Licensing and Innovation Process

Task before companies is to incorporate complex requirements of modern society into innovation process

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Licensing contributes to a considerable extent to the process of innovation. Successful licenses can enlarge the market, extend existing applications or even find new areas and open up new territories. In view of the importance of innovation with regard to licensing activities it seems appropriate to discuss in more detail what innovations are, which factors either promote or inhibit them, and how we foresee the future of the innovation process.

The credit for drawing the attention of economists to the nature and significance of innovations undoubtedly belongs to the Austrian economist Joseph Schumpeter. According to his studies, innovations could be defined, in simple language, as doing something differently in the whole area of economic life, or, as he expressed it more exactly in economic terms, as the setting up of new production functions whereby production is not quantitatively expanded but changed in form, that is reshaped in a qualitative manner. A technological change is thus accomplished.

In our everyday language we often tend to equate the terms invention and innovation or at least to see them in direct relationship to each other. Schumpeter clearly differentiated the two terms. Accordingly, an invention is a new combination of existing knowledge which satisfies a need (Schmookler, Schumpeter). Inventions have also been called the product of knowledge and information.

An invention may therefore be either the starting point or a component of an innovation (product innovation), but must not necessarily be so. It is in fact quite irrelevant whether innovations contain anything scientifically new. Opening up new markets, employing new processes (process innovations) and creating new organizational structures also bring about qualitative changes in the production function. By virtue of the fact that they affect the pattern of economic activity they have the status of innovations, often quite significant ones.

In later years the sharp distinction between inventions and innovations drawn by Schumpeter, Schmookler, et al did not remain unchallenged. Usher, Ruttan and other economists pointed out that the transitions are fluid, and indeed presented the concepts as being closely related. Latterly, the area of discussion has been extended to social innovations, which need have nothing to do with inventions but which can exert a tremendous influence on economic life and the production functions. We will return to this point later.

Anyone who has had firsthand experience of the nature of inventions and the transitional process to innovations, and calls to mind the many following innovations, will be inclined like myself to favor a clear-cut distinction between invention and innovation. The following observations will bring out this standpoint more clearly.

IMITATION

It is sometimes difficult to draw a sharp dividing line between innovation and imitation, for here again there is no generally accepted principle of separation. In the narrow sense of the word, imitation is direct copying and represents a merely quantitative extension of the original innovation. Innovations can be improved upon in relatively minor aspects, for example, by increasing a product's storability, or with a pharmaceutical product through a modification of its structure, duration of efficacy or metabolism while retaining the original therapeutic indications, or again by a more highly rationalized manufacturing process or other means. Personally, I would term such modifications followup innovations in the narrow sense. They produce some change in economic life and hence can be regarded as innovations sui generis. They are not imitations, although they are occasionally called so in the literature.

THE ECONOMICS OF INNOVATION

Schumpeter has set forth in most impressive terms the preminent importance of innovations for the whole of economic life. To a certain extent, innovations are the motor of economic development, of growth and change including technological change. As such they are an essential function of an industrial enterprise. Along with credit financing and profit maximization, innovation is one of the three main pillars of the theory of economic growth. Innovations invariably modify the economic scene in some way, whereas inventions in themselves entail no immediate economic consequences.

Schumpeter placed innovation in the very forefront as one of the intrinsic internal factors of economics, on the ground that it is neither presupposed by, nor follows as a consequence from, any other factor. Today, however, the majority view is that innovations are strongly influenced, positively or negatively, by the prevailing social and economic climate, the dynamism of the economy and the level of economic activity. Thus the resulting technological change is brought about by forces which are not accidental but

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of a primarily economic nature. Technological change depends to a high degree on the economic framework (Schmookler). Supporting evidence for this statement will be given in the next section.

It follows that innovations do not appear at a steady, uniform rate but rather in a rhythm comparable to biological cycles: they come into being, flourish, and wither. Schumpeter compares them to life, a process of growth and decline followed by an awakening to new life. An innovation gives rise to imitations in the narrow sense, but also to succeeding innovations, to a sequence of events triggered by the initial innovation but differing from it qualitatively. The breakthrough creates a base for further novel features, which eventually yield fresh innovations. Writers in the subject speak of a "cluster of innovations".

From the advent of the first automobile through the introduction of mass production by Ford to the high-ranking importance of the car in today's economy, a great number of innovations following one from the other have made their mark. If we take into account the associated innovations such as tire improvements, automatic gears, electrical accessories, aerodynamic body styling, and safety devices, we can see that it is fair to speak of a snowballing or cluster of innovations.

S Curve

It can also happen that an innovation reaches its peak rapidly without engendering any followup innovations. The trend of development sets in slowly, passes through a steep dynamic phase and finally flattens out; the curve is like a sloping S and is known as an S curve. But generally there are further innovations, each of which follows the same S-shaped course though at a later period of time and on a technologically higher level, so that a set of curves takes shape which are spaced out on the time scale and located on increasingly higher levels. These are called "envelope curves".

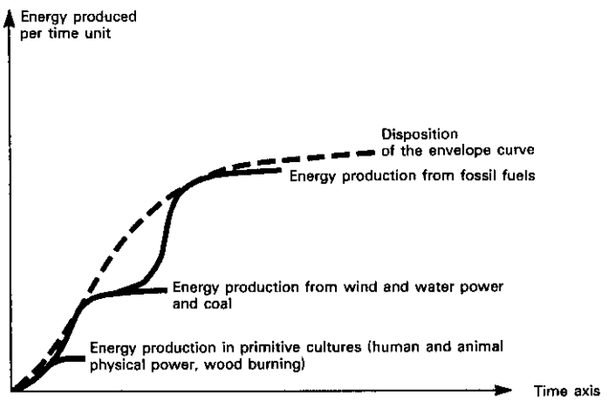
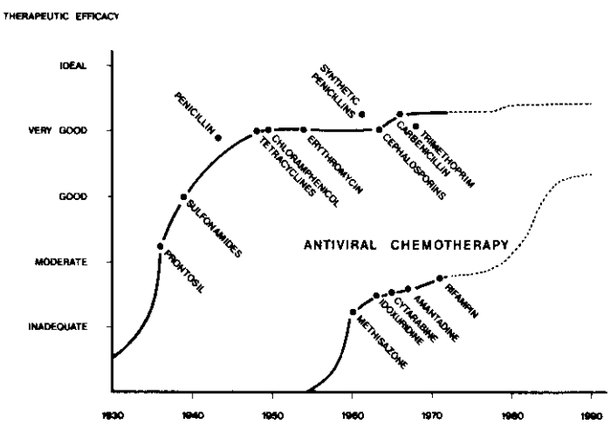


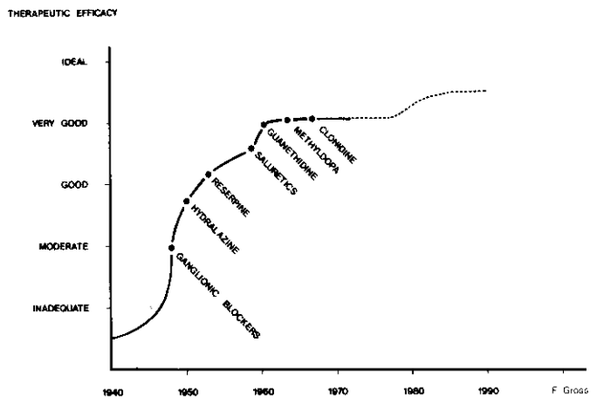
FIGURE I

The overall development of an innovation and the succeeding innovations yield another S-shaped curve. A well known example is heat production; the energy source wood was gradually superseded by coal and this in turn by oil, which in future will be replaced by various alternative energy sources. In medicine we have a number of these staggered S or envelope curves.

See Figures II and III.



Antibacterial Chemotherapy
FIGURE II



Antihypertensives
FIGURE III

These observations highlight the dynamic coming and going of original and followup innovations, and of new innovations evolved from existing ones, and point to the geographical expansion of the relevant technologies and consumer markets. The competitive situation created by the appearance of imitations in the true sense of the word completes the variegated picture. Without taking into account the effect of environmental factors and the barriers to innovation, the inherent dynamism of innovations in itself creates a colorful and constantly changing scene of economic development and technological advance.

This brings us to the further consequences of innovations, which can be illustrated with two cases, each representing one of the two extremes.

Faith

On the occasion of a treaty signed in 1949, U.S. President Truman declared that with relatively few but well directed breakthroughs and innovations, hunger and want, overpopulation and unemployment could be banished from the world. This faith in technological progress was unanimously shared. The

panacea could become reality.

Opposing currents of thought leading to the other extreme did not fail to arise, indeed they seem to have gained in strength over recent decades. There are theories which assert that technological progress is by its very nature destructive to man, the human psyche and psychic well-being (a proposition advanced by Illich), as well as to the human environment. Technological progress erodes the highest human values and destroys mankind's natural habitat. The great confrontation between the forces of good and evil, the final battle between good and evil lies before us, as in the Biblical Armageddon.

Extreme views are always one-sided. Certainly our society will grow increasingly dependent on science and technology, and the maintenance of our living standards will necessitate continued technological progress, but at the same time, as technology advances we shall have to place greater importance in our calculations upon its implications for man, his differentiated psyche and his environment. This is considered at more length in the section on barriers to innovation.

PREREQUISITES FOR INNOVATION

Just as an invention need not necessarily lead to an innovation, so innovations are not invariably successful simply by virtue of their nature. Indeed, we can go a step further and say that detecting a present or future demand is a more important factor for successful innovation than recognizing the potential of a technological breakthrough. Let us look at some of the factors which form the prerequisites for successful innovation, for an innovation is not an isolated result or a single act but a complex system involving many partial processes.

The first step is to establish its technical feasibility *and* the existence of a market demand (the generation of ideas).

The second is to give the idea concrete form or to sketch a solution to the problem (the problem-solving process). One of the determinative factors is the social and economic environment in which the innovation is to be launched on its career.

The cotton-picking machine was invented in 1889 and was technically realizable at that time. The first step, the generation of ideas, was accomplished, and all the marginal conditions existed, but in the social and economic climate of the American South, where manual labor was so cheap, there was no need for such a machine. Later, mass unemployment prevented the innovation from taking on tangible form, and it was not until 1942 that the machine was first manufactured on a limited scale. Only in 1948 did it come to a breakthrough, that is, to a technical innovation. In the realization of this invention the socioeconomic conditions played a critical role, which again shows that the decisive factor in not the invention itself but the point in time at which the innovation process is initiated. An innovation will be successful only on condition that it is realized at the right moment. This applies not only to premature innovations like the cotton-picking machine but also to those that are realized too late, i.e. brought onto the market at a date when the demand no longer exists, having been met by earlier innovations.

Once the decision to promote an innovation has been taken, the third step is implementation in the market (or market diffusion). This is the most expensive phase of innovation. In the U.S.A. it has been calculated that of the total cost of innovation, 5-10% is for research, 10-20% for development, and 70-85% for market penetration, the final and most critical phase. In certain fields where the technology is highly advanced, the research and development costs may be higher than this. And it has to be borne in mind that by no means every invention leads to an innovation; a great many inventions have to be made before one is selected and market penetration can be started. This brings us to the foremost criterion for successful innovation, namely the integration of technological expertise and successful implementation in the market, which calls for a marketing style that correctly discerns existing consumer needs and introduces the product just at the right moment. The innovations that meet with success are those in which these two cardinal factors fuse into one. At the same time, the new element in the company's range has to be brought into accord with all its other operations.

There are several other factors which play a weighty part in the successful realization of innovations, the principal ones being the following.

INFORMATION AND COMMUNICATION

A British study revealed that of 158 important "ideas" from which 51 innovations emerged, one-third came from inside the company and two-thirds from outside sources. Several other studies have yielded similar data, although the ratio is not so extreme as this. The high proportion of creative stimuli coming from outside quarters underscores the high-ranking importance of information on events taking place outside the company. There has to be a global flow of information on discoveries, future needs, potential new markets, etc., and the numerous and often divergent items of information have to be fed into the company's innovative process in a cost-effective manner and processed with the company's own expertise. Accordingly, all incoming material has to be accompanied by a covering communication to the company department or section handling the information. Successful companies have a highly articulate system of information and communication, whereas backward firms sometimes spend years toiling laboriously at inventions and innovations which are already known elsewhere.

The management of innovation is critically important and two of its aspects need to be stressed: first, the role of the key persons in charge of the innovation process, and second, the organizational measures that have to be taken to create a climate conducive to innovation and to integrate emerging innovations in the context of company operations.

On repeated occasions it has been pointed out that by far the greater proportion of innovations are traceable to a relatively small number of key persons. These are the individuals who make the crucial contribution to the generation of ideas and supply the stimulus that sparks the innovation process. They too are the people who plan and carry through to success

the market implementation and diffusion phase.

It is the responsibility of management to select the right persons for these positions (they are known as gatekeepers or entrepreneurs) and to provide them with a climate that will encourage and further the creative process. Just as innovation as a whole is shaped by the socioeconomic environment, so the innovative success achieved in the market is heavily, sometimes decisively, affected by the climate, the organizational structure and the decision-making process in the company.

Integrated

A final requirement is that innovations should be properly integrated into the company's overall activity. In many cases this is easier said than done. Innovations are something new and strange for large and routine-bound organizations, an unfamiliar intrusion which is looked upon with skepticism; in fact the stereotyped functioning in the bud. A company which is aiming at successful innovation has to operate with a high degree of flexibility and coordination. With this in mind, attempts have been made to keep the innovation function more or less autonomous from the repetitive everyday routines of big business. The function is then named venture management.

Several studies have brought to light the fact that big corporations do not have a higher success rate commensurate with their size where the creation of innovations is concerned. On the contrary, the record shows that on the whole they are less successful than medium and small companies. The reason lies in the factors already mentioned, in particular the circumstances that generally speaking it is more difficult to fit innovations into the scale of operations of a large organization than is the case in the small or medium enterprise.

Bureaucratization (overmanagement and overplanning) is another inhibiting factor which is considered below.

Finally, we must not be led to believe that technological progress is attained by a few "breakthroughs". The cumulative effect of many small steps forward (the numerous followup innovations) is what spells success and technological innovation. Du Pont has frequently been instanced to prove that a company's success rests upon a great number of relatively minor innovations and subsequent followup innovations.

BARRIERS TO INNOVATION

Successful innovations are not entirely the product of a happy blend of technological expertise and marketing skills. We have already seen that social factors can have a significant impact on the creative process leading up to the appearance of an innovation. It is generally agreed that the postwar years up to the late 1960s were marked by a climate highly favorable to innovation. The U.S.A. set the pace throughout this period, which occasioned much talk about the technological gap between the U.S. and Europe. Latterly, Japan has advanced to the position of a leading industrial nation, not least because of an attitude of mind which gives every encouragement to innovative talent. But however forward-looking and optimistic our evaluation of the current situation, we cannot escape the fact that opposing forces have now entered the field. Every action calls forth a reaction, and the once unlimited confidence in technology and innovation has swung round to skepticism about the value of innovations generally. It would be an exaggeration to say that a wide section of the population is hostile to science and technology, but we cannot overlook the fact that such currents of opinion, even when they proceed from minority groups, do have some effect on our way of thinking. The root causes of these antagonistic trends are highly complex and there has been no lack of attempts at interpretation, but I do not propose to review the diverse theories that have been put forward. Some points have been touched upon in the foregoing. However it is clear that increasingly the human factor is coming to the forefront, and that the social elements in technological innovations and changes and their effects on the environment have acquired a higher priority rating. Among other things this has made the safety of new products and processes a matter of prime importance.

This movement of thought is to be warmly welcomed and will no doubt be elucidated further in the framework of social innovation. At the same time we should be aware of the inhibitory factors inherent in it. As exaggerated demand for safety based on a faulty understanding of the situation (for instance, duplication of the findings of animal tests in the pharmaceutical field) and complicated bureaucratic procedures are obstacles to the innovation process that add to the cost of necessary innovations and often nip them in the bud. Many technological innovations contain a certain risk which has to be accepted: no aircraft or automobile, no cable-car railway or pharmaceutical product is entirely free from risk. It rests with society to weigh the two aspects carefully and unemotionally one against the other—on the one hand progress, convenience, therapeutic efficacy, etc., and on the other the risk element. The controversy about nuclear energy illustrates this point better than many words. An inadequate rate of innovation has a depressing effect on economic growth; the consequences are known and will be analyzed in the concluding section of this article.

Human Factor

The growing significance of the human factor in the innovation process has other aspects.

In the preceding section we looked at the paramount role played by the key persons, the creative individuals, in the management aspects of innovation. It has often been observed that much of the credit for innovations belongs to these creative, dynamic individuals, either because they evolved the guiding ideas (inventions or the like) behind the innovation, or because their dynamic management talent carried the project successfully over the costly development and and marketing hurdles. These persons have to be furthered and should be able to work in a milieu which is in keeping with their specialized tasks.

Many authors who have written about the barriers

to innovation have laid the blame chiefly on overmanagement and overplanning. I doubt whether these expressions are a fortunate choice to express the true state of affairs. Planning and management are, after all, essential components of innovation. Personally, I would prefer to use terms such as bureaucratization and overregulation, by which I mean overly complicated decision-making processes, guidelines, rules, etc., that put the brake both on creativity and on the personal dynamism of the innovators. They are disheartened by complicated control and permission-granting procedures and by lack of readiness to take risks. I see this as one of the biggest obstacles to innovation.

Overmangement and overplanning are not, however, limited to the company sphere; on the contrary they tend to assume even greater proportions in the public field. Bureaucratic laws and regulations, unreasonable demands on the part of trade unions, indiscriminating public opinion, fashionable social trends, etc., set up barriers to the innovative process on the public scene.

W. Gruber Sloan of the MIT School of Management has described this unhealthy climate for innovation as "big government beating on big business and big companies making big mistakes". He calls this an almost tragic situation, since there is sufficient know-how and technology available today to realize the innovations and major technological advances that are necessary to satisfy private and public needs. What is urgently needed is to call upon government, the public, industry and science to work together more closely on joint constructive projects. This alone will prevent us from making wrong decisions on innovations and suffering the serious economic consequences.

THE INNOVATION GAP

Is this a fact or an illusion? After having emphasized the profound effect of innovations on the whole of economic life and on technological progress, and having seen that it is the motor of economic progress and growth, we cannot be indifferent to the question whether a gap exists today in innovative activity. We have indicated the extent to which the barriers to innovation have mounted. They do not all arise from outside sources; many are erected inside the company itself and are often to be sought in the attitudes of employees and citizens. It is always easier to criticize than to accomplish a creative (innovative) act. In consequence we are now experiencing a growing volume of discussion on the gap in innovation, a gap due not to any lack of technology or scientific knowledge but to the increasingly formidable obstacles. The more innovation moves away from the purely technological to the complex social aspects (man and his environment), the more insistent becomes the demand for the public to evaluate the issues factually instead of taking up an emotive or even worse a demagogic standpoint.

INNOVATION IN THE FUTURE

In conclusion, let's hazard a look into the future. We can sketch three scenarios:

a) The barriers to innovation will become ever greater, the bureaucracy will acquire excessive power, and creativity will be fettered: a scarcely believable prospect.

b) The barriers will be only temporary and will not hold back the driving forces behind innovation. Technological innovation will make further progress. We shall continue to look to innovation to supply the motive power for economic activity and growth.

c) The human factor will be the determining element and the social desiderata will grow in scale and importance.

It was mentioned at the outset that a category of social innovations is distinguished which do not contain primarily a technological invention but rather a novel element directed to social cooperation and the social environment as its sphere of action.

I do not think any of these scenarios will come into effect in isolated form. In the future, creativity and market dynamism, techological progress and economic growth will remain the determining factors, although a certain shift of emphasis will undoubtedly take place. Technology will have to give more room in its calculations to the immediate effects on the individual, while innovations will meet with a notable degree of success on condition they correspond closely to the needs of society. I am thinking here of social problems such as transport, the environment, health care and the prevention of disease, education and occupational training.

Industrial companies will come to see themselves more in their relationship to the new social structures and will conduct their operations in conformity with these structures. The task before us is to incorporate the complex requirements of modern society into the innovation process so that, while we continue to draw upon the resources of science and technology, we are able to resolve the major problems that lie ahead. In earlier days, technology and the market demand dictated the economics of innovation. As time goes on the situation will be modified only in so far as man and his environment will have to be included as the third (and perhaps the most important) constituent in future innovations.

REFERENCES

Robert U. Ayres
Technological Forecasting and Long-Range Planning.
McGraw-Hill Book Company

F. Gross
Future drug research-drugs of the future Clinical Pharmacology and Therapeutics.
Vol. 14, No. 1, January-February, 1973, S.1-11

J.R. Killian, Jr. Cambridge, Mass.
Unser Zeitalter der Innovation.
(Rationalisierung), 11. Jg. 1960-10, S. 225-232

David F. Midgley
Innovation and New Product Marketing.
Croon Helm, London

Robert Kirk Muller
The Innovation Ethic.
American Management Associations, Inc.

Keith Norris and John Vaizey
The Economics of Research and Technology, Studies in Economics: 7.
Edited by Charles Carter, Vice-Chancellor, University of Lancaster

Nathan Rosenberg
The Economics of Technological Change.
Penguin modern economics Readings
(Zitate Usher, Ruttan, Schmookler)

J. Schmookler
Invention and Economic's Growth.
Cambridge 1966

Josef Schumpeter
Konjunkturzyklus
Vandenhoeck & Ruprecht, Gottingen, 1961

S. Utterbach
Recent Finding About the Dynamics of Product and Process Change in Innovation, Economy, Charge, and Technology Policies.
Stroetmann (Editor) Basel 1977

James M. Utterback
Innovation in Industry and the Diffusion of Technology.
Science, Vol. 183, 15.2.1974, S.
620-626

Editoral
The Anatomy of Successful Innovations.
Harvard Business School, 1-671-012 TI 87, S.28-36