EIRMA

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ASSOCIATION EUROPEENNE POUR L'ADMINISTRATION DE LA RECHERCHE INDUSTRIELLE

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EIRMA/84.36 August 1984

SPECIAL CONFERENCE

"TOWARDS A NEW TECHNOLOGICAL BASE FOR INDUSTRY IN THE '90s"

17th - 19th October, 1984

Montparnasse Park Hotel, Paris

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INTRODUCTORY NOTE

Industrial activity is subject to increasing pressure for technical change. Research has created the basis for innumerable applications in products and processes. In some sectors, such as electronics, new technologies have swept away almost completely the old ones.

New materials, first used in specialist applications, are entering traditional sectors such as the automobile industry. New technologies for shaping materials and for assembling the final product coexist with the old ones. Complete automation of entire production areas is developing alongside traditional production. Information technologies transform our ways of living, of working and of producing. Biotechnologies may hold some of the keys for mastering the future.

The question arises whether we are undergoing a fundamental transition to a new "technical system", characterized by a new "technological base", i.e. a new set of materials, tools, components, facilities, which will invade the production processes and products of most industrial sectors.

The new EIRMA Special Conference will pose this question and try to find answers. It is addressed to people in member companies responsible for formulating and implementing the long term technical strategies, i.e. those responsible for research and development, engineering, production and corporate planning.
As in previous conferences of this type, the emphasis will be on the exchange of

experience and expectations between practitioners from different industries. Such "horizontal" discussions are the strength of EIRMA ; they will again have preference over the more specialized sector approach.

Five major fields have been identified in which developments are now so rapid that, together, they might determine a new technological base. These are: "new materials", "material shaping"', "production systems", "information technology" and "biotechnology". One plenary session will be devoted to each of the five fields, with three or four presentations, mostly by EIRMA members drawing on their own industrial experience. These presentations will be illustrative rather than exhaustive and will form starting points for the subsequent discussion.

Discussions will be in parallel for each of the five fields, and in plenary, structured by a panel of eminent experts. There will be ample time for discussing trends in the five areas under consideration and the question of their relative importance. Other fields of similar importance may come to light and, finally, it will be considered whether the notion of a "new technological base" is correct and has implications for forward thinking in industry.

TOWARDS A NEW TECHNOLOGICAL BASE
Chairman's address: The Conference mission.

1. The Conference mission

If we look at a conference as a product, to judge of its quality we should first define which is its mission and then how the mission is performed.

A Conference, usually, it is a flexible multi-missions product, and it is especially so for EIRMA Conferences due to their intrinsic inter-disciplinarity, Each user - each attendant to the conference - will look at the product according to its particular valued mission. This is a fortunate situation for the conference's design team since at least some of the users will find the quality of the product satisfactory. A good advice to the Conference's Chairman might therefore be that in introducing the Conference he keeps silent on what was the intended basic mission of the Conference that the design team had in mind. This, in order to avoid that no-one will identify that mission as its own or by being forced to evaluate the Conference within the limit of that only mission will declare his dissatisfaction.

I will not follow this advice and I will insist in presenting you the ambitious, while vague, intended basic mission of the Conference.

Everyone during his lifetime tends to put to himself and to others the question: what are the characteristics of the period we are living in?

To this question, the preferred answer is that we live in a peculiar period, with a lot of problems, more or less exciting, but very different from former periods.

Keywords are passed around to characterize the period. Today, "transition" is such a password. But are we really living in a transition period? What is the significance, taking history as a meter, of transition?

I am well aware of the danger to raise such a philosophical question at an EIRMA Conference. First of all, we should delimit the generalities of the question by referring to the transition of the technical system. The boundaries are still too ample, so we limited the mission of the Conference to debate the issue: are we faced with a transition in the "technological base" of the technical system?

I should now feel on a safer ground at an EIRMA Conference, provided we could agree on the notion of the "technological base". Unfortunately, this is a very vague concept and I will try only later on to indicate possible ways of having a common understanding on what we might mean by it.

I should first try to clarify the semantics of few terms that I am using here. I give for granted that we have a common understanding on what a single technique is, such as boring, milling or computing. We consider the single techniques as the components - the indivisible atoms for the time being - of the technical system. Techniques can be aggregated, like atoms in molecules, in "ensemble of techniques", i.e. the set of procedures and operations to perform a certain task, like producing a component for a product. Following the French literature, ensemble of techniques could be aggregated in "technical filières". i.e. the entire set of procedures and operations to produce a complex product, such as a car engine or the entire vehicle. A gas turbine represents a different filière, with respect to a diesel engine. Nevertheless, different filières might have in common some “ensemble of techniques", such as the fuel supply system for different engine concepts.

We could now define the "technical system" as the most complex system we could imagine made of techniques, ensembles, filières, the derived products and their use. The technical system is not only a highly interactive system at its interior (coal is needed to make steel, which is needed to make trains to transport coal), but with the societal system in general. A recent complication in the definition of the technical system is the extension of the concept of product to services, like e.g. this Conference.

The history of techniques has shown that the technical system has a characteristic dynamic of change. There are periods characterized by a certain technical system, somewhat in equilibrium with the society, followed by periods of “transition" to a new technical system. A given technical system is not a static system. Innovative changes pervade it, but somewhat one can detect a static "structure" of the system, which imposes bounds on the changes themselves or might block radical innovation because they are not compatible with the overall technical system.

How many different technical systems have characterized the development of mankind from the Neolithic age? it is difficult to give a precise answer, especially because of the difficulty to agree on how many different technical systems we had in the past. Overall, we might talk of about ten different technical systems of which - if we accept the theory that the long wave economic cycles are connected to change in the technical system - five in the last 200 years.

The question whether we live or not in a transition period, becomes now to a sharper focus if we accept the above general picture, recently developed by the historians of techniques, as a kind of paradigm. This does not mean, though, that we are able to define what are the characteristics by which we can distinguish a transition period from a more stable period of technical progress.

2. The bifurcation theory. A reference model.

The dynamic of a system of particles subject to external forces might help in developing a reference model to be used for heuristic purpose for our case of concern.

The system is said to be dynamically stable if its trajectory in the phase space behaves as an “attractor", in the sense that attempts to depart the system from this trajectory will be written-off after some fluctuations. To describe the system trajectory, we might describe every trajectory of each particles of the system. Fortunate]y, the system trajectory shows some kind of global structures and characteristics that reduce the task to that of characterising some fundamental macro trajectories or "modes" of the system. So, to describe the motion of a string we do not have to study the motion of its constituent molecules (considered as elementary springs) but we could limit ourselves to characterise the vibration modes of the strings. The motion of a single molecule is “slaved" to follow the global vibration modes.

lf the external forces acting on the system particles have varied slowly, the system will adapt itself to the change, without modifying its modes of motions. In a certain sense, we could say that the "structure" of the system is not changed. This is valid up to a certain level of variation beyond which the modes of the system will change. The transition, in this case, is referred to as a bifurcation or a catastrophe. Far from the bifurcation, the system trajectory is characterized by a given set of modes, different on the “left" from the "right" side of the bifurcation. The theory of bifurcation shows that we could describe what happens during the transition by focusing our attention to what happens to the modes having a longer constant of time, which modes are the first to change when approaching the bifurcation.

The modes with shorter time constants are "slaved" in the transition to follow the longer time constant models change. The fundamental modes describing the system trajectory before the bifurcation show a certain inertia to change or hysteresis effects when passing and reversing the bifurcation points. To reduce the negative effects of such inertia and hysteresis - i.e. to have a prompter adaptation of the system to the new environment - fluctuations play a very important role. While, far from the bifurcation, the fluctuations are quickly written off , now they might help the system to find quickly the new modes characterizing. the trajectory of the system beyond the bifurcation.

We are now in a position to define the, analogy for our case. The technical system is a complex system subject to environmental changes as well as internal changes. Far from a transition period, the technical system, though very complex, can be described in term of a certain structure which puts bounds on the dynamics of the systems. Innovative changes are written-off unless they are compatible with the basic structure/modes of the system. The actual structure of the technical system might be able to respond to environmental and internal change, up to a point. Saturation of system and blockage of innovation might resist the revolutionary changes to a new structure of a technical system, sometimes for centuries (e.g. after the fall of the roman empire). Since the beginning of the modern science and the industrial revolutions, our ability to produce innovations has increased in pace and radical ness. The blocking effect of the inertia of the old structures of the technical system is therefore reduced and the transition period becomes shorter.

The model might help us now to define what could be intended as the technological base" of the technical system.

The technological base is the counterpart for the fundamental modes of the dynamics of a particles system. The technical system dynamics is "slaved" by the dynamics of the "technological base". To answer our basic question - are we living a transition period for the technical system? - we could therefore concentrate the analysis on what is happening to the technological. base.

3. The transition of the technological base.

There is now a second question that has to be addressed. How to recognise the components and subsystems of the global technical system that enter into the technological base?

The study of the long term economic waves has shown that changes in primary energy resources, base materials, transport and communication technologies are strictly correlated to the economic cycles.

The study of the diffusion of innovations in different technical filières has pointed out the important roles of some “ensemble of techniques" which act as an intermediating agent between the innovation in basic techniques (energy, materials or communications) and its diffusion in the filières. I am referring to the so called “générique techniques" such as instrumentation and control, governors, hydraulic-, electric-, pneumatic-drives, etc.

The design team of this Conference has selected materials and communication technologies as being part of the technological base because of their horizontal pervasiveness in all sectors. Energy was not included simply to limit the range of our debate, which is already too ample for a single Conference.

Ensemble of techniques in production process put long term constraints because of related investment in technological innovations. Their change should therefore be looked at as having a very important effect in the overall change of the technical systems.

Their change will "slave", using the semantics of the bifurcation theory, the changes in product innovations. Two of our sections therefore will be devoted to production process: material shaping and automation.

Générique techniques appear in the Conference programme when analysing the diffusion of a base technology, like information technology, in the instrumentation and control fields.

Why adding to our list biotechnology? Should it be considered part of the technological base, notwithstanding the fact that it is not an horizontal technology pervading al]productive sectors?

The rational behind its choice might be a different one. Our reference model tells us of the importance of large fluctuations to help the system to find the new modes of its trajectory after bifurcation.

Biotechnology, a well established field**,** is subjected now to very large technological fluctuations, like genetic engineering, that radically depart from the established technology. Will these fluctuations produce a large change in biotechnology or will their effect be confined .in special products and market niches? In the first case, the effect on the rest of the technical system will be very large because of the relevance of biotechnology among the manufacturing processes.

4. R & D managers and the transition paradigm.

The Conference has been structured so that the first intervention in each of the five sessions will describe - pointing out, when appropriate, the radical ness of the change - the general trends of change of the base technology or horizontal “ensemble of techniques" that give the title to the session. The subsequent interventions will analyse the diffusion of the base technique with its changes, in technical sectors or filières.

The parallel discussion groups will continue the analysis of the type of changes in the base technologies and of its diffusion in different sectors and I hope that the debate at a certain point will focus to the basic question of our Conference: are we really living a transition period of the technical system? This question together with that of how to characterize the technological base of the emerging new technical system should be dealt with by the panel discussion of the last Conference session.

As I remarked at the beginning, when talking about the multi-missions aspect of this as of any other Conference, I am well aware that many attendants today might react negatively to the Chairman’s pushing towards a more vague and philosophically oriented overall mission of this Conference. I am sure that, on the contrary, everybody will enjoy and find enriching the prepared interventions and the debates on the single topics.

Why then insisting on focusing everybody’s attention to the question: transition or not transition?

The reason is that, if really we are faced with a transition period, our basic attitudes as managers in general, and R & D managers in particular towards technological changes and innovation have to change.

In fact, the role of industrial R & D changes considerably during the transition period.

The established technical system has a "predictable evolution" before the transition: the principal role of industrial R & D is to support the diffusion of innovation in the company’s well established products and processes. The necessary “esprit" is basically analytical (*esprit géométrique*), with increasing importance of disciplinary specialization.

During the transition period, the R & D should intervene directly in the conception of new products and related manufacturing processes. The necessary “esprit" is now holistic and synthetic (*esprit de finesse*).

To mark the difference, one could underline the different approaches to technological forecasting to set objectives for R & D. In the first case, the Technological Forecasting is basically an exercise in technological trends, while, in the second case, writing alternative scenarios is the basic tool.

To be able to answer the question whether we are in a transition period or not, is therefore of great relevance, first to manage the needed changes internal to R & D (which might require a change in the R & D motivations and "culture"); secondly, to perform the change in the role and relationship with the other company functions.

Being in a technological transition period means in fact to be in a "state of flux" in the company organizational structures and R & D function cannot pretend to be an exception.

The posed question bas a strong philosophical scent. Furthermore, because of our technical backgrounds, I suppose we are not at our ease if we limit ourselves to pose, a problem without breaking it down in its components, trying to solve it.

This explains why I have introduce the Conference pointing out a reference model which might help us in developing such a problem solving appr oach.

CHAIRMAN' s CONFERENCE SUMMARY AND CLOSING REMARKS.

In the last few decades, industrial activities have been subject to increasing pressures for innovative change. Research in different sectors and interdisciplinary research has created multiple practical applications. In some sectors, such as electronics, new technologies have swept away almost completely the old ones. In many other sectors new technologies coexist with older ones. The formal presentations at this Conference and the discussion in the Working Groups have confirmed that.

New materials such as composites, have already made a deep penetration in aerospace industries. But even there the new materials have not displaced the old ones, which in the meantime improved both in quality and costs. In other sectors, such as the vehicle industry, it is surprising how much the number of different materials used has increased.

An increased complexity of the mix of techniques available to design and manufacture goods seems to be a common feature of all sectors. Take as an example the case of manufacturing technologies for mass produced electromechanical goods. A host of new technologies for shaping the materials (electrochemical forming, squeeze castings, laser cutting, etc...) and for assembling the final product (robots, flexible machining, etc...) coexist with the old one's. Complete automation of entire production areas (with complex computerized management, dispatch and control systems) has sometimes developed alongside traditional production requiring human operators.

Is this complex situation here to stay or is it a sign of the "fluctuations" that pervade our old technical system while undergoing a transition to a new one?

This Conference has not, and could not possibly have, answered such a question. First of all the transition period may last decades and different sectors face the transition by slow changes at different times.

I have the impression, though, that the Conference works have reinforced the hypothesis of the transition to a new technological base. It is my feeling anyway that such an hypothesis is more productive than denying the idea of the transition, because it can induce creative thinking about the effects of the hypothetical new technological base on product design and the related manufacturing processes, (i.e., thinking about the new technical system).

While keeping in mind our basic theme - and the Chairmen have lost no occasion to remember it to you - the presentations and the discussions have been axed on specific cases and trends of specific technologies, which have made this Conference so much interesting and concrete. But after leaving the Conference, in the spare hours when each of us indulges in speculations, tries to take a more global look, possibly using some heuristic model of thinking. I summarized here the model I briefly indicated in my introduction to the Conference works and which I have used formerly at the Göteborg Conference to debate another problem of research management, that of investment of R & D.

The idea is that the dynamic behaviour of the technical system is similar to that of other complex open systems and follows a typical cyclical pattern.

- a period of stability and "predictable" evolution exploiting the system potentialities;
- a period of transition where large fluctuations appear;
- passing through a bifurcation (or catastrophe) towards a new system structure;
- repetitions of the dynamic change patterns, starting from a new period of predictable evolution exploiting the potentialities of the new system structures.

Fluctuations in the technical system are identified with basic technological innovations.

lf we are in a transition period, we should be able to detect signals from the technical system. In general, for a complex system the conditions to be looked at ~ that permit the amplification of fluctuations and strong departure from the equilibrium - are

a) increased difficulties to match environmental changes;
b) saturation of system growth potentiality, "complexification" and reduced efficiency;
c) positive feedback effects of fluctuations, followed by irreversibility of the induced changes.

The choice of the cases at this Conference has been done having in mind the last conditions i.e. to monitor positive feedback effects to sustain the diffusion of basic innovations.

We have, in fact, concentrate the attention on the “horizontal” technology (the technological base), because of their intrinsic feedback effect. We have heard of the penetration of composite materials in aerospace industries. This penetration by reducing the cost of producing the materials and, moreover, by diffusing the designing know how will open the way to their applications in other sectors.

A second important signal is related to reaching the threshold of penetration of new technologies in capita]intensive, mass products sectors. This marks the irreversibility (because of the inertia effects of the large application) of the mutation in the technical system. This is the reason of the attention given in selecting cases in the vertical sectors, to mass produced goods.

It is certainly a very difficult task to try to present you here a preliminary analysis of our discussion from the point of view of the Conference basic question whether we are in a transition period or not. I will first of all try to define a recipe on how to proceed with such an analysis to help you in your rethinking, later on, on our Conference.

I foresee the following four steps:

a) identify the technological changes and their potential for diffusion to renew today’s products and processes;

b) analyse the sectors where the changes have already taken place and discuss the relevance of such sectors in the economic system. Make them "case histories" to forecast what could happen in other sectors where penetration will. take place. E.g.: Do the innovation changes have been preceded by a period of "technological confusion" (many technologies competing among themselves)? Is the role of R & D function changed? etc...;

c) analyse the case of sectors where the innovations have not yet made a large inroad and debate the need for changes (difficulties to meet environmental changes, state of technological confusions, reduced R & D efficiency, etc...), evaluate more global signals pointing to the de-maturity of the sector, etc...;

d) debate the possibility that the penetration of new technologies could be blocked because of constraints (social and economical), non-saturation of existing technologies, etc ... Vice versa, point out possible "multiplication effects" due to society (governmental. intervention), culture (favouring products' innovation to respond to new needs), etc ...

Let us try to use the recipe for the case of the materials. We have been certainly faced in the last few decades with the development of quite new materials with high potentials to renew today's products (step a).

In the aerospace sector, new materials such as composites with organic matrix have already amply diffused, as Mr. Balazard has indicated. The diffusion of new materials - even for products like in the aerospace sector where a large premium is put on high performances - is not without resistance from the old materials, which react by developing all their potential of technological evolution. This is the case, as we have seen, of aluminium alloyed with new materials, such as lithium.

lf we consider the case of innovations in structural materials in aerospace, . as a forefront of the changes in materials in other more conventional sessions, what is the lesson to be derived (step b)?

It seems to me that a more complex mix of materials to be used in products is a characteristic of the technical system of the future. The increased complexity of the mix of materials will produce a change, first of all, in the way we design the products. Fortunately, the progress in the knowledge on materials behaviour and in designing techniques is advancing at such a pace that technical offices have no special difficulties in managing the increased complexity of the material mix.

As an example of a sector with high inertia in material changes, the case of automobile bas been discussed.

Mr. Dimmock has indicated that new materials like organic matrices composites might find only limited utilisation. He has elaborated on the factors which limit the diffusion of such new materials in automobile (step d). The increasing complexity of the material mix will in this case not necessarily produce a big change in the automotive design offices. In fact, the components using new materials might be made available by suppliers as special items. Because of the importance of the automotive sector in our technical system, if this sector can accommodate innovations in an evolutionary way - without radical departures of today's procedures and process - it might be an important sign against the hypothesis of the technological transition.

The actual situation, however, is more complex. The presentation of Mr. Larsson and the discussion in the Materials Working Group indicate that there is a strong pull to change materials in vehicles coming from markets and societal needs (step c),'such as energy conservation. While steel will continue to have the lion's share of the car weight, lighter materials - metallic and organic - will continue to increase their share.

lf we now pass to consider the case of material shaping, the presentation of Mr. Huart has shown that we are confronted with technological changes which are not less dramatic and varied than for the case of materials (step a). One peculiar feature, among those indicated by Mr. Huart, of new shaping technologies which I consider having a revolutionary impact in transforming the production process is that of their intimate relationship with the control system that provides feedback information in real time on the quality of the surface being worked.

Moreover the new shaping processes to be applied require, much more scientifically based knowledge and use of mathematical modelling. This will produce quite a revolutionary change in the Company's manufacturing function, where empirical knowledge has prevailed up to now.

Going to step b) of our recipe, it is more difficult for the case of material shaping, with respect to the case of materials, to select sectors which play the role of technological "avant-garde". The two cases presented in the plenary sessions refer to mass produced goods, such as automobile parts and office machines. The latter sector has seen a dramatic change in the product characteristics and designs, and this had a large effect at the shop floors. Mr. Mosca has pointed out the basic changes in design and related materials specifications.

An interesting feature, which might be considered as a reference for future changes in other products, is related to the integration in one single place of multi-functions, such as in the machine covers, which was made possible by the evolution in the shaping process and has required a stronger interrelation than in the past between the company's design office and production engineering. The role of internal research has also increased, e.g. by running pilot experiments because of the need to accelerate adoption of shaping technologies new for the company together with the adoption of new materials.

In the case of automobile parts, as illustrated by Mr. Kuntzmann, the changes were less dramatic and new technologies, such as laser beam working, have been introduced as a substitute to old ones. The resulting improvement in productivity and quality in this case can be considered as typical of mature business and does not offer special indication of a revolutionary transition in production technologies. This nevertheless, if we look more closely, to motivation of technological innovation on the shop floor in mature business, we find a much more varied and complex set of motivations than in the past, where the increase of productivity and quality where the prevailing motivations.

To this type, of question addressed itself to Working Group in Material Shaping. The need, e.g. of increasing the flexibility in production, is producing a change of industrial engineering ground rules. The optimal dimension of scale of production is subject to re-evaluation in many instances. The introduction of new technologies and new materials make obsolescent the existing empirical knowledge on which much of today manufacturing plant optimisation is based and on which value analysis is based.

The related change in the role of well established production functions, the increased intervention of research laboratories., the need to base the design choice on more scientifically based knowledge are all indications that the final resulting change might have the characteristic of a new technical system.

There are stronger evidences that the production system for goods that requires mechanical processing is undergoing a dramatic change. Flexible manufacturing, computer integrated manufacturing are new passwords used to describe the change. Mr. Levasseur has described how automation can be extended to small and medium series productions. The diffusion of computer by integrating the various operations and assuming information feedbacks tends to make a mechanical workshop similar to a continuous chemical process plant. The production system for computer manufacture can be used as a reference to forecast what is going to happen in other sectors. As Mr. Heizinger bas indicated, automation bas fully extended to such operations like part assembling and, most important of all, to the final product testing. I suggest that there is a very important lesson for products like automobiles. Although it is a very difficult problem, that of simulating, at the end of production line, testing conditions which reproduce the most constraining use’s mission, there is here an important challenge for R&D.

The Working Group on Production System has discussed the credibility of unmanned programmable automatic factories and ways by which the new technologies are diffusing in different sectors. The Group seemed to agree that we are confronted with a revolutionary type of technological change.

The session on Information Technology (IT) has confirmed its importance as a basic determinant of change in the world of products and production processes. The changes are already well visible in the information technology sector itself, as shown by Mr. Catania for the case of telecommunications. Looking at possible impacts on other sectors, it is likely to lead to a scenario of major changes in the way we conceive traditional products (changes in specifications and performance) and in the way we produce them. These changes are relevant not only in production but also in design, in product experimentation, in the R & D laboratories, virtually in all company functions.

If we take the case of automobiles, presented by Mr. Heintz, although the diffusion on the product itself might seem yet limited, the needed change in the “culture" of the technical office might have a multiplicative effect for a faster pace of diffusion of IT on vehicle in the next future.

The case of Instrumentation and Control presented by Mr. Wood shows the state of deep penetration of IT in such a “générique technique”. IT has not only improved the performance of instrumentation and control systems, but has helped in diffusing it in cases where control was obtained via mechanical feedbacks (as intrinsic part of the mechanical design itself). With a little imagination one can derive a scenario of drastic product changes when the IT technology culture will be diffused more thoroughly in mechanical design offices. Electronic phasing of multiple cylinder engineer is already on the test benches, as an alternative to camshaft phasing, more will come.

If the discussion of the case of IT bas confirmed its potential revolutionary effects, the session on Biotechnology has somewhat thrown cold water on the expectations. This, at least, is my impression. Mr. Strijkert, in the plenary sessions and Mr. Nielsen, in the discussion group, have remembered us that biotechnology is a very old process. The revolutionary new techniques of genetic engineering cannot be utilized without taking advantages of the tools of the classical biotechnology, such as microbiology, biochemistry, fermentation, and so on.

The pace of diffusion of the new techniques will therefore be conditioned by the existing biotechnology processes.

It is too early, here, to tell whether we could foresee a new technological base for the year 90's or whether the new techniques will be confined to the exploitation of specialty sectors. The pharmaceutical industry might be one of them, as pointed out in the presentation by Mr. Schöne.

A more revolutionary scenario was presented by Prof. Schëll concerning, the impact of genetic engineering on agriculture.

Without taking part for one of the two sides, I suggest that the fate of diffusion of new biotechnology discoveries might depend from the conditions in which the entire technical systems finds itself. In fact, in a technical system highly perturbed by the fluctuations - induced by the new horizontal technologies high potential of diffusion, such as IT - favourable conditions might develop for the penetration of new technologies, such as genetic engineering, which otherwise might have a limited application range.

Trying to reach conclusions, I should admit that I am personally biased in favour of the transition hypothesis. It was not the aim of the Conference to reach consensus, but simply to throw the seed of doubt.

But even if we would agree that we are in a transition period, we have to remember that the final state of the technical system after the transition is far from being determined neither in its configuration nor in time scale.

In fact, it is typical for a system approaching a bifurcation, that several states are possible in which to develop after the bifurcation. Which state might result the most probable depends on the solutions which are anticipated during the transition and the extension of the related fluctuations. The R & D functions play here a very important role in developing technological scenarios to orient their activity, and to convince the company to anticipate investments along the scenario indications.

Those of you who will leave the Conference with the opinion that we live in a transition period should therefore start thinking of the need to develop a different role for R & D in respect to the past (from analysis to synthesis).

Appendix

Brussels, June l0, 1983.

Proposal for the Terms Of Reference for
EIRMA Special Conferenee
"THE NEW TECHNOLOGICAL BASE FOR INDUSTRY"

INTRODUCTION.

In the last few decades industrial activities have been faced with the need to manage an increasing number of proposals of innovative changes coming from different disciplinarian and inter-disciplinarian research. Such proposals have found multiple inroads for practical applications in different sectors.

While for some products, such as electronics, the new technologies have swept away almost completely the old ones, in many other sectors new technologies co-exist with the old ones.

If one considers, e.g., the case of materials in the vehicle industry he may be surprised by how much the numbers of different materials used in the product has increased.

As a consequence, to-day the job of the designer and that of the manufacturing engineer has become much more complex than in the past.

Let us face as another example that of manufacturing technologies for mass produced electro-mechanical goods. There also, a host of new technologies - to shape the materials (electro-chemical forming, squeeze castings, laser cutting, etc...), to assembly the final product (robots. flexible machining, etc...) - coexist with the old ones.

Complete automation of entire workshops (with complex computerized managing, dispatching and control systems) has developed in the same building near-by old fashioned, but still very important human managed operations.

Will this complex situation stay for ever or a new technological base will emerge, which will simplify the entire product development and manufacturing operation?

lf one looks backwards to the last two hundred years of our industrial society one finds that periods of peak innovations have appeared at certain time intervals producing rearrangements in the technology base. Without entering into the debate of the technological long waves theory, there are several signs that indicate that our decennium might be one that. looking back at it from a far-away future, will appear with peak technological innovation activities leading to a re-structuring of our technological base.

The assumption of such an hypothesis is, in any case, more productive than denying it, because it will induce creative thinking on the effects of the hypnotised new technological base in changing our products design and the related manufacturing process.

The scope of the EIRMA Special Conference will be to:

- identify some of the components of the new technological base and the state of their diffusion in specific industrial sectors, forecasting their further diffusion;
- develop a scenario for product design changes and for manufacturing changes due to a large diffusion of the new technological base.

THE COMPONENTS OF THE NEW TECHNOLOGICAL BASE,

A first important component that comes to surface with high evidence is microelectronics. This subject will - this notwithstanding - not be included among the considered components of the new technological base, because it is already too much spoken of and to it EIRMA itself has dedicated a special conference. This will not be the only exclusion.

The Conference is designed not to give a complete picture of all the candidate components of the new technological base, but to select few of them. and for each one to develop an in-depth analysis of the state of the art and the perspective for a large diffusion with the related impact on products and processes.

The following five candidates will be retained

- new materials (long fibre components, engineering ceramics., structured metals);
- new materials shaping processes (laser, electrochemical machining, gluing. Etc...);
- new productions system processes (flexible automation, robots computerized shop);
- new communication technologies (optical fibre, computer networks and data base);
- biotechnologies.

FIG. 1 - IMPACT MATRIX

Components of the new technological base → / Impact on production function ↓	New materials	New material shaping processes	New production systems processes	New communication technologies	Biotechnology
Product specification	(X)			X	X
Products design and engineering	X	(X)	(X)	X	X
Manufacturing production cycle	(X)	X	(X)		X
Production plant management			X	X	(X)

The special approach foreseen for the Conference is not so much to explore each subject separately, but to consider the entire set, examining in different product areas., what are the evidence of changes already underway and to extrapolate future impacts.

However, due to the large differences among the subjects, an introductory paper for each of them will summarize the state of the art of its application and diffusion across the different product sectors.