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「シナジェティックス：自然と人類における協同と自己組織化について」

シュツッツガルト大学教授　ヘルマン・ハーケン

Dr. Hermann Haken

Dr. Haken, as an initiator of “Synergetics”, has theoretically clarified the complicated mechanism of the order formation of systems and transversely applied its results to comprehensive scientific fields including not to only natural science but also engineering、 medicine, and social science, extending great benefits over these and many other research fields.

Personal History

1927	Born in Leipzig, Germany
1946～48	Study of mathematics and physics at the University of Halle
1948～50	Study of mathematics and physics at the University of Erlangen
1951	Ph.D. in mathematics, University of Erlange (group theory)
1959～60	Visiting Associate Professor, Cornell Uninersity
1960	Professor of theoretical physics, University of Stuttgart
1961	Visiting Professor, Research Institute for Fundamental Physics, Yukawa Hall, Kyoto, Japan
1961～62	Consultant to Bell Telephone Labs
1964～69	Consultant to Laboratoire Telecommunications (ITT), Paris
1970～76	Member of the Scientific board of the Max-Planck-Institute for Solid State Physics, Stuttgart
1973～76	Director of the Quantum Optics Division of the German Physical Society Consultant with the German Sciences Foundation
1972～78	Member of the IUPAP Commission of Statistical Physics

In addition, Dr. Haken has received Max Born Prize and Medal from the British Institute of Physics and the German Physical Society, Max Planck Medal from the German Physical Society and so on. He also has been internationally appointed as members of the academy of science for Synergetics in various countries including Eastern Europe.

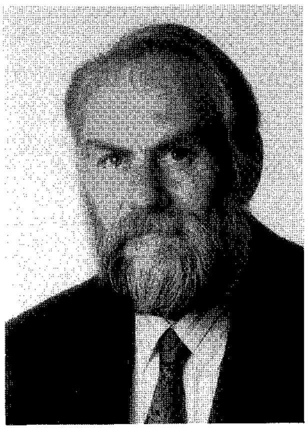
ハーケン教授の受賞は、氏がシナジェティックスの創始者として、複雑なシステムの秩序形成の仕組みを理論的に解明し、これを自然科学のみならず工学、医学、社会科学などの諸分野に広く学際的に適用して、多くの学問領域に多大な影響を及ぼされたことによるものです。

●略歴

1927	ドイツ、ライプチヒ生まれ
1946～48	ハレ大学で数学と物理学を専攻
1948～50	エアランゲン大学で数学と物理学を専攻
1951	エアランゲン大学で数学博士号を修める（グループ理論）
1959～60	コーネル大学客員準教授
1960	シュツッツガルト大学理論物理学教授
1961	京都、湯川記念館、基礎物理学研究所客員教授
1961～62	ベル電話研究所顧問
1964～69	パリ、遠隔通信研究所（ITT）顧問
1970～76	シュツッツガルト、ソリッドステート物理学のマックス・プランク研究所科学委員会メンバー
1973～76	ドイツ物理学会量子光学部部長 ドイツ科学財団顧問
1972～78	統計物理学IUPAP 委員会メンバー

その他、英国物理学会及びドイツ物理学会MAX BORN賞、ドイツ物理学会MAX PLANCKメダル等を受賞。国際的にも東欧圏も含めた各国でシナジェティックスに関わる学会等の会員として名を連ねる。

Synergetics : on the Cooperation and Self-organization in Nature and Humanity



Prof. Dr. Hermann Haken,
Professor, University of Stuttgart

Acceptance speech delivered at Tokyo, Japan on Novermber 17, 1992,
on the occasion of the award of the Honda Prize

The award of the world-wide highly esteemed Honda prize represents a very great honour for me. It is a great pleasure for me to be here in Japan and to have the wonderful opportunity of meeting a number of my old Japanese friends, of whom I wish to mention in particular Prof. Ryogo Kubo. I got acquainted with Prof. Kubo nearly forty years ago at the international semiconductor conference in Garmisch-Partenkirchen in Germany. He explained to me his new results which were soon to become known as the famous Kubo formula. The first time I visited Japan was in 1961 when on the invitation of the famous Prof. Hideki Yukawa. I spent several months at his renowned institute in Kyoto. Since that time I have been deeply impressed with Japanese culture and its rapidly developing science and technology、and I always felt very happy when I had the opportunity to visit Japan.

The field of synergetics, which will be the main topic of my talk today, grew out of laser theory. So please allow me to remind you of some of its salient features. The construction of the laser had been proposed by several scientists, in particular by Schawlow and Townes, Shimoda in Japan was one of the first who gave important contributions to the physics of masers and lasers.

In the following I will try to illustrate my own approach to this problem. Let us consider a gas laser. In this case the laser consists of a glass tube filled with atoms of a gas. At the end faces two mirrors are mounted. They serve the purpose to reflect light that runs in axial direction very often so that this kind of light can interact with the atoms for an extended period of time. Leaving all complications aside, we may say that the individual atoms are excited by an electric current sent through the gas. The higher the electric current, the higher the number of excited atoms. Now consider what happens in a lamp and what happens in a laser. To this end let us consider the individual atoms more closely. As we know, an atom consists of an atomic nucleus which is surrounded by one or several electrons running around it. For our purpose it is sufficient to consider a single electron. Once an electron of an atom is hit by an electron of the electric current, it may be energetically excited and after that excitation it may give away its energy to the light field, i.e. to say, it emits a light wave. This event may be compared as if we are throwing a pebble into water, where the water gets excited and a water wave emerges. In a lamp, the individual excited electrons emit their corresponding waves quite independently from each other. It is as if we are throwing a handful of pebbles into water. A wildly excited water surface will emerge, or in the case of light, microscopically chaotic light is generated. In the laser quite a different phenomenon occurs. A beautifully ordered wave emerges instead of the microscopically chaotic light. This phenomenon can be understood only if we assume that the atoms emit the light wave in a well-organized fashion, or, in other words, that the motion of the electrons is highly correlated. Quite surprisingly, however, there is no force acting from the outside on the laser which tells the electrons in the atoms how to behave in such an orderly fashion. In other words, the electrons find the highly ordered motion by themselves or, in other words, the laser atoms show the phenomenon of self-organization.

How is this achieved ? To this end we have to consider the processes of light emission from an excited electron more closely. As we know from quantum mechanics, an excited electron may spontaneously emit a light wave. Once such a light wave hits another excited electron, it may force that electron to give away its energy to the impinging light wave, whereby the impinging light wave is enchanced. This process is called " stimulated emission " . If many excited electrons are available, quite evidently a light avalanche will occur with ever increasing amplitude.

Now we have to observe that there are different light waves which can be emitted, namely light waves may differ by their wave lengths (or frequencies) . As it turns out, the avalanches belonging to different light waves may grow more or les rapidly or may even decay, because in every case the light waves escape, eventually, through the mirrors. Between different waves a competition sets in ; they are competing for the energy stored in the excited electrons. In a way, some Darwinism occurs : the fittest light wave wins the competition and survives. The winning light wave will be called the order parameter. Since the electrons can provide this winning wave only with a limited energy supply, this light wave does not grow forever, but it saturates. Now a remarkable process occurs, which, as it will turn out, is at the heart of synergetic processes. Once this light wave, the order parameter, is established, it causes the electrons to move in a rhythm corresponding to its own rhythm, or, to use a technical word of synergetics, the order parameter enslaves the individual electrons. On the other hand, by their light emission the electrons support the existence of the order parameter all the time. In this way, on the one hand, the existence of the order parameter is made possible by the individual electrons, on the other hand, the individual electrons are determined in their motion by the order parameter. We are dealing with the phenomenon of circular causality.

What causes the difference between a lamp and a laser ? This difference lies in the rate at which the individual electrons of the atoms are excited. When they are excited at a small rate, only occasional light waves can be emitted and those have, practically, no chance of meeting another excited electron so that the process of stimulated emission cannot occur. However, when the number of excited electrons is sufficiently high, which is caused by a sufficiently high electric current sent through the laser device, suddenly laser action may set in.

Let us reformulate all these phenomena from a more abstract point of view. First we are starting with an old state, namely the state of a lamp. Then we change a so-called control parameter that represents the electric current sent through the gas. At a critical value of that control parameter, an instability sets in and a new state, namely that of the lasing state, evolves. Quite generally it turns out that a system may pruduce not only one but also several order parameters that enslave the subsystems.

What characterizes an order parameter and what characterizes the enslaved subsystems ? When we disturb the order parameter, in our case the light wave, it returns to its former state only slowly, whereas the perturbed subsystems return to the former states very quickly. In other words, the order parameters are slowly changing variables, whereas the subsystems are quickly changing variables. Because the order parameter determines the behavior of the individual parts, we need to know only the order parameters in order to know what the individual parts do. This leads quite obviously to an enormous information compression. In order to describe the motion of the individual electrons of the atoms in a lamp, we need a great amount of information. In the laser case, however, we know that the electrons behave in a well-defined fashion and we need to know only the information about the order parameter.

As the laser example has taught us, under different circumstances of its operation, laser light can be still more complicated. The corresponding order parameters may not only compete but they may coexist or cooperate. For instance, when we consider lasers with a still higher excitation rate, the formerly well-ordered coherent light wave may become unstable and may be replaced by ultrashort regular pulses. Under still other conditions, another type of order parameters occurs and generates what is nowadays called " deterministic chaos " . This highly irregular light emission is, however, quite different from that of a lamp exhibiting microscopic chaos. This example tells us a highly interesting feature of nonlinear open systems, such as the laser. Even if we change one or a few control parameters only slightly, the system may develop quite different kinds of behavior. This phenomenon may occur in many eco-technical systems.

Let us illustrate this qualitative change of behavior from a still other point of view which is based on the mathematical treatment. As we have seen in the lamp-laser transition, the behavior of the system is governed by that of the light field that wins the competition - the order parameter. This transition can be visualised as follows : We indetify the size of the order parameter with a variable q which denotes the position of a ball in hilly landscape. When the current sent through the laser or lamp is only weak, the landscape has only one valley. The order parameter has a stable resting state at zero, and only the spontaneous emission acts of electrons push it around so that it shows small fluctuations around its stability point. These fluctuations are quite random ; we are dealing here with the microscopic chaotic state of the lamp. When the electric current is enhanced, we reach a region where the bottom of the valley becomes very flat. In this case, the ball is pushed heavily around ; it shows the phenomenon of critical fluctuations. Because the bottom is very flat, the balls roll back to its equilibrium position only slowly. We are dealing with the phenomenon of critical slowing down. Finally, when the current through the laser is enhanced still more, the landscape is deformed still more and two valleys show up. A highly interesting phenomenon occurs, namely the system has now two available states, one at the bottom of the left valley, another one at the bottom of the right valley. Of course the system can choose only one of these two possibilities - but which one ? As it turns out, a small original microscopic fluctuation, namely the spontaneous emission of a light wave by a single electron, decides which course the system will take to build up its macroscopic order. In an unstable situation, microscopic events may give rise to macroscopic phenomena and decide the path the system takes. The study of the motion of a system from the middle peak to a valley under the impact of fluctuations is a difficult and important problem that has been solved by M. Suzuki.

So far I have been talking about a rather special physical system, the laser. It shows a remarkable transition from disorder to order. In physics and chemistry a number of phenomena of disorder-order transitions have been known since a long time. An example is provided by ferromagnets where the individual elementary magnets of iron above a certain temperature are entirely disordered but become ordered when the system is cooled below that critical temperature. Another example is superconductivity, where the irregular motion of the electrons in a conductor become highly correlated when the conductor is cooled below a critical temperature. These systems show also the effects I described above with respect to the laser, namely critical fluctuations, critical slowing down, and symmetry breaking. But there is a profound difference between a laser and the just mentioned systems. A laser works only if it is continuously fed by energy from the outside. Indeed, its ordered state is achieved only when the energy input is sufficiently high. On the other hand, in ferromagnets and superconductors the ordered state is generated in thermal equilibrium provided the substances are cooled down. While these systems undergo an equilibrium phase transition, the laser undergoes a nonequilibrium phase transition. As we know, phase transitions in thermal equilibrium are quite a common feature in nature. The question arose to me whether nonequilibrium phase transitions are a rare event or a rather common one. Some twenty years ago, this idea led me into synergetics.

I coined the term synergetics to characterize a field of research that did not exist at that time but that would hopefully emerge. In many fields of science, but also in technology, ecology, and the humanities, we deal with the following problem : We are dealing with systems that are composed of many individual parts that interact with each other. By means of their interaction, these parts may produce a total action on a macroscopic scale. More precisely speaking, spatial, temporal, or functional structures (or patterns) may be formed. In many cases, the total action is produced by the parts of the system by themselves and is not imposed on the system from the outside. In other words, we are dealing with self-organization. The question I asked at that time was : Are there general principles for self-organization irrespective of the nature of the subsystems ? This question may have sounded rather strange, because the subsystems I had in mind were as diverse as atoms, molecules, cells in biological organisms, animals in animal societies, or even people or groups in human society. As it has turned out, however, over the past twenty years this question could be answered in the positive for large classes of systems provided we pay a specific price. The price consists in looking for qualitative changes of systems on macroscopic scales. This is, of course, one of the most interesting features of such systems, namely that these systems show the emergence of new qualitites. For instance in the laser the highly ordered light wave is quite a new quality as compared with a microscopically chaotic light of a lamp.

Depending on the kind of problem, we have different mathematical approaches at our disposal that I will try to describe verbally. In a number of cases, in particular in physics and chemistry, we may start from basic equations in these fields. In them we may take care of the behavior of the individual parts of a system. Then, when a control parameter is changed, we may study the stability of the system. When the system becomes unstable, collective modes, the so-called order parameters, emerge and the original highly complicated equations may be reduced to, in general, few order parameter equations. They determine the evolving pattern and I will give a number of examples below. A second approach applies if we don't have a detailed information about the behavior of the individual parts. In this case, we may start from the idea of order parameters and may formulate order parameter equations directly.

Let me illustrate the first approach. A well-known example is that of a liquid layer in a circular vessel that is heated from below. When the temperature difference between the lower and the upper surface exceeds a critical value, suddenly a well-ordered motion of the fluid sets in, where, for instance, hexagonal patterns appear. In the middle of each hexagon the fluid arises, cools down at the upper surface and then sinks down at the borders of that hexagonal cell. More recently it was found experimentally that new patterns appear in the form of spirals when the border of the vessel is heated also. This transition is clearly shown by numerical calculations in my institute based on the order parameter concept. In the upper part of the picture no heating has yet occurred and we find the hexagonal pattern. When the heating of the circular wall is switched on, the hexagons are transformed into a stripe pattern which, eventually, forms a well-defined spiral pattern. Other applications refer to meteorology, where we treated models of the earth atmosphere. In our simplest model we assume that the sun heats the surface of the earth homogeneously and that the outer surface of the atmosphere is kept at a certain low temperature. The atmosphere is subjected to the gravitational field. In spite of the totally isotropic conditions, quite different structures may occur, e.g. static convection, where one part of the atmosphere shows a hot spot and the opposite part a cool spot. Under different conditions, the spots may start a rotation around the earth, or, under still different conditions, the convection, i.e. the upwhelling and downwhelling of the atmosphere becomes chaotic, where e.g. a hot stripe disappears, gives rise to a hot spot which lasts for a while, then suddenly disappears, a.s.o.. These models are, of course, rather artificial, but they already show some pertinent features of pattern formation in the atmosphere.

A more realistic example is provided by the so-called baroclinic instability, where the motion of the earth is taken into account. Our calculation then allows us to determine lines of equal pressure which have specific shapes strongly resembling those of familiar weather charts. It is interesting to note that even these complicated patterns are determined by only few order parameters, for instance four. Our concepts have been applied to the formation of macroscopic patterns in chemical reactions, to morphogenesis in biology, and other phenomena.

The laser helped us to formulate principles of synergetics. Now I wish to show how these principles allow us to construct another device, namely a computer for pattern recognition. Nowadays computers for pattern recognition are developed world-wide, where, in particular, new concepts, such as that of neural computers, are discussed and applied. In Japan these works have a long tradition. I just mention the names of Prof. Amari and Prof. Fukushima.

Here I wish to indicate the application of synergetics to the development of a computer for pattern recognition. My concept is based on three ingredients :

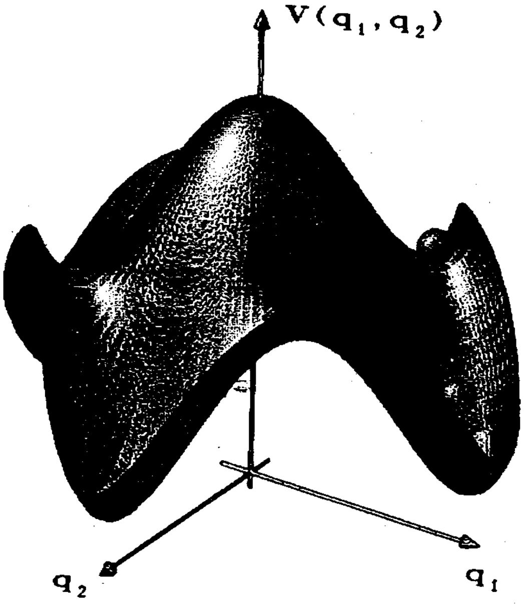
1. Pattern recognition is based on an associative memory. An example for such a memory is provided by a telephone dictionary. If we look up the name of a person, the dictionary tells us his telephone number. More generally speaking, an associative memory complements a set of incomplete data.

2. We assume that associative memory is realized by a dynamic process, where the patterns are described by order parameters and are moving in a potential landscape, where the different minima of the landscape correspond to different patterns.

3. The essential ingredient of our approach is the idea that pattern recognition is nothing but pattern formation. To this end consider the example of a fluid that is heated from below. When we prescribe an initially upwhelling stripe, then the fluid complements this pattern to a full pattern in form of an assembly of stripes. If the original stripe has a different orientation, the evolving full stripe pattern has the same orientation. Finally, when we have two upwhelling stripes, one somewhat larger than the other, a competition sets in. The somewhat stronger stripe wins and, eventually, a stripe pattern corresponding to that original stripe emerges. In the terms of synergetics, the following happens : The initially given patern generates its corresponding order parameter that competes with all other possible order parameters. That order parameter wins the competition and thus determines the evolving pattern. In pattern recognition the same happens : We present the system some specific features of a pattern. These features generate the order parameter which competes with all other order parameters belonging to different patterns. The one original order parameter wins the competition and generates all the other features belonging to that order parameter. I will not present here the mathematics, but rather I will present the individual steps. First we determine the basic prototype patterns, e.g. a set of faces (Fig. 1). These patterns can be either encoded in the com-

Fig. 1

Fig. 2



puter or they can be learnt by it. Then we construct a dynamics that may be described by a hilly landscape, where the valleys correspond to the stored prototype patterns (Fig. 2). If an incomplete or distorted pattern is offered, it is represented by a point uphill in that landscape. The dynamics is constructed in such a way that this point is pulled to its closest valley. Fig. 3 illustrates the recognition procedure. If part of a face is offered to the computer, it can reconstruct the whole face in the presence of all the stored prototype patterns, i.e. by a completely parallel process. With some slight modifications, the computer is able also to recognize scenes, e.g. in Fig. 4 it recognizes the lady in front first, then in the second run, a so-called "attention parameter" attached to the lady is put equal to zero, and then the computer can recognize the face in the rear. In this way, the computer was able to identify up to five faces in a scene.

Fig. 3

Fig. 4

Now I want to make a big jump to other fields, namely those occurring in sociology. Synergetics has unearthed the peculiar relationship between micro-systems and the evolving macro-systems, where the behavior of the system at the macro-level is determined by the order parameters which enslave the subsystems. When we try to apply these concepts to social systems, it appears that the word "enslavement" is too rigid and not adequate enough. Certainly we have still the influence of the order parameters on the individuals or subsystems, but in society this usually happens in a much softer way and it depends on the consensus of the individuals. This is why in the following I shall replace the word "enslavement" by "consensualisation". The essential feature of the relationship between the macro-level and the micro-level persists, however.

Let us now consider some typical examples for order parameters and for the parts of a system. As we remember, the order parameters are characterized by the feature that they change slowly as compared with the change of the individual parts of a system. Language is quite evidently an order parameter. It lives much longer than any individual of a nation. Once a baby is born, he or she is subjected to the language of his or her parents. The baby learns the language and then carries the language further. We here observe the same relationship between the order parameters and the individual parts as characterized by circular causality. Another example is provided by rituals and the individual obeying rituals. In our context, the meaning of a ritual is the marking of a consensus between people or the marking of the identity of a group. Other examples for order parameters are nations that are supported by their citizens, or law that, at least in a democratic country, is produced by its citizens. Another example for an order parameter is described by the climate in a company or by corporate identity. The climate of a company is formed by the individual members of a company who, in turn, are determined in their behavior by that climate. It is well-known that especially in western countries a discussion is going on in how far the great success of Japanese companies depends on their climate. Another and less serious example for an order parameter is fashion and in what way it determines the kind of dresses people wear.

There are far more serious examples for order parameters, however. For instance, scientific theories may be considered as order parameters, or as Thomas S. Kuhn called it, as paradigms. I refer to his book " The Nature of Scientific Revolutions " . Scientific theories are carried on by scientists and then the students are taught these theories. In that way they are, if one wishes to say, " enslaved " by theories or concepts. Another order parameter is the kind of economic system that determines the behavior of producers and consumers and in turn is determined by their behavior. It is worthwhile mentioning that prominent economic scientists as Samuelson already distinguished between slow and fast variables in economic processes. But, of course, they had no mathematical tools to formalize these concepts during their time.

In all these examples the order parameters seem to be rather rigid and one may wonder how one may change order parameters, e.g. the climate in a company, or an economic or political system. And what phenomena are accompanying that changes ? Synergetics has elucidated the mechanisms by which such changes may occur, and I refer here again to the laser paradigm. In all cases, where self-organization occurs, or is wanted to occur, we cannot directly determine the behavior of the individual parts. Rather we have to change unspecific control parameters. Let me demonstrate these ideas by a rather extreme example which can be nicely illustrated by means of the hilly landscape I have shown you before. How can one go from one economic system to another one ? First the landscape must be deformed, i.e. one has to destabilize the old system. This may be achieved, for instance, by loosening strict regulations, by allowing other kinds of monetary fluxes than before, a.s.o.. Then, eventually, a new system may evolve as characterized by new appearing minima. But there are several important features to be noted : one runs through a period of critical fluctuations and critical slowing down, a phenomena which is well observed in some economies at present, e.g. the former Soviet Union, and later on we have to expect the problem of symmetry breaking. I.e. according to the laws of synergetics, we must not expect that a destabilized system will automatically run into a specific new state. Quite often there are several possible new stable states, some being optimal, some being suboptimal, and small fluctuations, for instance the action of a small group of people, determine the course of the events.

The visualization of the behavior of a complex system by means of the movement of a ball in a hilly landscape may serve us also to discuss the relationship between stability and adaptability. When there is only one valley with deep slopes, the ball is in a very stable position. Any small pushes won't move it around appreciably. However, there may be situations where softer slopes are more desirable. Consider a landscape with two valleys, one being deeper than the other one, and let us assume that the deeper minimum represents the state of a system with a higher efficiency. If the system is originally in the upper minimum, it cannot jump spontaneously into the lower one unless it is driven there by fluctuations. This may serve as a metaphor for many complex systems including those in economy. We must allow systems to adapt by means of fluctuations and the possibility that these fluctuations may even grow up. This picture seems to me to be at the heart of creativity. We must be able to let our mind diffuse around so that it, eventually, can conceive entirely new ideas. In a number of cases it may be desirable to change the behavior of systems between stability and adaptability. Nature shows us how adaptability is obtained by means of her evolution. Here the fluctuations are represented by mutations which in a favorable environment can give rise to new species. The same relationship between stability or even rigidity on the one hand and evolution on the other hand may be found in the pair ecology and technology. For me there is not the slightest doubt that mankind needs technology to be able to cope with the needs which are coming up time and again and to keep mankind adaptable enough to cope with all the difficult problems. Quite evidently, we have to find a balance between ecology and technology, or, in other words again, between stability and adaptability. There is certainly not a simple recipe how to obtain that balance, rather we have to strive to that goal. Let me pick up her one important aspect : In a way, nature is our great teacher from whom we can learn important things. One is, quite evidently, the aspect of recycling. When we look, for instance, at a forest, trees grow, die and then are recycled in the soil to give food for new trees. Matter is preserved in all these cases. What is needed in addition is the energy provided by the sunlight to the trees and the information in their genetic code. Thus, quite evidently, we have to strive after the exploration of new energy sources and the use of more and more information or knowledge. In his studies, Ake Andersson in Sweden has quite clearly identified knowledge as one of the most important order parameters in economy. This is, quite obviously, a trend which has to be followed up. We have to replace material by information. Since our energy resources are limited, we have also to replace energy by information. This, quite naturally, leads to the requirement of higher and higher education, for adequate school systems, universities, industrial training, a.s.o.. I have always been impressed by the diligence with which Japanese children and students are educated and I feel that a good deal of the Japanese success in our times is based on this highly cultured tradition at all its levels.

Minimizing the exploitation of energy sources means that we have to increase the efficiency of processes. Again the laser provides us with a beautiful exmple : When it acquires its coherent operation, its efficiency rises dramatically. At a more abstract level, we may say that the ordering of the laser electrons is brought about by a sufficiently strong exchange of information. But there are profound differences between a laser atom and a human being. The difference lies not only in the complexity of humans but also in the ability to learn and to transfer their knowledge to further generations.

According to synergetics we may change a state of a self-organizing system by indirect means. These means may be quite subtle : even small changes of "control parameters" may induce dramatic changes of the whole system. They may lead to an improvement of the system, but even a slight change of a control parameter in the wrong direction may lead to serious difficulties. We are becoming aware of how fragile complex systems are. What can we do in such a situation ? First and above all we need a new consciousness, a new feeling of responsibility towards nature and humanity. I think, over the recent years considerable progress has been made in generating such a general consciousness. Based on the wise foresight by the late Soichiro Honda, the Honda Foundation has given lucid examples of how to improve the public attitude towards the relationship between ecology and technology. One of these examples is the organization of corresponding symposia. By bringing leading scientists, managers, engineers, journalists, politicians, and other interested people together to profound discussions, again and again new ideas emerge that produce more consensus, more coherence among people, where our highest goal must be the preservation of our planet earth.