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"A Critical View of Schumpeter's 'Theory' of Innovation"

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Abstract

This paper reviews Schumpeter's theory of innovation in light of the findings of a series of case studies in product design and development conducted at MIT in the 1990's and published in Richard Lester and Michael J. Piore Innovation, the Missing Dimension. The principle finding is that product innovation is a two-part process, with contradictory logics. One part of that process, analysis, is essentially problem-solving as understood and taught in engineering and business education. The other part is interpretation: It is more like an ongoing conversation where the participants explore in an open way the interconnections and relationships among disparate areas of expertise and communities of practice. Analysis places a premium on clarity and closure. Interpretation emphasizes ambiguity, and is open-ended. A technologically dynamic economy must somehow accommodate both processes.

These finding are at odds with Schumpeter's approach to economic and social analysis. The second half of the paper explores why this is the case. Where Schumpeter seems most insightful is the notion that a capitalist system is constructed around several contradictory ethos's. His ethos's (the business logic of the capitalist and the logic of the protective feudal shell in which capitalism grows up) are of course different from those that emerged in the case studies. But the structure of the argument is similar, and both point to the problem of institutional design. Unfortunately, Schumpeter himself has virtually nothing to say about that problem and seems to imply that it is unsolvable. On innovation itself, the problem is that Schumpeter's models of the economy and of society are basically static. Innovation is exogenous to his models. It is introduced from the outside by the "entrepreneur"; both the economy and the society, especially the latter, are hostile and resistant to innovation and the entrepreneurial process is one of confronting and breaking through that resistance. But the picture that emerges

> in our case studies is one of a society which is better modeled as open, and of successful innovation as a process of exploring that openness to find a place within it. The analogy is to language or the rules of a language, which leave space for individual expression and creativity and which evolve as that space is exploited. The economist who is most interested in and comes closest to modeling society in this way is not Schumpeter but Hayek.

This paper is the outgrowth of two quite distinct projects. One is a series of case studies in product design and development conducted over the course of the 1990's through the Industrial Performance Center at MIT with my colleague Richard Lester, a nuclear engineer. They constituted the basis for a book which we ultimately published entitled Innovation, the Missing Dimension (Cambridge, MA: Harvard University Press, 2004). The other is a long time interest in Joseph Schumpeter, which actually began as an undergraduate, but which I never pursued in a formal way. Part of the attraction of Schumpeter for me was his theory of innovation and technological change. In principle, there ought to be a relationship between Schumpeter's theory and our findings in the case studies, although in point of fact, I was never consciously aware of the potential parallels here until I accepted the invitation to this conference and began to think about this paper.

To jump immediately to the conclusion, the case studies led me to conclude that Schumpeter's views about innovation and entrepreneurship are ultimately a very misleading way to understand the innovation process, certainly in the kind of economy in which we live today, but ultimately I would guess in any economy. The point is developed in two parts below. The first part summarizes the case study findings and the argument that Lester and I developed in our book. The second part discusses the implications for Schumpeter's theory of technological change and innovation.

I. The Case Studies

The IPC innovation project centered on three case studies: Cellular Telephones, Medical Devices, and Garments (principally blue jeans). The three industries were chosen in order to get some variation across the types of innovation and the types of expertise involved. We thought of the cellular phone as a particularly radical break with existing technology; it was also an engineering innovation. The medical devices we studied drew heavily on basic science. We thought that garments would involve fashion rather than technology. In each of the studies, we sought a distribution of firms in the three major industrial regions of the world, North America,

Europe and Japan. We also interviewed extensively in firms in several other industries where we had good contacts. As it turned out, the basic innovative process we observed did not seem to differ very much along the dimensions that we though were important in selecting the cases. Companies differed as much within regions as they did across them, and the differences within each of the industrial cases were often as great as the differences from one case to another. A single underlying pattern emerged in all of the firms and each of the different products. That pattern was one in which successful innovation involved two distinct processes. We termed these processes analysis and interpretation. The analytical process emerged quite clearly with the engineers and managers in all of the firms in our study; it is well-understood and articulated in the engineering and management literature on product development. The people with whom we spoke were obviously familiar with this literature and drew their vocabulary directly from it, but they illustrated it with so many examples from their own experience that there was little doubt that it actually captured an important part of the reality of product design and development as they experienced and practiced it.

Analysis is essentially the process of problem solving or rational choice. The first step is to define and carefully specify the goals of the new product. A limited number of feasible design approaches are then identified. Each design is broken down into a series of independent components; each component is then optimized so as to achieve the design goals in the most efficient and effective way. Where several design alternatives are considered, each is developed in this way; they are then compared, and the single most effective alternative is chosen. In practice, this approach is more complicated and less straightforward than it appears in the simple model, and the literature, which is extensive, is devoted to identifying ways in which it might be achieved in practice.

There are new products, or more often improvements of existing products, which fit this pattern. But more generally, and particularly when technological innovation is not closely linked to a particular product, the basic design alternatives are not at all obvious, and before the design can be analyzed and optimized the broad character of the product must be specified. And thus the design/development process involves a stage prior to analysis in which the design specification ultimately emerges. We came to call this interpretation.

This second stage is not anticipated in the standard literature on product development, and the managers did not have a standard vocabulary or an easy way to talk about it. A phrase which cropped up repeatedly in the interviews was “you got to kiss a lot of frogs…”. But this

does not capture very well the nature of what managers and engineers actually described when pressed. What the interviews ultimately suggested is that in this phase people seem to "discuss" and "play around" with the new technology. As they do so, they look for how it might be combined with existing technologies and for ways in which it can be applied to products that will prove useful in this world and then image how those products will fit into daily life. This phase involves the crossing of barriers and borders, the merging of technologies and of different organizational cultures. It involves continual reference to and interaction with the social context in which the product is going to be used and the different technologies out of which the product grows are understood and practiced. It is here that our findings come most directly into conflict with Schumpeter's characterization of the social nature of innovation.

Each of our case studies illustrates the nature of this process and the contrast to Schumpeterian innovation, but in slightly different ways.

Cellular

The cellular telephone is the marriage of radio and telephone technologies, and the idea derives from military walkie-talkies and the radios used by police, taxis and fire departments. It was originally envisaged as a car-mounted device, mobile only in the sense that the vehicle to which it was attached was mobile. And it was not really clear who would use it or for what. Radio and telephone technologies involve two very different engineering cultures and business traditions. Telephones are historically highly engineered, and enormous emphasis is placed on quality. In the land telephone tradition, a call is virtually never lost. The system is produced by very large, highly sophisticated companies; their customers are equally large and sophisticated. The two sides of the market are thus expert in both the technology itself and the issues associated with its use and implementation. Radio engineers are by contrast "cowboys": They understand the technology empirically, and when there is a problem they play around with it until it is fixed. Variations in the quality of the signal are expected and not of great concern. Radio producers are very large and expert companies, comparable to telephone manufacturers, but their customers are small, often public service enterprises for whom the radio is an ancillary instrument, and definitely not central to their main mission. One important step in the development of cellular was to get the engineers from these two different traditions to respect and understand each other enough so that they could work together on the new product. But the other problem was to figure out how the product would actually be used. And that involved following the consumer

and recognizing that it had to evolve into a portable device that could be carried and would accompany people in a way which required integrating it into virtually all environments in which people live and work. To make the instrument portable, the borderlines between different components of the cellular system, which in the analytical phase of the engineering process had to be separately identified and independently designed, kept changing. This process is exemplified by the way in which the problem posed by the power source evolved as the instrument moved from a car-mounted to a handheld device and then became progressively smaller. To accommodate these changes, functions initially housed in the instrument itself had to move to the infrastructure, and what several companies initially conceived of as a division of labor and expertise broke down.

The distinction between the interpretative and analytical phases was particularly marked in the cellular industry. At some point in its evolution, each of the major companies we studied faced a financial and organizational crisis where it began to lose market and it became clear that major investments were required to remain in the industry. At that point, they reorganized their cellular divisions and, while the interpretative component was not completely suppressed, much more emphasis was given to analysis. This transition was especially marked at AT&T. The cellular division was initially housed in Bell Labs where the atmosphere, in contrast to that in the rest of the company, was particularly open and academic and where people freely interacted with each other without much concern for the "bottom line". In response to the crisis, however, the unit was moved out of Bell Labs, made a separate profit center, and reorganized into the traditional hierarchical lines of the company. Few of the managers from the Labs were carried over to the new division, which was staffed largely by people brought in from other divisions of the company, and communication within the division and between the cellular division and the other parts of the company which supplied parts and components became limited and highly structured. The shift in other cellular companies was less dramatic and less sharp, but the contrast to the informal and open-ended communication of the interpretative phase was similar.

Medical Devices

The underlying conflict between the interpretative process and Schumpeter's characterization of innovation is clearly apparent in our medical device case. The distinction between the initial idea or invention and its implementation in an economically profitable innovation which Schumpeter highlights is clearly apparent. But the innovation does not

involve, as he suggests, breaking out of the preexisting social mold, but on the contrary, it involves figuring out how to fit into it. The innovation we followed most closely grew out of the "discovery" that each organ of the body emits a distinctive set of electrical signals and that these signals follow a standard sine wave. This suggests that it is possible to monitor an organ by measuring the key parameter which characterizes that wave. The intuition was that this would prove an economically useful technological insight, and the "inventor" (originally a graduate student at Harvard) was able to launch a start-up and attract considerable venture funding on its strength. But the process of realizing the economic potential turned out to be involved and drawn out. Most organs were already effectively monitored (e.g., the heart) or not in need of close monitoring. The company finally focused on monitoring the brain to determine the effects of anesthesia in the operating room. At the time, anesthesiologists did this on the basis of their clinical judgment, and there was no perceived need for an alternative monitoring procedure. Hence, the company's first move into this market was to create the perception of need through a public relations campaign which placed articles in influential publications reporting the impact of inadequate or excessive anesthesia. Once the need for monitoring was established, they had to figure out how to win a place for this new piece of equipment in an already overcrowded operating room and integrate it into the clinical practice of the doctors there. This last and critical step thus involved a careful study through observation, discussions with practitioners and trial and error, of the social practice of the operating room, not to disrupt it or break it up, but to align with it.

This is not an unusual example, but instead appears fairly typical in biotech as technical change comes out of academic science at a far remove from the actual practice of medicine. A very similar problem was faced by a second company we studied whose technology enabled it to measure the DNA imprint of an organism but then had to find a disease for which medical treatment depended on this index, which was in effect a measure of viral load. The therapy for most diseases, it turned out, did not vary with viral load. The company finally focused on HIV, where doctors were finding that new drug treatments were most effective when tailored to the particularities of individual patients, and where the clinical judgment did in fact appear to be highly correlated with viral load. But here, as in the case of anesthesiology, the economic success of the new measure required the company to understand and develop a way of fitting their new test into the pattern of existing medical practice. A subsequent effort to enter the

Japanese market failed because of the company's inability to appreciate the differences between American and Japanese medical practice.

Garments

Still another example of the relationship between innovation and social practice is the clothing industry. We actually chose this case because fashion was thought to be the critical component of innovation in the industry and we wanted to understand the difference between fashion and what we thought of as "pure" technological change. We ultimately focused on the blue jeans industry, and particularly Levi Strauss, a company whose product design had been completely stable for over 100 years, but suddenly found itself in the 1980's facing fashion competition. The fashion in the blue jeans industry, however, was driven by the technology of the finishing operations performed after manufacture in industrial laundries (e.g., stone washing). The technology component required integration across three communities of practice (i.e., textiles, which had to be redesigned to sustain the finishing operations, manufacturing, and finishing) with different cultures and business traditions in ways reminiscent of the cellular case. But the fashion element required the company to develop an understanding of consumer culture in a way similar to that of the medical devices case. In contrast to medical devices, however, the social world into which the innovations in jeans had to fit was in motion, and what the company was trying to do was to anticipate the evolution of a social process so that it could be there with its product when the social process got there. This notion of a society in motion, driven by its own momentum, that is so central to fashion is basically inconsistent with Schumpeter's characterization of society as conservative and static and innovation as a destabilizing and disequilibriating force.

Understanding Interpretation

Ultimately, we came to think of the interpretative process as we observed it in our case studies as essentially involving an ongoing conversation among the different engineers and designers involved in the new technologies and between them and the customers whom they thought of as the ultimate consumers of what they were attempting to design. In the process of talking to each other in what seemed like an unstructured, meandering and undirected way, the different people involved in product development tried out various ideas and possibilities, but in some ways, more importantly, they learned to talk to each other and became accustomed to the

very different ways of thinking which each brought to the table. In a certain way, they learned to think like each other, or, to use another analogy to which I will return, developed a shared language. The difference between the analysis and interpretation thus seemed to be captured by a fundamental difference in the role of the manager in the two phases of development. The image of the analytical manager is one of a technician, a problem solver or, sometimes, a negotiator mediating among the competing goals of the members of the product development team, drawn as they typically are from different parts of the organization. The manager in the interpretative phase of the process is more like a hostess presiding at a cocktail party, selecting the guests to invite to the party, introducing them to each other and suggesting topics which might stimulate a conversation among them, ensuring that once started, the conversation flows freely, introducing new guests to the group or suggesting new topics if the conversation flags, diverting the conversation or breaking up the group when it seems about to degenerate into irreconcilable conflict.

The different roles of the managers reflect the profound, in many respects contradictory, differences between the two parts of the design/development process. Analysis is time limited; it presses for clarity and closure. Interpretation plays on ambiguity; it is open-ended and ongoing in time. If the conversation about alternatives is not at some point closed and a basic design chosen, the product will never reach the market. But if the conversation is closed prematurely, the wrong product may be designed; the design will be uninteresting and there will be no customers when it is completed. Competitive pressure discourages interpretation. It does so in part through the incentives which it creates for secrecy, which in turn forecloses the free and open exchange of ideas that underlies the interpretative process. But it also creates pressures to resolve ambiguity quickly and push toward closure. The problem is then how to combine these two antagonistic processes into a single institutional structure. That problem has been resolved in the past by creating institutional spaces sheltered from competition in the universities, in government laboratories and sponsored research, within large corporations (e.g., Bell Labs in AT&T), and in the regulatory processes. Many of those spaces have been narrowed or eliminated in the last ten years by institutional reforms modeled on the competitive market and designed to introduce market-like pressures in non-market institutions like the universities or the sheltered spaces, like Bell Labs, within large companies, threatening the economy's long run innovative capacities.

II. Our View of Innovation and Schumpeter's View

The structure of this argument is reminiscent of Schumpeter, but the underlying view of the innovation process is very different, and ultimately the difference reflects an even more fundamental difference in how to think about and to model society, and socio-economic processes more broadly.

Where the structure of our argument parallels Schumpeter's is in the idea that society operates on two very different and contradictory, even antagonistic, principles and that social continuity depends on the ability to sustain that contradiction. Schumpeter, of course, emphasized the contradiction between the pacifisms of capitalism and the martial values of the feudal class which were necessary to protect a capitalistic society against its outside adversaries; we emphasize the conflict between the clarity and closure of analysis and the ambiguity and the openness of interpretation. I imagine that the parallel is no accident and that it reflects a way of thinking that I absorbed early in my economic education. On the other hand, for economists raised as I was in the era not only of Schumpeter but also of Keynes, the contradiction leads one to think instrumentally about how to maintain the two principles within a single system. The problem of how to maintain both processes within a single organization was in fact a concern of many of the managers whom we interviewed in our product development cases; and although they had difficulty articulating exactly what the interpretative dimension of their activities involved, they were nonetheless solicitous of it and the need to preserve it within their organization. We observed a variety of different approaches even within the same industry. The problem of how to maintain these two approaches within a single economic system emerged, as I have already suggested, as a central theme of the book to which the case studies led. Coming to Schumpeter from our own studies, one cannot help but be struck by the absence of institutional design as an issue in Schumpeter's own thought. He has a fatalistic view of the conflict between capitalism and feudalism which is more reminiscent of Marx than of Keynes.

On the more fundamental issue of how one thinks about social processes, the view which emerges from our case studies could not be more different from Schumpeter's. Schumpeter characterizes both social and economic processes as basically static, tending toward a stable equilibrium, one, in other words, that is resistant to change. This process is actually modeled for the economy as a circular flow. In the case of the society, it is not modeled; but the picture which Schumpeter paints is one of a world of social practices that are static and resistant, even antagonistic to, change. Innovation—technological change—comes from outside of the

processes upon which Schumpeter focuses; it is exogenous to his analytical schema. The ideas which underlie technological change, one can imagine, come from a third process—the development of knowledge, for example. But for Schumpeter that process is not problematic and hence is not critical to the understanding of innovation. In later capitalism, innovation becomes institutionalized in the structure of the large corporation, which again poses an issue of institutional design which Schumpeter does not explore.

The Language Analogy

The model that better captures the social nature of the innovative process is one of language or language formation. A focus upon language is attractive because language is at once peculiarly human and preeminently social. It has the properties of being open ended and admitting the ambiguity upon which innovation plays while at the same time being well-defined and bounded. It consists of a series of definite rules and, at any time at least, a finite vocabulary, and yet it admits an infinite variety of expression. The language analogy also inverts the relationship between the individual and society which emerges in Schumpeter's characterization (and also in standard economic theory). For Schumpeter, individualism and society are in conflict and innovation involves the individual breaking out of social restraints. But in language, the individual and the collective or community are complementary. Language is a communal property and the individual needs the language to express and realize him or herself. Indeed, the individual can only realize himself/herself within such a community among others who speak the same language. To an outsider, all the members of a language community sound the same. Anthropological and linguistic studies suggest, moreover, that language tends to emerge and evolve through conversation, and that as it does so it moves from the clarity which we associated with analysis toward the ambiguity associated with interpretation. Thus, two initially isolated communities brought into contact with each other develop what linguists call a pidgin and the dictionary calls a trader's language, individual words without a real grammar and the well-defined referents which one might imagine are associated with the commodities of Schumpeter's steady state. But if contact continues, the pidgin evolves into a patois or creole, a real language with a grammar as well as a vocabulary and a tolerance for the ambiguity out of which innovation grows. In this sense, the interpretative process that we observed in our case studies appears to be essentially one of language development. The economist who was most interested in language as a model for economic evolution was actually Frederick Hayek, not Schumpeter.