術的にほぼ同レベルに達した自動車で、最新の装備と安さのどちらを選ぶかというと、多くの消費者は安い方を求めるだろう。言うならば、技術進歩が安くて安全でカッコいい自動車の生産を、可能にしているのである。

コンピュータ技術を利用した自動車のデザインが、自動車の型は勿論のこと、最適な効率性の確保と、環境汚染の低減に大きく貢献していることも確かである。したがって、デザインもすばらしく、シンプルな自動車ほど安全で安く求められるようになったのである。たとえば、フランスの路上でよく見られる“Deux Chevoux”という自動車は、極めてシンプルで安く、かつ安全性も高い自動車である。

一般的にも、科学技術の研究成果を、産業界に導入する際、つまり新技術を研究室から工場に移転するとき、そこに技術者の果す役割は極めて大きいものがある。この実用化へのプロセスでは、欧州に比べ日本の方がはるかに早く見事なものがある。工業

化技術の飛躍的な進歩が、技術そのものよりむしろ人間の文化的かつ社会的要因によることが多い。日本が多くの製品において、新規市場の開拓や多くの製品の供給に成功していることは、このことに大きく関連している。

欧州においてもこの点を考慮して、研究分野での産業化の可能性を徹底的に摸索する必要性がある。欧州産業界の指導的立場にあるＦＩＡＴ副会長のアニエリ氏は、こう述べるとともに、欧州産業界の真のニーズに対する十分な配慮を呼びかけた。

自動車やエレクトロニクス製品など、主として民生技術についての、一般の人々の評価は、その人の教育程度や職業にも左右されるが、とりわけ若い世代では、感情的なムードにより決められることが多い。また、先端技術がつぎつぎに導入されることから、技術社会の未来にとって大切なことは、継続的にこれらに対処しうる技術者を世に送り出すことである。いずれにしても、技術革新の波が社会に拡大するにつれて、その社会的波及効果は計り知れないものであり、好むと好まざるとに拘らず、人々の日常生活と仕事に大きく関与してくるわけで、社会に生きるすべての人々は、この現実を直視して、技術革新の傾向をつねに学ぶ必要がある。

産業界においては、このことが重要視され雇用や労使関係にかかわる人々は、技術進歩の社会的波及効果について、さまざまな研究がなされてきたが、今やより広い分野の人々が、現代技術をよく認識し、それがどうなるかではなく、我々の見識を持って、それをどうするかを考えるべき時である。

多くの諸国が、失業問題に悩んでいるこの時期でさえ、技術開発についての国際協力の話題が多いが、我々はもっと人間社会の基本的課題に目を向け、技術をどうすべきかという理念づくりについて、国際的視野で討論をすべきである。技術進歩が肉体労働はもとより、熟練労働の需要さえ減少させてしまう恐れがあることから、労働組合の活動家などが、技術そのものについてさえ不安を感じるのは、当然のことである。これらについて、提案されている対応策、たとえば労働時間の短縮や標準化は、生産性に対し相対的な賃金の上昇を意味し、文化的停滞を生じさせるにすぎない。現代社会が持つこうした動態を、各国の政府も労働組合も、技術革新の真の意義として理解していない。残念なことに、長期的な戦略の展開よりも、研究資料や白書の作成に彼等はその活動の焦点を合わせているようである。

さらに困ったことに、実業家が政府にほとんど信頼を置いていないとともに、政府の側もまた産業界を信じていない証拠が多々存在する。そこでひとつの主要な結論を引き出すとすれば、先端技術の導入によって、約束された本来の社会的恩恵を、具体的なものにするには、その根本にある執拗な不信感や誤解を、社会のあらゆるレベルから取り除かなければならない。

●国際的研究プロジェクト

ある研究が、資金と技術者の両面から単独では実行不可能であり、国際協力によらざるを得ない研究プロジェクトから得られる、きわめて実質的な利益について考えてみよう。

欧州の政府間プロジェクトとしては、ジュネーブのＣＥＲＮ組織による基礎物質の研究、グルノーブルの独仏研究所、核融合開発に関する欧州共同体などがあげられる。また民間レベルでも、フランスの超音速機コンコルド、エアバスのA－300などは、2、3の国による共同開発の成果であることが知られている。

これらは、すべて国際協力にいくつかのメリットがあり、それぞれに成果をあげた反面、工業化でのプロセスにおいて、とりわけ特許権の取り扱いなどに多くの問題を残している。しかし、全体としてこの種の問題は、その成果に比べれば重大なものではなく、個々の投資額をはるかに上回る“付加価値要素”を含んでいることは明らかである。たとえば、研究者の交流は、それが現実的なものであるほど、考え方は勿論のこと、文化的背景、問題解決への異なるアプローチなどに接し、一流の研究者ほどさらに自分を研くことができ、最高のレベルにまで到達することができるのである。

このことに関連して、最近設立された欧州科学財団について述べてみよう。同財団はフランスのストラスブールに本拠地を置く欧州の非政府レベルの組織で、多くの西欧諸国の研究委員会や学界からの代表者で構成され、先端的な現代技術の分野で、科学技術的な研究開発の指針を提供したり、その運用管理を行なっている。同機関は将来、基礎研究のために必要となる大規模な“実験装置”や“施設”の優先順位を、具体的に勧告する欧州諮問委員会の創設を促すことになろう。

今後、ますます多様化する現代文明のなかで、共

同プロジェクトの創設、運営について直面する、いくつかの問題や障害についての研究が必要である。とくに、工業化でのプロセスにおける特性の問題、参加国間の国家政策や規準、規範の違い、通常１ケ国に限定される研究所の物理的な敷地の問題、非常に複雑な国際経営に伴なう問題等が含まれる。これらの問題は時としてかなり深刻なものとなるが、将来の科学・技術協力のビジョンづくりのためにも、またウィーンの国際原子力機関の後援の下で進められている“ＩＮＴＯＲ”核融合研究プロジェクトなど、具体的な目的をもつ研究開発のためにも、大いに期待すべきことである。

こうした協力が、技術分野に留まらず他の分野にも広まらないものだろうか。世界のすべての国々が衝突や摩擦など、相互に不幸な結果を招く方向ではなく、全ての人々にとって将来、利益となるような協力はできないものだろうか。

現代文明のなかで、我々が直面する最も難しい問題がこのことである。つまり、世界の変化に対する社会的抵抗、もしくは内在的な反発について考えることである。一般に人々は自らの慣習を変えることを欲しない。あるいは新しいことを進んで学ぼうとしない。新しい思考を身につけることに消極的である。このことは、文化的要素を基盤にしているためで、社会の変革には高い費用を要し、政治的にも理念ある政策の立案と実行が伴う。さらに、あらゆる分野に関連するからであろう。とくに、現在の世界的規模での経済活動の停滞も、この状況に拍車をかけている。

しかし、世界の多くの人々は、21世紀に向けてあらゆる分野での変化は今や避け難いものであり、すでにその方向に進んでいる国々に目を向け、最終的には自らもその方向に、かじを取らざるを得ないことを認めている。このことは、とくに若い知識人のなかに多く、社会にはあまりにも矛盾に満ちたことが、多すぎることを見ても理解されよう。

先進諸国においてさえ、若い科学者や技術者の需給に、大きなアンバランスがあり、しかもその傾向が増大しつつある。もっとも、この現象は、社会科学や人文科学に進む方が、理工系を勉強するよりずっと楽だと考える若者を、たしなめることには役立っているようである。しかし、一方では時流にながされ、自らの職業を選択することにも通じ、やがてそれを自らも認識することになると、優秀な頭脳の持主が非生産的な分野に転向してしまうことになる。このことは、教育と職業選択の自由を一応保証している民主主義社会のジレンマである。

3．　アメリカの先端技術

先端技術の普及は、いまや驚くべきものがあり、“スターウォーズ”などの映画やテレビをはじめ、テレビゲームなどに利用されている。とくに、アメリカにおける先端技術の利用は、軍事はもとより、民生技術としてもおびただしいものがある。たとえば、パーソナル・コンピュータは数千台も家庭に入り込んでおり、それと同程度のものが学校でも教材として利用されている。

大学教育においても、ＭＩＴ（マサチューセッツ工科大学）などでは第一学年の学生はコンピュータ・システムやプログラミングに当然通じているとされており、また実際に通じている。こうした傾向は、次第に日本にもみられるもので、“パソコン”なる新語を生み子供達の間にまで人気をよんでいる。

産業界においては、コンピュータによる自動化は当然のこととされており、そのペースと規模は日々拡大の一途をたどっている。

また、技術分野における新技術の開発は日進月歩であり、昨日の技術開発は翌日にはすでに時代遅れになるという有様で、米国社会において企業間の競争を激烈なものにしている。

どんなに業績のよい企業でも、毎日のように生産や管理システムを、最新の技術システムに置き換えることは不可能である。まして、そのシステムが複雑なものであればある程、その経費を償却するのに時間がかかる。さらに、要員の再教育が必要ともなれば、当然生産システムの切り換えに多少の遅れが生じてくる。

先端技術、とくにコンピュータによるオートメーション技術の革新は、労働人口の激減と質的変化を余儀なくしている。そのため、労働力の３％が常に余剰となっている。情報産業の展開もめざましく、その結果この分野に従事する労働者が、全労働力の46％を占めるに至っている。

いわゆる知識産業であるこの分野は、誰もが理解しうるものではなく、一部の人々にとっては、それが大きくなればなるほど不安のもととなり、その結果、科学者や技術者などの専門家が、茫然とした恨

みの対象となることは、労働組合や労働者自身の態度を見れば明らかである。こうした労働者の心理から社会がこうむる被害は甚大なものがある。

雇用面で見てみると、今や重工業分野での非熟練労働者に対する需要はほとんどなく、半熟練労働者についても将来の見込みは定かではない。一方コンピュータのプログラマーやエレクトロニクス関連の人材に対する需要は非常に大きく、データ記憶装置やデータ処理システムの利用分野は毎日のように拡大されている。今や情報は資産となり、他の商品と同じように集められ、蓄えられ、整理され、そして売買され、時には犯罪の対象となっている。今日、アメリカにおいては情報の取引は、法によって管理され、多くの産業情報は機密事項となって、その保護、伝達、公開の権利をめぐって争いの種となることもしばしばである。

アメリカ社会では、企業の指導層の多くが文科系の出身者で占められている。したがって、コンピュータによる経営モデルや技術開発となると、すべて部下の作成したものに目を通し、経営的な立場から判断することが多い。つまり、科学技術について十分な知識がないまま中央集権的に企業経営に当っているのである。ここに日本社会との相違がある。日本では幸か不幸か終戦により、産業界では当時の工場長クラスが企業のトップの座を占め、技術能力を身につけた経営となったのである。科学技術者が自分の専門分野の知識と特質を生かして、企業の管理や政治的かつ社会的問題の解決はできようが、一般教養程度の知識で科学技術が当面する諸問題を理解し、これを解決することは極めて困難である。

欧米と日本との産業活動にみられる格差は、こうしたことにも大きな原因があろう。いずれにしても情報化技術の展開により、最も大きな影響を受けるのは中間組織、つまり商品やサービスの製造者とその最終消費者とをつなぐ中間業者である。このような業者とは、製品の保管や輸送、梱包などの「中間的」業務を行なう。これには銀行、卸売業、運送業、小売業も含まれる。また知的産業としては、図書館、出版業、放送会社などが含まれる。今後はコンピュータとコミュニケーションによる包括的な電子通信技術により、最終製造者および消費者は、欲しい物を各自の端末装置から受注や発注が可能になり、仲介機関は遅かれ早かれ不要となる。商品などの非知的なものを扱う中間業者は、それ程深刻な影響を受けないが、これまで図書館や書店、出版社等が行なっていた情報の選別、予備評価、また明らかに不要な素材の作業は恐らく消えてなくなるであろう。こうした機能は直接的情報検索システムである、ビデオテックスなどに置き換えられ、この種のシステムが、実質的に新しい中間機関の役割を果たすことになる。

この結果、ただでさえ危くなっている情報の消費者とその提供者の間の“人間的つながり”がなくなってしまうであろう（双方共機械やコンピュータの端末を操作するだけである)。こうした人間社会での孤立化が、どのような結果をもたらすかについて考えるべきである。いずれにしても、コンピュータは最終的に我々の考えをどのように変えるか、ということは現段階では明らかでない。コンピュータは本来、膨大な数の方程式を解く計算機であると思われていた。ところが今では全く違うものになっている。それは人間の質問に答えるワードプロセッサーであり、図表表示器でありゲームマシンなのである。

いずれにしても、技術の展開が社会を変えつつあるという認識が、指導者にとってまだまだ十分なものではないようである。我々にいま必要なことは、技術の理解とともにその開発の哲理を模索することである。具体的には人類にとってエコロジーと調和する技術づくり、つまりエコ・テクノロジーを実現することである。ここでもこうした認識の重要性が再確認された。

4．　発展途上国における技術と文化

発展途上国においては、多くの議論があり、とくに技術移転については“適正技術”(appropriate technology）などについて、いくつかの国際会議も開催されている。文化や文明の発展に終着駅があるわけでなく、ある意味では全ての国が発展途上にあるとも言える。しかし今回の“MANTECH”シンポジウムでは現在 AIC（先進工業国）といわれる諸国よりも、高い率で発展しつつある諸国にまつわる諸問題について討議された。

サウジアラビアのヤマニ石油相は中進工業国家となったサウジアラビアと、そのために同国が払った大きな努力、とりわけ金融投資などについて興味ある話題からはじめた。

第二次世界大戦以降、サウジアラビアが多くの石油関連工場を建設するとともに、農地開拓、灌漑、施肥、植物保護剤の利用による農業改良を目指し、

人材育成計画を実施してきたことなどについての成果と問題点を述べた。とりわけ人材育成計画は、農地開拓において、繁殖力の高い種の使用により、中程度の資本投資にもかかわらず、土地の生産性が大きく向上するのに役立った。

これらのことは、今日の先端技術からみるとまだ初歩のレベルにあるが、必要としているものは上下水道設備や最低限の住居、そして輸送面での機械化などの基礎的設備であることが強調された。膨大な鉱物資源、農業資源に恵まれている国々も多いが、投資資本能力の欠如から、これらの天然資源を有効に利用することができない状態である。サウジアラビアが大きな発展を遂げたのは、世界で最も安い豊富な天然資源に恵まれ、とくに石油を有効に利用する事ができたからに他ならない。“自由貿易体制の下では、石油を有効に分配するという原則に基づいてこれを世界貿易の促進に利用するべきである。サウジアラビアにおける石油政策は、この原則に従い、かつ着実な輸入の流れを確保するには、他国との競争の中で着実に輸出を伸ばしていくことが最良の方法であるという原則に従っている。”消費国の石油需要を抑えるため、各国が関税障壁を設けたにもかかわらず、サウジアラビアはこの政策を実行してきた。ヤマニ石油相は関税障壁に幾分批判的であったが“関税障壁が作られた本来の意味を今一度振り返ってみるべきではないだろうか……”と力説した。

発展途上国の多くは、これまで良好な貿易関係を維持してきた北側先進工業国に依存している。“第三世界”の多くは今なお幾多の深刻な問題をかかえているが、過去数年の間に一部の国は多額の投資資本の調達に成功し、財政面での安定と貿易国としての地位を獲得している。このように第三世界は徐々にではあるが、北の諸国の仲間入りをしつつある。これは近代技術を導入することによって達成されたものであり、これらの技術獲得のために第三世界は、時には多大な経費をかけ、また時には封建的な状況の中で学んできたのである。先端技術が一部の人々のものではなく、人類共通の財産として、全ての人が利用できるものでなければならないが、現実的には石油資源の配分などかなりの不均等がみられる。いずれにしても、第三世界からの発言はディスカバリーズ国際会議において、これまでもしばしばみられたが、今回のように先端技術という幻想の世界に酔う人々を、“力のある者は去り、力のない者は残って飢えに泣く”第三世界の国々で、何百万人もの人人が、栄養不良に苦しんでいる現実の社会に、思いをはせた一時でもあった。

こうしたことをも考慮して、国家資産の潜在力と国際貿易との関係を考えると、エネルギーや鉱物資源、および人的資源（人材）の有効利用のためのシナリオづくりが重要である。ただしここでいう人的資源とは、潜在的労働力のことではなく、むしろ少なくとも発展途上国においては、科学技術にたづさわる知的な人材をさしている。

潜在的な人的資源を堀りおこし、それぞれの分野での人材育成は極めて重要なことで、それらの人々の努力により風土や文化を基盤にした技術が生まれてくるのである。つまり、適正技術に限らず将来の文明づくりのためには“文化と技術の対話”は欠くことのできないことで、このことを可能にする人材養成は“優先的に配慮すべきひとつ”ではなく、、“最優先事項”でなければならない。

5．アジアにおける技術と社会

人類がはじめて道具をつくり、その価値を理解したことにより、現代技術がスタートしたのである。このことが火の利用技術はもとより、風力や水力という自然のエネルギーを有効に利用することを可能にした。しかし、その一方ではアジア地域特有の迷信や恐怖心などから自己を守るために、独特の宗教が人々の情念とともに、人間社会のなかに定着し、より精神的な言葉によるコミュニケーションが進行してきたのである。こうしたことを基盤として、人間の集団的目的を、道具を用いて実践するための技術がつぎつぎと誕生し、現代の技術体系が整ってきたのである。

とりわけ、アジアでは日本をも含めて、文化形成の初期には、さまざまな文化が同時平行的に発達し、その流れと他の流れとの間に、さして深刻な摩擦もみられなかったのである。大陸と半島と島々からなるアジア地域において文化は陸地を伝い、あるいは海を渡って、ある種の共通性をもって広まってきたのである。とくに、仏教などにみられる宗教の種類と、その布教のパターンは、アジア地域の特異性と文化の共通性をも、うかがわせるものがある。

アジア地域に限らず、技術の発達は、異なった文化が同地域で互いに接触する機会をつくり出し、ここに文化摩擦という新しい問題を人類社会に提起してきたのである。このことは、“自国文化のなかに、

ドカドカと侵透してくる異国文化に対する拒否反応”であると考えられよう。こうしたなかで、科学そのものは文化とはかかわりなく、自然に対する正しい認識として迎え入れられてきた。しかし、技術となると、このように中庸であり続けるわけにはいかなくなった。

一般的にみると、技術は科学的成果にさまざまな規則をもうけることからはじまる。そこに文化的な考察が入り込む余地があるわけで、技術は異文化の一部となり得るため、異文化圏からの技術移転は、そのまま文化摩擦の要因であり、社会的な影響もきわめて大きなものがある。とくに、従来の土木工事などのハードウェアの技術のみではなく、情報化技術のように、文化や社会に広く深くかかわりのある技術となると、その傾向は一段と強く、新しい技術に伴う、社会的な動揺や波及効果は、あらかじめ予測し得ないものである。

こうした考察にも、いくつかの議論があるが、過去のカルチャー・ショックとは、全く異質のものが到来しつつある現実をよく見きわめ、人間社会の適応能力を十分に発揮して、21世紀にそなえることが肝要である。

東南アジアの諸国においても、雇用問題は大きな社会的かつ政治的問題となっている。このことは、近代化へのプロセスにおいて雇用形態が変化し、さらに教育制度や社会環境の変容が、若者の態度に大きな影響を与えていることも、大きな原因である。それぞれの国の産業政策につれて、農村から都会の工業地帯に職を求める若人が増加し、なかでも女性の進出がめざましくなってきた。とりわけ、大学など高等教育を受ける若人が多くなり、高給で受け入れられる職種も増加し、若きエリートが社会のなかで活性化しつつある現状である。ここでも、情報処理やコンピューター技術にかかわるものが数多くみられ、なかでも、インドネシアはパラパという実験衛星をもち、宇宙通信を介して、赤道直下に広大な面積で散在する、インドネシアの島々を統括する、実験的通信システムの確立をめざしている。

こうした努力が、情報の価値とその利用度を、急速に高めるものと考えられる。エレクトロニクスによる情報化技術は、医学や医療にめざましい影響を、与えていることも衆知の通りである。すべての患者についての治療はもとより、健康についてのデータが蓄積され、必要に応じて速やかに、個人の診療記録を入手することができる。

ＡＳＥＡＮ(東南アジア)地域全体に、こうしたデータ・ベースをもつ病院をいくつかつくり、これを情報化技術で結ぶことから地域住民の健康管理を可能にし、よりよき勤労意欲の向上につなげるべきである、との提言がなされた。とくに、人口調節(family planning)については、各国ともに国家的事業として力を入れている。

さらに、わが国でもよく話題になるコンピューター・コミュニケーション・システムの実用化にも関心を示している。このことは、ＡＳＥＡＮ地域のように広域を対象とするとき、とくに有効なシステムである。しかし、ここでも大切なことは、患者と医療従事者との人間的コミュニケーションをいかにつくり、これを維持するかということである。そのため、何よりも重要なことは教育の問題であり、これは一朝一夕にできるものではなく、国家としての哲学をもとにした教育制度を確立することが大切である。人材の育成はいかなる時代でも、国家の繁栄をもたらす基本である。わが国の明治時代から今日に至るまでの、およそ 100年余の医学教育についての歴史的分析が論議され、このことが他の分野の向上にまで影響を与えたことに関心がよせられた。

すなわち、わが国の今日までの先進諸国への成長ぶりは、産業の分野で著しく、その基盤として国民の健康管理を実践した、医療教育があったことは興味あることである。言うまでもなく、心身の健康は人間として高い教養を身につけ、より文化的な思考に個人と集団をかりたてるものである。こうした“方向づけ”は、職業選択の自由を侵害するものであるとの意見もあるが、科学技術を身につけることへの若人の意欲が、そうした懸念を消滅させていくであろう。

いずれにしても、ＡＳＥＡＮ諸国の近代化は、一方では活力に満ちて進展すると同時に、他方では社会的に多くの矛盾を生み出していることも否定できない。立派な電子顕微鏡など先端技術の産物が、日本や他の先進国より供与されても、それらを使こなす人材が少いため、ガランとした研究室の片隅でほこりにまみれている光景をしばしば見ることがある。今後とも、どのように技術システムが発展しようとも、技術協力についての重大な計画策定や方針の決定にあたっての情報の収集と評価能力などは、人間の専門的な能力に依存していることを知らねばならない。したがって、高度な先端技術による情報化時代の国際協力には、ますます人間の知的能力や

感性が大きな役割を演じる時代なのである。

ＡＳＥＡＮ諸国の現状からわが国をみるとき、それは良きにつけ悪しきにつけ“未来のすでに訪れた国”であるに相違ない、このことは経済成長と技術革新の調和により、もたらされたものであるが、そこに産業政策の成果をみることも出来る。このことに関連して、過去20年間にわたる、わが国の産業政策についてのデータをもとに議論がなされ、産業化へのいくつかの課題がなげかけられた。

技術の教育・訓練について、日本は他の多くの先進国と比較して、多くの若者が技術教育を受けるよう、社会的なＰＲが成功したようである。このことが、将来ともに日本に繁栄を約束するかは別としても現代の先端技術の時代に、より有効に作用していることは確かである。アジアのなかの技術立国として、そこに西洋の一端をみるか、あるいは全く独自の文明を模索していくのか……。まもなく歴史が明らかにするだろうが、われわれはアジア地域の一員であることを、世界のなかで活躍するときの尺度にすべきであることを痛感させられた。

6．　不快感を超えて

ヨーロッパの伝統的な保守主義のなかで開かれた、ロンドン・シンポジウムであったが、さまざまな側面をもつ技術が、今後どのように展開されるかは、世界的な関心事でもあった。未知の世界を開く科学技術に対する恐怖は、既存の知識に対する懐疑より、はるかに大きいものがある。とりわけ、文化的に大きな蓄積のあるヨーロッパの人々は、先端技術に対する、ある程度のあこがれはあっても、それを利用することが、教養や文化を高めることであるとは考えていない。そんなわけで企業経営者の資質にしても、利益を求め、利潤を高めることこそ第１条件ではあるが、それらの人々が文化的な教養を身につけていることは、当然なこととして認識されている。

わが国とヨーロッパを比較するとき、産業分野においては、その効率性といい利潤では、著しくわが国が優れている。つまり、数字の上では格段の相違があるが、そこで働く人々、とくに経営者の質となると、技術主義的な人々が多く、とても比較にならないという思いが、ヨーロッパの知識人のなかに、かなり根強く存在していることを知った。つまり、技術能力と文化能力が、世界的にきわめてアンバランスな時代なのである。

国際社会のなかで、科学技術にたづさわる人々の間に、非科学的な分野の人々を、無教養であるとの認識が、広まりつつあることの指摘がなされた。こうした風潮は、文化的な人々を怒らせ、先端技術の展開されるなかで、科学技術者は、人間的かつ概念的なアプローチを、欠いているとの批判が高まっている。いかなる時にも、〝世界は人間の尺度であり、人間は世界の尺度〟でなければならない。よりよきコミュニケーションの基盤は、何んと言っても、より人間的なステージづくりであることは、言うまでもない。

文化と技術の対話は、われわれ本田財団の指向する〝エコ・テクノロジー〟の基本的な概念であり、これはまた現代社会の大きなジレンマを、いかに解決するか、という課題でもある。

技術とは、もともとより人間としてのフィーリングを具現化することであった。このことは、本田宗一郎氏との語らいのなかからも伺える。数学もまた人間の空想的な遊びであった。円を表わす数式や、微積分などの背景にあるあの美しい合理性は、記号や規則をはるかに超えたものであった。〝若者は遠近法を学べ〟と教えたレオナルド・ダ・ヴィンチの思考は、まさに芸術家のそれであり、ついで経験の弟子としての技術者の姿が出現してくるのである。

情報化技術の展開は、われわれにより人間的な感性の重要性を語りかけてくる。この分野の技術が進めば進むほど、より重要なテーマとして、〝感性の復権〟はつねに語りつがれなければならない。

ロンドン・シンポジウムは、その意味でその組織づくりから閉会の日まで、まさに異文化に接する経験の日々であった。モンスーンの季節におけるインド洋上の、皮膚がとろけるようなあの不快感が、時としてわれわれに襲いかかってきた。このドロドロとしたふれあいこそ、まさに異文化間コミュニケーションの現実であり、これらの経験を通じて、われわれの活動も、より成熟するものと確信している。不快感を超えてこそ、文化と技術の対話が可能になるのである。

THE SOCIAL AND CULTURAL CHALLENGE OF MODERN TECHNOLOGY

OPENING CEREMONY AND SESSION

26 April, 1983

Advanced technology can lead to enormous benefits for mankind, or to serious difficulties. The balance between the two depends on how it is used. That was the gist of the remarks by His Royal Highness the Duke of Edinburgh, Senior Fellow of the Fellowship of Engineering, at the opening in London of the sixth international DISCOVERIES symposium held under the title "MANTECH" the Social and Cultural Challenge of Modern Technology".

The symposium was organized by the Fellowship in the historic and adjacent headquarters buildings of the Institution of Civil Engineers and the Institution of Mechanical Engineers. Like its predecessors it was sponsored by the Honda Foundation in Tokyo, under the general theme "The Humane use of Human Ideas". The series is devoted to the application of advanced scientific and technological progress for the greatest possible benefit of mankind, at the same time alleviating any unwelcome repercussions that might develop.

The opening session was chaired by the Fellowship's President the Viscount Caldecote, who was able to announce that Her Majesty the Queen had just granted to the Fellowship the honour and distinction of a Royal Charter, so recognising the great contribution of engineers to the advance of technology in service of society.

In his address, His Royal Highness Prince Philip stressed the tremendous challenge to humanity presented by a world whose technology was constantly becoming more powerful, and so able to bring more and more important changes to everyone's life. The greatly increased possibilities of science in improving the quality of life required ever greater care to avoid the destructive use of, for example, nuclear weapons: the destructive application of a new source of energy which could also prove the key to future prosperity combined with environmental security due to its non-polluting character.

Ambassador Takeso Shimoda, President of the Honda Foundation, thanked His Royal Highness for his stimulating remarks and drew attention to the mission of his Foundation in trying to resolve some of the very severe problems now confronting mankind. Recalling that "DISCOVERIES" symposia had now taken place in Tokyo, Rome, Paris, Stockholm and Columbus (Ohio), he was sure this new meeting in the country which had cradled the Industrial Revolution would continue the same tradition.

In a profound and inspiring development of the theme "Technology, Master or Servant?", Viscount Caldecote surveyed the growth of improved technological approaches to solve everyday problems of food and energy supplies, shelter and a continual improvement in the standard of life, and the parallel growth of fear, in some parts of society, that these improved technologies were inseparable from new and severe dangers for the future. The classic case was that of nuclear energy, where the necessary development of a new and exceptionally significant source of electric power had been equated by some with severely increased risks of disastrous war. Very few could recall without astonishment, said Lord Caldecote, that less than a century ago there were virtually no motor cars, no refrigerators, no television, and only very elementary medical defences against diseases such as tuberculosis, diphtheria and cholera. Here were the very real benefits of science and technology, and few would now deplore such developments on the grounds that the same science and technology could well have been used disastrously.

In this context Viscount Caldecote drew attention to some of the figures often quoted by opponents of advanced technology, for example concerning the radioactive pollution which could result from a nuclear bomb explosion. There were "natural pollutions" which could easily equal this radioactive pollution, for example and annual discharge of 15000 million tonnes of methane from the world's natural swamps. Viscount Caldecote concluded with some cogent remarks for those who deplored the social effects notably on employment—of increasing technological advances in industry. Such advances were essential, he said, if industry were to remain competitive in world markets: and no healthy purpose could be served by resisting such changes in order to bolster employment in obsolescent or obsolete sectors. Re-education and retraining were essential for economic survival, and opposition to such advances could only lay up greater problems for the future.

Viscount Caldecote was followed by Mr. Moeen Qureshi, Senior Vice-President of the World Bank,

who spoke of the severe problems of giving financial aid to developing countries when, very often, such aid could disrupt these countries' internal structures. "Simple help" was never simple and "Complex help" – however valuable–often had unwelcome repercussions both in donor and donee nations. Increasing transfer of technology from the advanced to the less-developed countries was essential for the future well-being of the world, but it raised many intractable problems.

Concluding this opening session, at the invitation of the Chairman, His Royal Highness Prince Philip offered some remarkably succinct "instant comments" on what he had just heard and which he believed (others were well convinced) could be helpful.

First, he was puzzled by the considerable opposition to reeducation for new jobs: we did not, he noted, still have an industry for making bows and arrow, for the skilled tradesmen had turned to other things.

Second, he felt that although improved living standards were highly desirable, it was necessary to avoid these leading to further population increases: otherwise the more people would soon bring standards back to their former levels.

Third, His Royal Highness wanted to warn against over-rapid consumption of the world's finite resources, and improved technology had valuable contributions to make in increasing efficiencies of such use. But there were real limits –as also there were for the so-called renewable resources, for if consumption were at a greater rate than renewal–these resources were also finite. Expenditure, in fact, should not be allowed to exceed income.

Fourth, His Royal Highness had been much impressed by improvements in communication, and there was no doubt that technology could and would bring further improvements. But, he pointed out, there was no indication at all that "technology was improving the rubbish that was so often communicated".

Finally on pollution, His Royal Highness had noted a remarks by Lord Caldecote that, compared with an average "polluting discharge" from the horse-drawn transport of the last century of some 150 grammes per mile travelled, today's motor vehicles averaged only one gramme of pollution per mile. But, said Prince Philip, the former pollution could at least be used for ground fertilisation and growing mushrooms: the pollution from modern transport (carbon and nitrogen oxides, lead, and often sulphur derivatives) had no such useful applications.

However, the Senior Fellow was in no way calling for a return to the nostalgic but unreal world of the "good old days". Today's world problems were of a magnitude then inconceivable, and their solution called for the fullest possible employment of the best efforts of advanced science and technology.

SECOND SESSION

Modern Technology in the Context of Western Europe

26 April, 1983

If the opening session had been marked by inspiration and aspiration concerning the contributions to be expected from advanced technology in overcoming the world's social and cultural problems, the second session got quickly down to practical problems, and not least those problems for which advanced technology was often held responsible.

The scene was set by one of Western Europe's most involved industrialists, the Vice-Chairman of Italy's huge Fiat organisation (and Chairman of Fiat Auto SpA) Umberto Agnelli, who was clearly no less aware than others in motor-manufacturing of the great difficulties facing his industry. However, while evidently championing innovative development in transport (in many respects today's cars, trucks and trains were very different from their counterparts of only a decade ago) there was perhaps a tendency to assume without proof that all these changes were necessarily for the better. The large stocks of unsold vehicles which may be seen "stored" at disused air-fields and similar places in most European countries certainly indicate a disparity between demand and supply, and although the basic reason for this may be financial rather than technical, it is nonetheless real. (Asked to choose between sophistication and cheapness, a great many would-be customers will opt for the latter, sometimes because the alternative is out of their practical reach*). But very advanced electronic technologies have certainly become an established part of motor vehicle design, and have enormous contributions to offer in securing optimum efficiencies combined with minimal environmental pollution.

Signor Agnelli stressed the vital role of engineers in applying the developments of advanced scientific research to practical ends—in, as he said, transferring new technology from the laboratory to the shop floor. This process had always been much faster in Japan than in Europe, and doubtless was not unconnected with the success of Japanese industry in creating new markets for many products, as well as supplying those already existing. Signor Agnelli also called for more "engineering realism" in research, which otherwise could rather easily follow modish trends with insufficient regard for the real needs of industry.

However his main message, entirely in keeping with the subject of the symposium, concerned public attitudes to technology, to new scientific developments, and particularly towards the young people who, faced with a wide choice of education and career, were often influenced by social trends and attitudes based on emotion rather than reality. It was undeniable that an advanced technological futrue could not be assured without a continuing supply of advanced technologists, and there was still a widespread feeling that "technology was for others", while the real problems of life were the domain of Social Scientists and others whose hands never got dirty. "The general public", said Signor Agnelli, "must be better educated in the real facts of technological innovation which, like it or not, is going to make far-reaching changes to the daily life and work of everyone".

But more and better understanding of modern technology was needed in all sectors of society and at all levels, and not least in circles connnected with employment and labour relations. At a time of high unemployment in most countries, it was not surprising that technology capable of reducing the demand for manual labour (even "skilled") caused apprehension to Trade Unionists and others. But some of the countermeasures proposed, such as a general and standardised reduction in working hours—which meant paying more for less production —could only lead to cultural retardation. In this field Signor Agnelli felt that both Governments and Trade Unions rarely understood the true significance of technological change, and both seemed "readier to produce studies and white papers than to develop long-term strategies".

Perhaps it was inevitable that an industrialist should display so little confidence in the administrative establishment, and there is no lack of evidence that the establishment (in general) equally lacks confidence in industry. If one principal conclusion is to be drawn, it is surely that this persistent mistrust, and the persistent misconceptions on which it is based, must be eliminated, if the very real social benefits promised by advanced technology are to be realised.

The next speaker was Dr. Günter Schuster, a former Director-General of the Commission of

*The commonest car to be seen on the roads of France is the "Deux Chevaux", a brilliantly-designed but extremely simple (hence reliable and cheap) transport machine.

the European Communities (CEC), now co-ordinator for bilateral co-operation in the German Federal Ministry for Research and Technology. Dr. Schuster was anxious to convince his audience of the very substantial benefits to be gained from international research projects, often involving investments (both of money and technical personnel) which participant countries individually would be unable to find. Dr. Schuster cited some of the better-known European inter-governmentally sponsored projects: particularly the CERN organisation in Geneva for research into fundamental matter, co-operation in the European Space Agency (ESA) for the development of the Ariane space launcher, the French/German High-Flux Test Reactor at Grenoble, and the most important technical project of the European Community, the Joint European Torus (JET) for the development of nuclear fusion. All had demonstrated the clear advantages of such co-operation, but had also shown where problems could arise, notably in connection with the commercial exploitation, under patents, of knowledge acquired. But overall these problems were insignificant compared with the benefits offered, which in Dr. Schuster's words, included an "added value element" well beyond the simple sum of the individual contributions. "In the interaction with other people", he said, "with other ways of thinking, other cultural backgrounds, different approaches to solving problems, good people and even the best people became better".

Dr. Schuster made special mention of the comparatively recently established European Science Foundation, a nongovernmental European organisation based in Strasbourg, France, which comprises representatives from the Research Councils and Academies of most Western-European countries, and which provides scientific guidance and surveillance in many of the newer fields of modern technology. This body might one day lead to the creation of a European Advisory committee to elaborate priority recommendations for large "Science-tools" and facilities for basic research, a body which Dr. Schuster strongly advocated.

Concluding, Dr. Schuster noted some of the difficulties and obstacles which could be encountered in the establishment or operation of joint collaborative projects. They included difficulties due to the involvement of industry (including the exploitation of patentable knowledge and processes, already mentioned); difficulties due to differing national policies, norms and standards in the participant countries, as well as problems of choosing a research site which often had necessarily to be in one country only; and difficulties due to the great complexity of international management. Sometimes these difficulties could be extremely severe, yet considerable hope could be drawn—and not only for the future of scientific and technical collaboration—from the "INTOR" (International Torus) fusion research project under the auspices of the International Atomic Energy Agency in Vienna, which had recently produced a design for a new large "Tokamak" fusion machine.

Would that such co-operation should spread into other fields, even beyond technology! Would that all the countries of the world should work together for the furture benefit of all, rather than against one another and towards mutual disaster!

The third speaker in this afternoon's session was Professor Gunnar Hambraeus, Chairman of the Royal Swedish Academy of Engineering Sciences in Stockholm. After describing recent technological development in some of the more traditional fields of European industry (raw materials, energy, food production and processing, distribution, and transport), Professor Hambraeus turned to what he described as "our greatest difficulty in many cases", namely societal inertia or the inbuilt resistance to change. "People are reluctant to change habits" he said, "or to learn anew, to move to new locations and to acquire new working habits. They resist changes in production methods, in product and distribution patterns. They stick to old tranditional tools in their work."

Not all of this inertia, asserted the Professor, was psychological: such was tied to capital and market investments, research and development that had been expensive and must now be exploited to the limit, and the education of those both already within and just entering an industry. Declining economic activity, such as much of the world was currently experiencing, also encouraged inertia. Nevertheless most people recognise that change was largely inevitable, and has only to look to those countries where it was already being exploited to see that, in the end, it paid good dividends.

Professor Hambraeus drew attention to the considerable and increasing inbalance between

demand and supply of young qualified scientific and technical personnel, gently chiding those who found it "much easier to go into social science, the humanities or languages". This is certainly a dilemma in a democratic society, which is supposed to guarantee liberty to pursue any career chosen (though without guarantee of a paying job in that career).

What may sometimes cause greater distress is seeing brilliant brains turning in an unproductive (even in the most liberal interpretation of the word) direction because the exact sciences are passing through an "unfashionable period". Perhaps, as was suggested in subsequent discussion, education might be extended somewhat so that all technologists could have some training in "liberal" subjects, and vice versa.

Concerning the problems of unemployment, which are beginning (at last) to feature quite prominently in symposia such as the present one, Professor Hambraeus hoped to see an end to the idea that fixed and regular working hours were to be championed, whatever variations might occur in work to be done. This was acceptable in the past, but changing circumstances now could make it a very inefficient approach.

This very full first day's work of the MANTECH Sympsoium concluded with a nostalgic look into the past, by Sir Peter Gadsden, formerly Lord Mayor of London and now President of the Ironbridge Gorge Museum Development Trust. Sir Peter gave a fascinating account of some of the monuments in his museum to the past prowess of British engineering. If there were lessons to be learnt here for the present day, they were perhaps that the first Industrial Revolution was due to co-operation between all sorts and levels of devoted workers, working together because they believed in what they were doing. And because success (like peace) was indivisible.

THIRD SESSION
ADVANCED TECHNOLOGY IN NORTH AMERICA

27 April, 1983

The third session of the London "MANTECH" symposium was chaired by Sir Robert Clayton, Technical Director of the (British) General Electric Company and a former Vice-President of the Fellowship of Engineering. Despite its title, the session was in fact devoted to the state and effects of advanced technology in the U.S.A.

It began with a paper from Professor Herman Feshbach, Professor of Physics at the Massachusetts Institute of Technology and current President of the American Academy of Arts and Sciences, who had no difficulty in convincing his audience that advanced technology in his country was more widespread and more widely used even in "trivial" applications (e.g. "Star Wars" types of electronic games) than anywhere else on earth. Several thousand "Home computers" were in use, plus some thousands more in schools, while in higher institutes of learning such as MIT, first-year students were expected to be, and were, familiar with computing systems and programming methods.

Computerised automation in industry was becoming commonplace, and the pace and scope of its applications were increasing all the time. Throughout science new developments were constantly making obsolete yesterday's novelties, and this had led to the first problem mentioned by Dr. Feshbach.

No undertaking or organisation could afford to be updating its systems every day, and the more complex the systems, the longer was needed to amortise sufficiently their costs. When in addition staff re-training was necessary, there was inbuilt incentive to delay changes to at least some degree.

A second effect of the greatly increased use of advanced and especially computer-based automation (including robotics) was that the production of goods now required so few work-people that 3% of the labour force was permanently producing surpluses. At the same time the phenomenal expansion of the "information industry" had led to its employing 46% of the total workforce.

In face of this it was not surprising that a substantial part of the population felt itself in the grip of permanent uncertainty, threatened by changes which were rarely understood and were certainly out of the control of those principally affected. The resulting resentment (of "the system" and of the "experts"—the scientists and engineers—who had brought it into being) was apparent in the attitudes of labour unions and of the people themselves, and the social costs were high and rising. Nevertheless there was little concerted resistance to the new technologies: they had arrived and could not be turned away.

In the all-important field of employment, there was very little remaining demand for "unskilled" labour, and even some "skilled" categories were uncertain of their future. On the other hand, computer programmers and related personnel were much sought after, and new uses for data storage and data processing systems were continually being found. "Information" had become a resource, to be collected, conserved, improved, then bought and sold (or stolen) like any other commodity. Laws now governed its trading, and much industrial information was subject to secrecy, leading sometimes to conflict over rights of protection, communication and diffusion.

One consequence of these developments, of which Professor Feshbach was somewhat critical, was the increased use of automatically collected and processed information to consolidate the control of enterprises by centralised leadership, often a leadership (by lawyers, financiers and other "non-technicians") unable due to ignorance to exploit fully or efficiently the system in their hands. For example, computer systems could be used for modelling and forecasting, and programs for these purposes could be bought, but their successful use often required understanding of statistical mathematics which the users did not possess. No computer system could give a "good" answer unless it had been asked the right question, and Professor Feshbach ended with the ell-known dictum: "Computers are useless—they only give answers."

The next speaker was Dr. Robert A. Frosch, Vice-President of General Motors Corporation and Director of the GM Research Laboratories. Although his paper had been prepared (one may assume) without direct collaboration from Professor Feshbach, he was quick to take up and further emphasise the latter's final remarks about centralised direction, by legal and financial leadership, of incompletely understood technological

operations by incompletely understood technological methods. These remarks were not the only ones suggesting that those without some form of technological training were automatically at a disadvantage in using "the tools" provided by scientists and engineers: in subsequent discussion it was suggested that, while a technologist could usually apply the disciplines of his profession to resolve administrative, social or other non-exact problems in a satisfactory manner, it was rare for anyone trained only in the liberal arts to be able to resolve scientifice problems.

Dr. Frosch was, in fact, in a gauntlet-throwing mood and his paper contained a number of challenges to a society which, though more and more technologically based, still prefers to keep the scientist or engineer "on tap but not on top", and thus not permitted to hold the reins of administration.

Few administrators had yet fully grasped the significance of developing communications and computer-based society, said the speaker: even less was it appreciated that "unskilled labour"—now comprising a major part of the unemployed—would probably never find new "unskilled work" to do. Thus a stratified soceity was in the making, with widening gaps between the strata, and although the administrators and politicians of government were constantly being told of this by their technological advisers, they showed no sign of awareness that a real probelm was developing.

Turning to another subject, Dr. Frosch considered the somewhat stratling proposition—at least to some of his listeners—that robots could be conceived which could design and construct machines for the construction of more robots. Already in Japan there was a factory where such a process was operating with only two human beings in charge: one in the control-room and one carrying out maintenance. If self-reproducing robots could be made, then they could be of great help in the exploration of planets beyond our earth. The spectre this concept raises of an ultimate "Sorcerer's Apprentice" situation, even on our own planet, might perhaps be the subject of further discussion at a later DISCOVERIES symposium.

Discussion immediately following this paper, however, remained more earth-bound, and was largely concentrated on the problems of communication between technologists and those ignorant of the scientific method in either experiment or the transfer of information. There was general agreement that politicians are perhaps more difficult in this respect than any others (although there are occasional exceptions), and it was left to Professor Hambraeus of Sweden to suggest that the technologist could also, on occasion, be naive in communicating with the politician. Dr. Frosch did not disagree. However, in a further contribution to this discussion, Dr. Harold Chestnut, of the (American) General Electric Company, suggested that politicians were not always as uninformed as migh appear. Sometimes they understood the technologist very well, but did not act on his advice since, for them, his propositions had low priorities compared with their own.

The next paper was by Professor Ithiel de Sola Pool who, like Professor Feshbach came from the Massachusetts Institute of Technology. Turning immediately to the impact of computers on society, he believed this would prove greatest in the case of "intermediary" instituttions—those between the originators of good or services and their ultimate consumers. Such institutions were concerned with storage, transport, packaging and other "instermediate" operations.—they included banks, whole—salers, shipppers, and retailers. In thie intellectual field they compresed libraries, publishers and broadcasters. In all these areas, they arrival of computer-based "global electronic communication", whereby the ultimate consumer, or customer, could acquire what he needed directly from the original producer simply by "ordering" through his own electronic information link, would make the intermediary more or less reduandant.

This might not be particularly serious in the case of "nonintellectual" intermediaries such as shops etc., but Professor Pool was concerned that the invaluable services of filtration, preliminary assessment, and elimination of clearly unwanted material, which are normally provided by libraries, bookshops and even publishers, should not suffer and perhaps disappear. He saw their traditional functions being replaced by direct information retrieval, videotex, or other similar systems — these systems in fact becoming the new "intermediaries".

All this could unfortunately lead to elimination of the already frail "human links" between consumers of information and its providers (each

operating only through machines and remote computer terminals), and Professor Pool speculated on the consequences of such isolation. "How the computer will ultimately shape our thinking", he concluded, "I do not know – What was originally thought of as a mathematical machine to solve big set of equations is now a very different thing: it is a word processor, a graphics display device, a game-player that answers back to the human."

It was comforting that the Professor did not consider it (at least as yet) to be a trans-Descartean super-brain.

The next paper (if such description can apply to a commentary on a series of colour slides) was by Dr. Roger Levien of the Xerox Corporation. In a comparatively short but most interesting presentation, he traced the history of "Information Technology" from the earliest use of language, through communication by written signs and drawings, to the development of printing, the invention of electrical devices such as the telegraph, telephone (and gramaphone), radio and television, and thence to today's electronic "question-and-answer" systems. These last, he said, gave everyone* a "personal window on the world". As a result he foresaw great "democratisation", information specialisation (or diversification) at the will of the "consumer", and individual control by each consumer of his information supply. Although he also saw the risk of cutting human links and contacts (c.f. previous speaker Professor Pool) he was convinced that in fact the human being, as long as he remained in charge of his destiny and his machines, would not permit this to happen.

The final speaker in this session was Professor Harold W. Lawson, Head of the Computer Architecture Laboratory at Linkoping University, Sweden. His paper, "Some Consequences of Tomorrow's Electronics Computer Aided Design Systems" (CAD) was substantially more esoteric than any others in this session, and its subject was certainly not confined to the North American scene. However the Professor does come from the United States.

Broadly, the paper dealt with the automatic production of computer hardware (processors, memories, communication units or even entire systems) in what he termed silicon foundries, production facilities where complete digital computers (in miniscule form) could be only parts of a large capacity system produced, perhaps, even with "inbuilt" algorithmic programs. Computer Aided Design systems for these purposes are currently being developed in several parts of the world, particularly the U.S.A. and Japan.

Professor Lawson's paper dealt in some detail with the principles behind CAD systems, which can provide ways of optimising the series and parallel performance of system operations in the micro-hardware. It was unquestionable, he believed, that availability of the Tomorrow's CAD Systems of his title would be a dominating factor in the competitive race to provide tomorrow's electronic components and systems. He considered various concepts of "design by analogy": personal analogy, direct analogy, symbolic analogy and fantasy analogy, all of which have fortunately been defined in the literature.** The Professor then examined and explained abstraction philosophies and strategies for use with CAD systems, together with the forms of logic involved, some of which he illustrated by a "home-made" type of ideographic diagram.

While this paper was undoubtedly fascinating for other electronic information specialists, for whom it certainly represented a cultural if not a social challenge, that challenge appeared to be presented more to the already initiated than to the scientist or engineer concerned with social and cultural repercussions of the rather speculative technologies described.

*who possessed the necessary apparatus.

**e.g.: Gordon W.J.J. Synectics, Harper and Row, 1961.

FORTH SESSION
TECHNOLOGY AND CULTURES IN DEVELOPING COUNTRIES

27 April, 1983

Develpoing countries may be so-called at virtually any stage of their development (indeed it might be argued that development is a permanent process from which no country can be excluded). However, this session of the "MANTECH" Sympsium was concerned with countries where development, even today, is generally at a higher rate than in those more usually referred to as AICs (Advanced Industrial Countries).

The session began with an address by H.E. Sheikh Yamani, Minister of Petroleum and Mineral Resources in Saudi Arabia, who gave a most interesting account of the rapid rise of his country to "semi-industrial" status, and of the great investments in both money and effort which had brought this about. This was certainly a salutary exercise after the previous sessions devoted to technologies that were not simply modern but ultra-modern – or even, as in the last paper of the previous session, still to come.

Sheikh Yamani described in detail how Saudi Arabia, since the end of World War II, had installed a great amount of new industrial plant – much of course connected with the country's oil producing industry, and had at the same time pursued a programme of labour training in farmland creation and improvement by irrigation, fertilisation, and the use of plant protecting agents. Combined with high-fertility seeds, this had produced a significiant improvement in land productivity for a comparatively modest financial investment.

Other developing countries, said the Sheikh, were pursuing similar programmes, though not always with the same success, but the important message for MANTECH was that these countries' needs, while elementary in terms of today's technologies, were often desperate, involving such fundamentals as water an sanitation, elementary housing and heating, and at least some mechanised transport. Often the countries had great mineral or agricultural wealth, but could not exploit it for lack of capital investment. He recognised that Saudi Arabia had achieved her great advances because in fact she had been able to exploit her oil – the cheapest still-abundant source in the world. "Under a free trade system" he said, "this should be utilised for furthering world trade efficiencies, based on the principle of efficient allocation." "Our oil policy in Saudi Arabia", he continued, "is geared to further this principle and the principle that the best means of securing a steady flow of imports is through a steady rise in exports on a competitive basis". This Saudi Arabia has certainly done, in many cases despite artificial tax barriers applied to reduce customer demand for oil. If Sheikh Yamani was somewhat critical of these barriers, it may not be inappropriate to examine their origins.

The next speaker was Dr. Surendra J. Patel, Director of the Technology Division of the United Nations Conference on Trade and Development (UNCTAD), who presented the cases of some developing countries perhaps less successful than Saudi Arabia. Historically, he said, what are today referred to as North-South relations, with the understanding of aid flows from the former to the latter, had been flows in the opposite direction, and many developing countries were now looking to the industrialised north which had long traditions of successful trading relations with them. Although much of the "Third World" was experiencing severe difficulties, over recent years some countries had succeeded in raising considerable investment capital and had now achieved financial stability and a sound trading position. Thus the Third World was gradually achieving its rightful place alongside its hitherto – dominant neighbours of "the north". Most of this change was due to the acquisition of modern technology, sometimes at great cost, by purchase or through learning under "feudal conditions". "I would like to dream", said Dr. Patel, of technology as a common heritage of man, available for the service of all men everywhere." And although this remark prompted a rejoinder from the floor asking whether the speaker would like to see, for example, the world's oil resources similarly treated, there was no doubt that he had put before his audience a statement and a plea which merited more than passing attention. This was not the first time that a representative of the Third world had brought a DISCOVERIES meeting back from technological fantasies to the realities of millions suffering from malnutrition or worse, in countries where "those who could, went: those who could not, starved at home" – and that applied particularly to scientists and engineers.

The next contribution was from Mr. Barry M. Grime, Director of English Clays Lovering Pochin

& Company, whose paper "The Potential for National Resources with Reference to International Trade" comprised a masterly guide to using resources of energy, minerals, certain other products and – a resource not always regarded as such – people. However the people mainly referred to were not the large potential workforces, but rather, at least in the developing countries, those exeptional few described at the end of the previous paragraph.

Mr. Grime's paper was largely a record of personal experience, and experience that had proved successful for all concerned. For that reason alone its study is to be recommended. But it was also noteworthy for restating a concept, by no means new and in fact as old as the earth itself: it was encouraging for those to whom DISCOVERIES means concrete efforts towards a better, united world community, to find in this paper's second paragraph the expression "Spaceship World".

The last paper in this session was from professor Brian May, Dean of the Faculty of Agricultural Engineering, Food Production and Rural Land Use at the Cranfield Institute of Technology. Entitled "Effective Application of Agricultural Technologies in Developing Countries", his paper was perhaps the most practically-orientated of the entire symposium towards helping people in the field to improve crop yields and animal production, and helping research and development institutions towards greater support for such field activities. Like Mr. Grime before him, Professor May spoke from personal experience of the problems and difficulties he had himself been attacking; it was noteworthy that, although as he said "Agriculture is comparatively a very modest user of commerical energy", he continued "if it should come to allocating scarce energy supplies then agriculture must have one of the highest priorities".

That is the practical answer to those who deny a connection between energy and efficient agriculture. The world's population is increasing at an almost frightening rate, and food production has to increase in step simply to maintain present nutritional levels. Many would consider this not just "one of the highest priorities", but perhaps the highest priority of all.

FIFTH SESSION
SOCIAL ASPECTS OF TECHNOLOGY IN SOUTH-EAST ASIA AND JAPAN 28 April, 1983

The fifth session of the London "MANTECH" Symposium was devoted to relationships between advanced technology and social culture in the Far East. In view of the particular importance of technology in modern Japan (as well as the Honda Foundation being a Japanese organisation) it is not surprising that six of the seven speakers were from that country, the seventh coming from Malaya.

The first paper, entitled "Technological Society and Cultural Friction" was presented by Dr. Shinroku Saito, Professor Emeritus at the Tokyo Institute of Technology and, inter alia, Chairman of Japan's National Space-Shuttle Utilisation Committee.

Professor Saito began by tracing the progress of technology from man's earliest realisation of the value of tools (marking one of his first differences from other animals), through the taming of fire and the use of other natural elements (wind and water) as sources of power, in parallel with superstition, fear, and the development of religion – all contributing to the gradual evolution of communication by signs, speech and then the written word, and to the assembly of skills for thinking, predicting and planning future actions on the basis of past experience. This was how cultures began to take shape, and initially there was no serious friction between one evolutionary trend and another. But in fact different cultures were evolving differently in different places, and it was when one came into contact with another that fricition became inevitable. "Always" said Professor Saito, "there is resistance to the alien culture which invades the blank portions of the home culture".

In any such environment, he continued, science itself was selfless (and neutral). Science was nevertheless the basis of technology, and because technology could be part of an alien culture, the spread of its effects through society made friction inescapable. Conclusion: disquiet concerning new technology was to be expected and should cause no surprise. Yet man's adaptive capcity, which has enabled him to absorb many previous cultural shocks, should surely guarantee surival even through the information and communications revolutions now under way.

Professor Saito's encouraging conclusion was followed by a no less encouraging account, from theVice-Chancellor of the University of Malaya, Professor Ungku Aziz, of how changing employment patterns in his country were affecting the attitudes and conditions of young people – in this particular case, young girls from peasant country homes. His paper in fact was mainly a report on an experiment, conducted by his University, to follow the lives over a number of years of young girls who had allowed themselves to be persuaded to leave the normal life of peasant parents' homes for the brighter "city light".

Most such girls in Malaya were recruited, at ages between sixteen and twenty-five, to work in the new "high technology factories" which were springing up in the industrial areas of the country. Some (the comparatively small fraction having sufficient initial funds) were able to enter university where a suitable initial qualification earned them a state grant. On graduation they could easily find employment offering salaries as high as ten times those of their parents, giving them the entree to a growing stratum of young elites. Professor Aziz reported on his project with understandable satisfaction: it bore witness to the creation of a completely new body of highly-skilled factory workers and junior executives, urgently needed and vital for the future well-being of Malaya.

The next speaker was Professor Shuhei Aida, Professor of Systems Science at the University of Electro-Communications in Tokyo and a Director of the Honda Foundation. He emphasised that, of all the possible and extremely important impacts of advancing technologies, those related to information processing and communication were the most likely to affect cultural (intellect-based) activities, while such developments as factory automation and even robotisation would have their most immediate effects on the social framework of life, notably the balance between paid and other forms of employment. The Professor's principal interest was clearly in the former effects, and he outlined some of the most recent technical advances in information collection, processing and communication – particularly the spectacular reduction in physical volume and costs of equipment, combined with enhanced technical capacity and greatly increased rapidity of response to data input and output demands.

All these improved techniques, together with developing ability to place and maintain communications satellites in precise (geostationary) orbits round the Earth, would certainly increase the value

and uses of "information" (the raw material of communication) in the service of mankind.

It was here that the work of the Honda Foundation's DISCOVERIES programme could perhaps have its most important impact, in helping to ensure that the new technologies were used with humanity and human understanding. This was the basis of what Professor Aida had termed "ecotechnology". At least some of those in his audience might have called it compassion.

Next, Dr. Kazuhiko Atsumi, professor of Tokyo University, spoke. He is the director of the Medical Electronics Research Institute and a pioneer of the medical information system in Japan.

Even though the demand for medical care has been increasing sharply in recent years, medical care resources responding to this demand are limited. This has resulted in providing both developed and developing countries with serious problems. To cope with this state of affairs, the best solution would naturally be to effectively allocate the limited medical care resources to increase medical care effects. It is the purpose of the medical care information system to systemalize medical care by employing information and communication network techniques. Actually, ASEAN countries are short of medical care resources and are eagerly hoping that this medical care information system will be widely applied. This system need not necessarily to be a high grade system, the essence of up to date scientific technologies which can be seen in developed countries.

Considerable effects can be expected if a computer is installed at each principal medical care center in the various ASEAN countries and several units of micro computer are installed in each satellite hospital of these centers, with all of such facilities connected by a telephone network.

The development of software for the above system is an important issue reliant on the status of the medical care organizations, medical care needs or medical care resources of each country. This development should be supported by Japan.

In addition to the above, a re-utilization project for various medical care instrumens, which have been left to stand idle in hospitals and medical laboratories due to delays in catching up with the spearhead of development.

As background to Professor Atsumi's presentation one of his co-workers in the Tokyo University, Professor Toshiyuki Furukawa had prepared a short historical analysis of medical training in Japan from the start of the Meiji Era (1868) to the present day. This account was particularly interesting because it also covered the general development of scientific and technical training, and for those not very familiar with Japanese history over the past century, it offered a new insight into how that nation has achieved, far more rapidly than the other highly-developed nations of today, its own industrial revolution and associated scientific and technological expansion. The present report is not the place for detailed analysis: suffice it to remark that the key to all has been education, education moreover within a system which has given considerable attention to expected future demands in the various technological and other disciplines which together comprise a truly literate society.

That this "orientation" has not led to protests over infringement of liberty in choice of careers is a tribute to success in convincing young people that a scientific or engineering choice was best for them (cf. the comments of Professor Hambraeus on this matter in the second session). Professor Furukawa's paper also drew attention to the very high proportion in Japan – compared with other industrialised "Western" countries – of first-degree graduates in the applied sciences in relation to holders of degrees engaged in research. Japan had embarked on a carefully planned "mass production of B and C class scientists" to support the "development of class A scientific research".

Professor Reikichi Shirane, President of the Telecommunications Science Foundation in Tokyo, next contributed a speculative view of the "Advanced Communications Society" of the 21st century, still almost two decades away in time but – at least in Japan – already here in essence*. The Professor foresaw an almost universal use of personal computers not just individually but as active access terminals coupled to much larger systems with whcih the information flows would certainly be in both directions. The larger systems would provide for exchange, between anyone and everyone wishing it, of constantly updated and upgraded information in virtually every field of knowledge

*The author of the present notes, following his first visit to Japan many years ago, recalls describing it on his return to Europe as "the country where the future has already arrived"

and intellectual activity: they could also be used for the diffusion of administrative decisions and instructions, to help with understanding and meeting social criteria and community obligations, and for obtaining "instant measures" of public opinion on controversial (eg. political) questions. Moreover, Professior Shirane foresaw a plurality of information networks, avoiding that any one could have a monoploy of communication and so enabling users to escape what many regarded as a serious danger – the danger of controlled information leading to a controlled society. "However advanced the technological systems may be in the futrue" concluded the Professor, "most of the critical planning and defining of objectives, the collecting and editing of information, etc., will still depend on man. It may be said, therefore, that the highly advanced age will be an age in which man's intellectual faculties will play a decisive role." For anyone with doubts as to who or what was going to be in charge of the futrue, this was certainly most reassuring.

The session concluded with a fact-and figure-packed review, by Professor Toru Yoshimura of the Saitama University Graduate School for Policy Science, of the relationships between "Economic Growth and the Technological Revolution". This was no theoretical forecast of what might happen in the future (though it had its lessons for such exercises) but a factual record of what had happened, in Japan and eleswhere, and a list of questions to be answered concerning the future expansion of science and technology for the national benefit.

It is not possible to give here a full review of Professor Yoshimura's paper, for more than half comprised tables and graphs illustrating the evolution of Japanese expenditure on research and development during the past two decades; its comparison with equivalent evolution in other "major countries" (France, the German Federal Republic, the UK, US and USSR); the distribution of this expenditure, in Japan and the other countries, by sector (university, research institution, industry) and by type of work (basic research, applied research, development research); the relative shares of industry, government, research institutions and universities in funding these programmes in the various countries; and the numbers of workers (researchers, assistants, technicians etc.,) involved. All these data are of profound interest, and make the Professor's published text particularly worth seeking out for study**. Just two points may be noted immediately:

> Japan, where indigenous oil resources are virtually zero, has managed by rigorous price controls to maintain a real growth rate of more than 5% per year every year since 1976.
>
> In the five years from 1975 to 1979, Japan achieved a 42.8% increase in labour productivity in the manufacturing sector, whereas the increase in the same area was less than 1% in the US and England, and approximately 25% in Germany and France.

Naturally, such remarkable expansion has not been welcomed everywhere in the world. But it has certainly helped to focus world attention on the subject of "MANTECH" – the social and cultural challenge of modern technology. Although the right answers to this challenge are still barely perceived and uncertain, papers like Professor Yoshimura's contribute greatly towards asking the right questions.

This and the other papers of the session provoked considerably more discussion than in the previous session, partly due to the encouragement and tolerance of the Chairman, Loard Sherfield, who inter alia is Chairman of the British Parliamentary (House of Lords) Select Committee on Science and Technology. The most commonly raised subjects were mainly concerned with technical training, and there seemed to be general agreement that Japan had been more successful than most other countries (all other "advanced" countries") in pursuading a large portion of her youth to seek technical instruction. This suggested that these young people had greater confidence than the youth of the more elderly technological nations in the benefits that advanced technologies had to offer. Here, perhaps, is a field for much more profound enquiry, which might well hold the key to revising the common tendency, among many sectors of "Western" society, to regard science and technology as "dirty" and even immoral, while thinking beautiful thoughts on the way to disaster was entirely commendable.

**The same data are doubtless available, and in much greater detail, in many of the admirable though voluminous publications of such international boides as the OECD, World Bank and others. But Professor Yoshimura's paper has the advantage of comprising only 20 pages (14 being tables or graphs) and can thus be read even by the very busy people who could most profit form it.

CONCLUDING SESSION AND CLOSING CEREMONY

28 April, 1983

The work of the "MANTECH" Symposium was concluded by a general discussion, led by a panel chaired by the Viscount Caldecote and comprising Sir Francis Tombs, Vice President of the Fellowship of Engineering, and earlier speakers Professors Aida (Japan), Frosch (USA) and Hambraeus (Sweden).

Sir Francis Tombs opened the proceedings with a comprehensive review of the questions raised and answers suggested in the five previous session. Recalling that modern technology, besides offering new opportunities for improving the lot of mankind could also have bad effects if used incautiously, Sir Francis listed what some of these disadvantages might be: pollution (although nature herself was a great polluter and technology could alleviate some of these effects); social disruption and the weakening of traditional authority (of parents, tribal chiefs, parliaments or witch-doctors); aiding the growth of power and domination in the hands of small elitist groups (some believed this was possible the most severe long-term danger); increasing "Social gaps" between rich and poor (though there were many examples of the opposite effect); increasing societal vulnerability if large all-embracing systems should break down; and increasing unemployment (in the traditional sense of no paid work leading if uncompensated to comparative poverty).

Some of these undesirable effects, said Sir Francis, could be minimised and possibly avoided by a greater general acceptance of change, change which was often resisted for no reason other than traditional conservatism (fear of the unkown is more powerful than suspicion of the known). Rate of change was a most important factor here (although Professor Furukawa's paper had demonstrated how careful preparation and "pre-training" could increase substantially the acceptable rate).

Like most other participants in the symposium, Sir Francis had noticed a widespread and persistent feeling among scientists and technologists that non-technologists were illiterate, a criticism which provoked the non-technologist to retaliate by accusing his scientific critic of being incapable of a humane conceptual approach to his work. This was an underlying dilemma of modern society, and its resolution clearly needed each side in the controversy to increase its knowledge of the other's expertise. In the words of one of the participants in the 1977 DISCOVERIES Symposium in Rome (Professor Barrington Nevitt of Toronto University), "Engineers should be encouraged to become poets, and poets to become engineers". Or at least, concluded Sir Francis, engineers should learn to read poetry*.

Professor Aida followed by formulating what might be considered the practical interpretation of Professor Nevitt's appeal: "How can we better apply Dr. Soichiro Honda's engineering spirit to the construction of a better world?" The answer was by developing ecotechnology, the technology which linked man with his science and engineering. Information and communications technology were particularly able to contribute to this new branch of knowledge and progress: the computer had already shown itself capable of contributing far more to society than society had devoted to its creation. Other comparatively recent developments, notably biotechnology, also clearly had important contributions to make, but as always could be used for the benefit or for the disadvantage – even the eradication – of mankind as now understood**.

Professor Frosch, reminding the meeting that it was 200 years since the death of Adam Smith, 100 since the death of Karl Marx and only 30 since the death of J.M. Keynes, believed there was still much scope for new social experiment, designed to encourage an educated public to ponder the questions of the future and declare their wishes as to how it should – if possible – evolve. The Professor had great faith in encouraging "users" to choose what they wanted: few could disagree, always provided the users were fully aware of the factors affecting, and likely consequences of, their choice.

Professor Hambraeus, agreeing with Dr. Frosch, observed that the only real difficulty facing advanced technology was people. It would be idea, he said, if there were none to deal with! Although a remark made with tongue in cheek, there is no

*Those who have regularly done this throughout their lives can vouch for its remarkable inspiration, as for that of great music and visual art – although the scientific basis for such an effect remains for the present hidden in the clouds of speculation. Incidentally, it is rare for poets to be advised to study, for example, the infinitesimal calculus, or the pure and beautiful rationality behind, say the laws of thermodynamics.

**This oblique reference was the nearest the sympsoum came to the subject of genetic engineering, a subject which had featured prominently in some of the previous DISCOVERIES meetings. Could this have been because engineers (the majority of the participants) having their feet traditionally and firmly on the ground, were unmoved by over-enthusiastic – or pessimistic – speculation, and convinced that as genetic technology develped so would the ability to avoid its more "dangerous" applications.

doubt that this summarised, in a most penetrating manner, the entire question of what was mankind's destiny and how he could best fulfil it. Clearly many traditional ideas were no longer as valid as in the past, particularly concerning the "dignity" of hard manual labour, even of manual work in any form. Professor Hambraeus hoped soon to see employment separated from its present direct relationship with wages and salaries (see his remarks in presenting his second session paper).

The discussion was then opened to the floor and immediately produced more comment on the dilemma of finding employment in a world of over-production in many fields. Professor de Sola Pool remarked that, as a Social Scientist, he was optimistic that a way out of this dilemma would be found. Because society was very much slower to advance than was technology, the immediate question was how the changing technological environment might be adapted (temporarily) to long-established social habits and practices, with the later objective of inverting the process and adapting those habits and practices to more advanced technology. Desirable certainly, but more than one participant felt this suggested an unending pursuit of a moving target – a cogent description, perhaps, of life?

Among many other interventions in a truly rich exchange of thoughts and ideas, several speakers called for the greater application of "scientific method" to resolving social problems, while more than a few were unconvinced that this could yield any spectacular advances. It was left to Dr. Fred Margulies, of the International Federation of Automatic Control (IFAC) in Vienna – a social scientist who had taken part in all previous DISCOVERIES symposia, to remind his colleagues that they had been discussing "MAN-TECH", and to plead that man's interests should always take priority over what might be called "machine urgencies". For most of the race of man, which would certainly be profoundly affected by the advanced technology of the discussion, had so far been excluded from the debate. It was, said Dr. Margulies, like the custom of doctors; consulting with one another about the fate of a patient, to place themselves well outside the patient's earshot.

Finally a quiet, profound and deeply humane comment from Professor Eduardo Caianiello – who had also been with the DISCOVERIES Project since its inception and had been Organising Chairman of the Rome Symposium in 1977 – brought the discussion and the meeting near to its close.

Professor Caianiello reminded all present that they were acting within and debating about a system of which all were parts, and therefore, according to Godel, their judgments could not be definitive or certain. Accident, he recalled, had played a considerable role in past history and in current developments, and certainly the future would not proceed without more. No one should therefore believe that the future could be precisely (or in some fields even imprecisely) predicted, nor that beautifully constructed plans would necessarily materialise as foreseen. Mankind was not lord and master of all destiny, although he could certainly influence his own ever more profoundly as his scientific and technical knowledge advanced.

The floor was finally taken by the Vice President of the Honda Foundation, Mr. Hiromori Kawashima, whose task was to thank all participants, the Fellowship of Engineering and especially the Senior Fellow, and all others who had contributed to the London Symposium.

And a final thought for participants – about education, communication and understanding whether by use of sophisticated electronic systems or simply in personal conversation:

> Grieve not when you are not understood by another, but grieve when you do not understand him.

A fitting reflection to carry away as Lord Caldecote formally brought "MANTECH" to a close.

"Negentroypy"

Seek not to halt the onward, upward thrust
Of man's enquiring mind on nature's track
Hoping to ease an overburdened back
Before – like those before – he turns to dust.

Seek not to block invention's lively mind
With fear of consequences unforeseen
Remember what may come will soon have been
Surpassed by wonders we have yet to find.

Look not ahead with blurred myopia
Fearing to seek, and find, a better view –
New understanding leads to order new
Created in a New Utopia.

by Bruce M. Adkins
London
April 1983

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