INNOVATION AS COLLECTIVE ACTION: PRODUCTS, TECHNOLOGIES AND TERRITORIES[1]

Technological Innovation: Framing the Question as that of Collective Action

Learning and interaction are now widely accepted as central elements in the process of technological innovation: learning as that which allows agents to create dynamic advantages so that the force of imitation is outrun by the pace of innovation; interaction as the characteristic of complex systems, whether internal to firms o production units or between them and the environment, which articulates the economic phenomena of specialization and coordination. This line of reasoning, now well established in the literature on innovation in evolutionary economics, largely rejects the traditional notion of "induced" innovation and focuses attention, whether implicitly or explicitly, on the supply-side of economic life in general, and in particular on the institutions which deliver up resources crucial to learning and interaction.[2] Analysis is then concerned to decipher the mysteries

[1] This is an abridged version of chapter 5 of Michael Storper (1997), *The Regional World: Territorial Development in a Global Economy,* New York and London: The Guilford Press. An earlier version was published in *Industrial and Corporate Change,*(1996) v.5, 3: 761-790.

of innovative collective action: the forces that bind individuals into interactions that allow or stimulate them to create economically-viable innovations.

Yet the "supply architecture"[3] for innovations is not likely to be the whole story. The extreme diversity of outputs of modern economies implies that different kinds of products will “demand” different kinds of innovation systems. Each economy requires a specific type of innovation system to stimulate the innovative behavior which is consistent with its actual or realistically desirable trade specializations and output compositions. Products (or product-based subsectors, the equivalent of 5-digit SIC sectors) -- not establishments, firms, filières, branches of production, or territorial production complexes -- are the basic units around which innovative action can be supplied.[4] Understanding and promoting innovation, it follows, requires that we understand both the demand and the supply sides.

A system of innovation refers to the interaction of demands, attached to products, and supplies, attached to these organizational structures of the economy, as dual sequential processes "out of equilibrium"[5] and involving reciprocal selection.[6] In place of such concepts as the "old" system of mass production or Fordism and a putative singular "new" system of innovation (whether it be "Toyotism," "networks," "flexibility," "coordinated capitalism," etc), it is more appropriate to reason in terms of a diversity of possible (coherent, effective) innovative systems.

The demand architecture for systems of innovation defines a collective action problem for innovators, associated with each particular kind of product. By “collective action problem” is meant the rules and conventions which coordinate actors -- give them a common and coherent action context -- so that they can innovate in a particular kind of product area of the economy.

The first task in this analysis is therefore to build up an analytical picture of products as

domains of collective and reflexive action. On the basis of this picure, we will draw out in greater detail the three main aspects of their collective action realms, those which comprise the holy trinity of regional development theory today, technologies, organizations, and territories. By going about the problem this way, we will be able to see how these multiple aspects of the productive economy are tied together, and how the ties that bind them into coherent wholes are largely conventional.

Products, Uncertainty, and Action

We may identify four basic types of products, each associated with fundamentally different forms of markets and technology and hence defining different requirements for the coordination of actors in their development and production. These are ideal types, in the sense that they represent basic product characteristics which can be decomposed no further, something like building blocks for the more complex outputs of the economy.

Two principal dimensions of the product can be identified: whether it is standardized or specialized, on the one hand, and whether it is generic or dedicated on the other. The first opposition refers to whether the supply of critical inputs to the producer, such as the technology, information, and skills necessary to carry out production comes from a community of specialists, in which case such inputs are rare or costly and time-consuming to reproduce; or whether their supply is easy, and relatively cheap, to expand. It also refers to qualities of the product which are defined by the product's user. The second opposition is in terms of the structure of demand, specifically the degree of anonymity and uniformity of the client: generic products correspond to undifferentiated markets, while dedicated products are made for clients whose demands have precision and

personality, i.e. to whom the particular efforts of the producer must be targeted. The competitive process in capitalism is strongly marked by the identification of products according to this double opposition. For the producer, this is experienced as a type of market structure; for the user of the product, the way s/he approaches the satisfaction of wants.

A standardized product is made with a known, widely-diffused production technology in which quality is so widely attainable that competition comes to be inevitably centered on price. The specialized product, on the other hand, is made with technology and know-how which are restricted to a community of specialists. The quality of the product is always an important ingredient in the competitive strategy of these firms, where in the extreme case price becomes a secondary element in competition.

The generic product can be sold directly on the market, because its qualities are so well known (either through standardization of the product's qualities or through a well-developed brand name such that the product's qualities are conveyed in the name); the generic quality of the product, in other words, allows it to be sold via impersonal market mechanisms, the information being contained within the product itself (the pure case is a spot market). A generic product is thus typically associated with, and indispensable to, the construction of a predictable market, in the sense that its appeal to a large number of potential buyers at any given moment allows producers to estimate fluctuations of the market and thus plan their investments and allocation of resources (the law of large numbers).

A dedicated product, by contrast, is oriented toward a particular demand; its specifications or qualities are defined by the needs of a particular client or type of client. The limit case of dedication is customization, where the "market" as such reduces to interpersonal negotiations rather

than normal supply and demand curves. Dedication assumes less radical forms as well, as in differentiation to particular groups of clients. Dedicated products face truly uncertain markets because the ratio of number of products to number of clients reduces the feasibility of probability estimations of demand; the law of large numbers no longer works.

Frank Knight (1921)[8] distinguished two forms of market fluctuation: those amenable to a probability estimate, which he called risk on the market; and those fluctuations that cannot be estimated and forecast, which he called true uncertainty.

Knight distinguished two forms of dealing with fluctuations: one founded on reduction of risks by regrouping resources, the other founded on selection of individuals charged with reducing uncertainty. He labelled them, respectively, consolidation and specialization. In the first we find development of products intended for a mass of consumers who possess no individuality or "personality" for the producer; consolidation means aggregating these impersonal demands together so as to produce at high volume, which in turn (via the law of large numbers) offsets market fluctuations. In the second strategy, specialists are called in to reduce uncertainty via the quality of their judgement as to the needs of clients or the qualities of the output (whether these be aesthetic, functional, or scientific qualities); the specialist can do so better than the consolidator, whose judgement would not have the same degree of accuracy. These product qualities and the strategies that accompany them correspond rather closely to different types of markets and production technologies, as is seen in Figure 1.

Both uncertainty and predictability may be associated with either specialization or consolidation (standardization), according to two additional sets of constraints: those of the production technology at hand and of the costs and payoffs to using such technology. Every

product and its associated production process have definite technological contours. Making a dashboard is different from making a transmission, making clothes has little which is similar to making airplanes. Yet the organizational (and, as we shall see, economic) effects of production technologies reduce fairly straightforwardly to a few major issues. The scale of production is a result of the possibility for consolidation or standardization. The scope-variety of production has to do in general with the benefits of specialization (whether in particular operations, or in particular products), this specialization generally associated with rises in the variety of both, whether at firm or production system level.

Nontrivial uncertainties are resolved in constructing the market by selecting a product as generic or dedicated, and then by employing a consolidation-standardization strategy or one based on specialization. The problem is to resolve these uncertainties in a coherent way, given that there are many of them simultaneously at work. This resolution comes about, essentially, when actors generate conventions or rules-of-thumb, which coordinate their activities as producers and users. Each such set of conventions describes a *framework of action*, different for each basic kind of product, which we label a *world of production*. The theoretical notion of a world is meant to convey the interlinkage of people, organizations, objects, and ideas, with a certain indivisibility and wholeness. The central analytical content of this notion is that actions undertaken by various participants in the productive project are interdependent, and must be coordinated in order to arrive at useful and economically-viable outputs. Conventions, as rules-of-thumb, constitute veritable guides to "what to do," which differ from one basic kind of product to another; hence, they are cognitive worlds in which actors exist. These action frameworks are collective because individual decisions can only generate their desired effects if they are taken with respect to expectations which

are consistent with the expectations of those whose actions will have a bearing on the realization of our intentions. Efficient production comes about when uncertainties are resolved via economically coherent conventions; for each kind of product, some such conventions are appropriate and others are not.

For each kind of output described above, there is a corresponding world. Producers of dedicated products, faced with uncertainty, may thus in some cases be able to consolidate, and in other cases be obliged (or able) to specialize, their outputs. In the former case, uncertainty and consolidation (i.e. production of a high variety of dedicated products, generating economies of scale) generally means that they must follow markets extremely closely, which is why we may call their sphere of action the Market World. Note that this combination of standardized yet dedicated takes us beyond the usual simple opposition between mass production (standardization) and variety-based production. Examples of this world include, at one extreme, groups of small- and medium-sized firms which produce relatively short runs of products for highly fluctuating markets, as in central city garment or furniture complexes in the USA,[9] and at another, the high-volume versions of flexible production networks centered on large firms which are found in Japanese consumer durable industries.[10]

Producers of dedicated products who either cannot or do not want to consolidate, instead use specialization to increase the "personality" of their products, the interface between the know-how, specialized skill, or quality of judgement of producers and the particular demands to which the product is targeted. It is their ability to use such specialization to follow a series of changing demands, with specialization linking the capabilities of producers to the ongoing evolution of buyers' desires (themselves continuously redefined by what they understand to be the capabilities of the

specialist producers), which constitutes the main offset to uncertainty. Critical here is the existence of a community of specialists who redesign the product, on very short time horizons, by deploying their tacit and customary knowledge of the product's qualities and possible dimensions. This is a highly interpersonal community of knowledge developers, based on traditional acquired skills, where constant communication between members of the community is necessary to carry out this kind of technology development. One major communicative process essential to innovation is interaction between the producers and the users of technologies: an example of this is the equipment maker who adapts to the needs of final product producers in order to accommodate the rapidly evolving final output. Typically, such communities are concentrated in particular geographical areas where informal processes of communication are central to their successful operation. This sphere of economic action based on true communities of producers and buyers may be labelled the Interpersonal World of economic coordination. The Interpersonal World applies not only to the famous cases of certain craft-oriented European industrial districts,[11] but also to the most specialized parts of the high technology industries, as in non-merchant semiconductor production in Silicon Valley,[12] the software industry in the Ile-de-France,[13] biotechnology in San Diego,[14] or the medical and scientific instruments complex in Orange County south of Los Angeles.[15]

In the cases of generic products, the future is subject to a risk estimation: investment and capacity may be planned with greater confidence than in the other cases. Once again, both consolidation (standardization) or specialization may be options, depending on the availability and costs of technology. In the case of consolidation, large irreversible investments are called for, and products must be generated at high scale in order to offset them. Where economies of scale and long production runs dominate, as in many consumer durables industries, products are typically

made by large oligopolistic firms. Such firms are capable of operating production systems at national and international scale, distributing parts and components and assembly plants across the landscape and coordinating the whole, as in the car industry. In their direct production activities in the high-wage market economies, there are downward employment trends, due to automation and relocation, and in many high-wage countries the wages paid in these industries have stagnated. These outcomes are, to a large degree, inscribed in the conventions associated with standardization of the product, which makes it economically and locationally substitutable. This is the sphere of action we call the Industrial World, that of mass production, as in the Chandlerian-Galbraithian firm of the post-war period and as still carried out for certain basic industrial inputs and relatively undifferentiated components for consumer durables.

There are some generic products for which demands cannot be consolidated and economies of scale are limited Many high technology outputs reflect, for the producer, precisely this dilemma: their nature is to be based on the application of codified scientific or engineering knowledge, and/or to find widespread application, either as final output or as component of more dedicated products. Because either the basic knowledge or its applied form is not yet developed, there is nothing to consolidate or standardize; yet the very possibility of developing such knowledge requires producers to proceed (usually via large scale R&D investments) as if risk could be estimated in advance, by employing specialists in knowledge development. This is the sphere of large-scale science- and engineering-product development *par excellence*, or what we can designate the World of Intellectual Resources, developing products which are generic but dependent on extreme specialization of the key input. Basic industrial innovations are developed in this world of action and coordination.

This is a much more formal process than in the Interpersonal World referred to above. The formal processes of knowledge development rely on communication that can be stretched over large distances, because it is carried out at regular intervals in a planned fashion (through meetings, congresses, and private-sector projects with long planning horizons, where what is communicated involves highly codified and hence non-culture-dependent, cosmopolitan scientific or professional languages). This occurs inside oligopolistic firms in high technology today. But often overlooked is that these oligopolists are tied, for some of their cutting-edge technology inputs, into precisely the kinds of interpersonal communities described above. Many of the core components of their large-scale research and development projects cannot be entirely planned; there is technological uncertainty. This uncertainty requires scientific and technical personnel to be able to interact informally, in unplanned and uncodifiable ways.

There are, of course, many complications to the development of these ideal-typical worlds. Products do not in any way automatically call forth an appropriate organizational structure; in many cases, organizations have to experiment in order to find the structure that meets the requirements of products they have chosen to produce, and sometimes they fail because they are not able to get into the appropriate world. They try to produce a product without developing the action framwork needed to do so, leading to inefficiency or bad product qualities; they are beset by coordination failures in this case. By the same token, existing organizational structures have effects of orientation, which may propel them into certain worlds and make it unlikely that they enter others, at least without a difficult and risky process of managerial and organizational restructuring. Moreover, there is no strict identity between product and organization -- in a world of highly differentiated products, a similar group of outputs may be produced in somewhat different organizational configurations. In

general, we can say that products and organizations have important effects of mutual orientation and co-evolution.

The Problem of Innovation in Each World of Production

Technological change does not concern some worlds rather than others, but all of them. In global markets where competition centers increasingly on innovation, the most competitive production systems, whatever the product may be, evidence the development, absorption and deployment of asymmetric information, such that they construct absolute advantages and earn quasi-rents. We can identify the possible characteristics of the "innovation problem" for producers in each world, in two principal stages: first by pinpointing the the qualities of innovative products, and then by analyzing the economic pressures which follow from their combination of specialization/dedication or generality/standardization, in the form of the composition of profitability in each world.

Innovative Action and Product Qualities

By "qualities" of products, we refer to the particular kind of asymmetric information which constitutes an advantage over the average producer in the market at hand.

For the specialized-dedicated products of the Interpersonal World, e.g. differentiated quality production which is specialized to particular uses or targeted niches of clients, innovation must consist of <u>inventing new dedicated qualities requiring specialized resources</u>. Continuous refinement and modification, and mastery of materials and designs in ways that are not entirely

codifiable (through formal labor or scientific training off-the-job) and not highly amenable to being incorporated in or transferred via special purpose equipment, are at the heart of product-based technological advantage in this world. An important role in this development of dedicated-specialized qualities is played by user-producer relations, where groups of "dedicated" demanders (users) and specialized producers engage in a communicative process which underlies knowledge evolution.

For the standardized-dedicated products of the Market World, differentiated (or "flexible") series production is the form of dedication of the product to a narrow band of tastes or uses. Innovation in this world consists of inventing new dedicated qualities which are amenable to standardization. Advantage is constructed by producing objects which are standardized (in the sense of drawing on codifiable combinations of products already widely available in standardized form), yet dedicated to particular uses (in the sense of a combinations which are highly differentiated and targeted): the keys to such advantage are thus ability to respond to the market and to do so rapidly. Producers must either take new standardized-generic knowledge or product qualities and differentiate it rapidly and more than can other producers, thus following consumer tastes more closely, or they must do the opposite, by standardizing dedicated products through development of appropriate production techniques.

For the specialized-generic products of the World of Intellectual Resources, innovation consists of developing new generic qualities via the exercise of specialized capabilities. The creation of new scientific and technical know-how is based on the paradox of a community of specialists who function according to rules of method which are themselves known and reproducible; thus the knowledge they create is generic, but they can only create it by virtue of their specialization at the

moment. The knowledge will be widely usable, hence generic; but it cannot be produced by standardized methods. Its product is thus a key input into innovations of the other worlds.

For the standardized-generic products of the Industrial World, competition is bounded by widely available products, widely diffused standards of quality and consumer expectations, and codifiable knowledge which can be incorporated in special-purpose capital equipment. Innovation consists of inventing new generic product qualities amenable to standardization. It involves basic technological innovations, in the sense of taking generic qualities and standardizing them, breaking them into constituent parts and tasks. New generic-specialized knowledge (coming from the World of Intellectual Resources, as noted above) is made codifiable and widely reproducible. The initial producers who do this will be able to drop their prices rapidly and will enjoy a (relatively short) period of quasi-rents before other producers imitate them or reverse-engineer their products, at which time they will need to repeat the process of taking new generic-specialized knowledge and standardizing it. Their advantage, like that of those in the Market World, is always fragile.

Economic Pressures and Constraints in Each World

Each of the four worlds has a different set of problems to solve in order to reach profitability, because there are different multiple and conflicting influences on profitability for each kind of product. The constraints and possibilities for each world are quite different, as is the pattern of interaction of these factors. In the Interpersonal World, necessary economizing on short-term capital commitments makes increases in capacity quite difficult; producers must invest in specialized resources while maintaining a low capital-output ratio, and "cheap" increases in scope-variety are

one way to do so. In the Industrial World, by contrast, the goal is to maximize capacity and its rate of utilization, but this raises the cost of circulating capital, which can weigh down the profit rate. Firms must therefore continually push down unit costs via standardization and scale, but this in turn is costly in terms of capital, leading to a repetition of the effort to outrun both circulating and fixed capital costs. Recourse to low-cost capacity (price squeeze) subcontracting may also figure prominently, where quality controls can be effective and transactions costs can be managed.

In the Market World, rapid response to differentiated demands may carry with it a price premium, but to the extent that uncertainty prevents full process standardization, labor costs occupy an important role in price. Moreover, since the product is standardized, competition is stiff on the supply side (generally, supply exceeds demand for intermediate outputs), and there is severe downward pressure on prices.

In the World of Intellectual Resources, high value-added and investment costs are likely to be reflected in high prices, but they also detract from unit margins. Labor and circulating capital costs are very high, as is the cost of specialized labor.

We may now summarize the effects of constraints on innovation in each of the four worlds. In all cases, they consist of product-based innovations which <u>deepen</u> the advantage related to the particular kind of product quality coveted in that world, while (in the best of all circumstances) coupling them to process innovations which <u>offset</u> the constraints and contradictions of profitability. In the Interpersonal World, for example, this would mean increasing the specialized and dedicated content of the product in order to raise producers' margins so as to offset high labor costs and low rates of value added, while increasing capacity and scale through efficient economies of variety.

In the Industrial World, product innovations should widen the generic content of the

product in order to expand markets, thus raising scale and offsetting the nagging problem of capital costs; process innovations would also enhance scale, but once again by adding together different generic products through economies of variety.

In the Market World, product innovations should make the output ever more differentiated, or more rapidly responsive to emerging differentiated demands, so as to raise the producers' margins, while process innovations should, once again, confer greater scope-variety so as to raise the overall scale of production and capacity utilization in order to drive down unit costs.

In the World of Intellectual Resources, product innovation is concerned to expand generically-applicable new knowledge, in order to widen markets so as to amortize the very high labor and up front investment costs related to the mobilization of specialized intellectual resources. Process innovations (in the very broad sense of this term) should be concerned to make possible economies of scope-variety, i.e. the production of more and more generic knowledge advances by the same groups of specialized producers, so as to enhance the "scale" of their output and thus drive down long-term average costs.

Thus, in each of these worlds actors carry out product innovation by deepening their mastery of the essential characteristics of their product, while at the same time trying to attain the golden fleece of all production, higher scale and lower unit costs. But -- and this is crucial -- in the worlds already standardized, more scale comes from greater scope-variety; and in the worlds which are specialized, more scale would also come from greater scope-variety, since standardized-scale is inimical to the product output.

Innovative Productive Systems: Organizations and Territories

Much has been written in recent years about the organizational form of innovative firms and production systems. There is much descriptive literature on the ways innovative networks or "network firms" are coming to replace old-style hierarchical "Chandlerian-Galbraithian" firms. There is a theoretical literature on new organizational "equilibria" in innovative situations, where the network is the way that the needs for resource reversibility (to avoid technological lock-in) and the advantages of specialization and scale (now both an external as well as an internal economy) are reconciled.[16] Valuable insights have come from these literatures. Yet we often seem to be saddled with caricatures, consisting of networks, districts, cooperation, on one side, and old hierarchical oligopolies on the other. What is needed is a way to discriminate among organizational forms appropriate to the supply of different kinds of innovative capacities. Here we begin to move from the product's "demand" for innovative capacities to the organizations of actors required to supply them or, in the terms of the holy trinity, from technologies to the organizations of production and their territories.

Figure 2 presents the way this is done (in a very brief and preliminary way) for the different worlds of production. The right-hand vertical axis reproduces Knight's distinction between uncertain and predictable (though fluctuating) markets. Under conditions of true uncertainty, the capacity to plan and stabilize external transactions will be more limited than in those production systems where the probabilities and magnitudes of fluctuations can be reliably estimated. Thus, producers of dedicated products tend to have more variable external transactions than those of generic products. Note that this analysis differs considerably from the view of transactions cost economics, where it is the nature of productive assets (specific vs. non-specific, numbers, resulting hostage problems,

etc) which determines the volume and nature of external transactions. In their view, the distinction between standardized and specialized (which they would label "specific") would determine transactional patterns, with a tendency for standardized assets to have large numbers and hence, external-market transactions, and for specific ("specialized") assets to have small numbers, hostage problems, and hence to lead toward internalization. The explanation is different here, and predicted empirical outcomes are quite opposite. Note, also, that mere quantity of external transactions is not the sole issue, but the nature of those transactions, and in particular the degree of uncertainty or predictability associated with them: this latter should determine much about the unit cost of transacting and well as the qualities of the contractual or non-contractual relationship of the transaction.

The latter also requires a substantive view of what the transaction is all about. The horizontal axes of Figure 2 ask what principle is likely to shape the division of labor in production for each product, and hence what kind of coordination each production system requires, drawing from Richardson's (1972)[17] four-fold distinction between similar-nonsimilar and complementary-noncomplementary phases of production. We need to divide the problem of external transactions into two, clear issues which are often confused in the literature: transactions having to do with the management of "normal" production activities, and those having to do with asymmetric information development which underlies product innovation, our subject here.

Specialized and standardized products have different divisions of labor in production and in innovation. For the day-to-day production of specialized products, the division of labor centers on securing of non-similar but complementary inputs, i.e. a "vertical" division of labor. This principle is self-evident for certain products of the Interpersonal World, such as fashion- or design-intensive

goods or certain outputs of the mechanical engineering industries. A word of clarification is needed for the World of Intellectual Resources, however; what constitutes the difference between "production" and "innovation" in this world? Production involves the application of specialized intellectual resources to the development of new, but generic knowledge; as such, producers in the Intellectual world seek out other producers with non-similar but complementary forms of knowledge, which are then recombined into a "whole" generic innovation, as when highly skilled research teams in the electronics industry, in differently specialized firms, teams, or units, come together to develop a new chip design, a material, or even a whole subassembly such as a peripheral or software package. But the dedicated-specialized elements of these whole, generic innovations constitute the "innovative" activity of this innovative world, as in those who experiment with software languages (which are then combined into generic forms). In effect, these latter actors, who are "deep" innovators upon whom the Intellectual World depends, are themselves in the Interpersonal World (much of that part of the electronics industry which is in Silicon Valley, for example). Their external relations in innovation are with other specialists dedicated to similar problems. Thus, both of the worlds with specialized products have exernal relations in production which are non-similar and complementary, and external relations in innovation with other specialists, where knowledge frameworks are deepened within these small communities. The Intellectual World, however, takes those and then recombines them into new generic forms, often through formal traded interdependencies wih firms having complementary and non-similar talents, as in technology partnerships and strategic alliances between big technological firms.[18] These transactions rely less on territorial proximity than do those of the Interpersonal World (which, remember, contains the most specialized-dedicated parts of the high technology industries), where uncertain transactional

relations <u>within communities of specialists</u> and between specialists and users, are the basis of transactions. Hence, there is a tendency for these relations to be untraded as well as traded, to rely on non-contractual as well as contractual forms of governance, and frequently to have high levels of territorial proximity as the basis of the common action frameworks of the cooperating specialists. This means, moreover, that the Intellectual World has a complex double pattern to its external transactions: in "production," over long distances in predictable, formal, contractual governance regimes; in "innovation" in the circumscribed "districts" of the Interpersonal World. Many big high technology firms, for example, have relations "upward and outward" to other technology-based oligopolists, but continue to root their core technological capabilities in the Interpersonal Worlds of their home countries.[19]

For standardized products things are quite different. In the day-to-day production activities of the Market World, producers use external relations within the division of labor to secure similar and complementary inputs, i.e. to smooth out market fluctuations with additional capacity, whether this be horizontal or vertical in nature. In the Market World, we find Marshall's famous supply-curve interdependencies (they may also exist in the Interpersonal World, but they are not the central reason for its territoriality). In the Industrial World, such capacity smoothing tends to be the object of long-term contracts and spread over large geographical distances, because market fluctuations are predictable; this gives us the typical multi-regional or multi-national production system. In the Market World, uncertainty is present, and immediate availability of vertical and horizontal suppliers is required, with little secure future promised to them; the specialized production region with a large collection of firms typifies this system.

The use of external transactions by actors in the two worlds of standardized products are in

both cases designed to complement what they lack, not to deepen knowledge, as in the communities of specialists. In the Market World, product innovation is the continuous rapid differentiation of standardized outputs, the key to which is rapid and expanding recombination of differentiated standardized inputs. Territorial proximity can be of help here, and both traded and untraded, contractual and hybrid interdependencies are likely to be found. In the Industrial World, producers of standardized-generic outputs innovate by finding new generic outputs which can be standardized. Firms may do this directly in their Methods and Engineering Departments, through interconnections with third party innovators, such as universities or government agencies, or -- as is quite likely -- via relationships with innovators of generic knowledge in the World of Intellectual Resources.

Developing Conventions and Action Capacities

Innovation is thus closely shaped by the kind of product at hand, with the set of constraints and opportunities it defines in terms of product qualities, construction of the market (as a temporal structure of expectations), technological contours of the production process, and its associated components of profitability. It is also a problem of action. It depends on the creation of particular kinds of persons, i.e. with particular capacities for action. These actors are not alone, however. The actors essential to innovation in a given world of production must have mutual expectations which coordinate their actions under the specific forms of uncertainty in that world. The action problem is collective and territorial in nature.

The regional development problem associated with building such different systems of innovation thus turns essentially on building the capacities for reflexive, collective action and the

forms of coordination consistent with the kind of action required in each world. This resides in the construction of conventions that allow actors to act in a coherently coordinated fashion that generates economically-viable innovations. For each kind of product (with its particular form of uncertainty), the coherence and coordination to be effected by these conventions is different. Having established this substantive nature of a system of innovation, we may inquire as to its visible form: what kinds of organizational, institutional, and territorial conditions are appropriate with the creation and exercise of such capacities?

In the Interpersonal World actors must have the capacities to increase the dedicated qualities of the product by deepening the application of their specialized knowledge. This is done by developing the communities of persons in which such knowledge is created, refined and transferred. Though there are other strategies for redressing the latent problems of profitability in this world (e.g. attempting to standardize and increase the scale of production), such strategies are inconsistent with the continued existence of the world and its particular way of earning quasi-rents when it innovates. As we have seen, innovation in the Interpersonal World is inherently based on close relations between specialist producers, and close user-producer relations. The system of innovation for this world is inherently defined by the problem of knowledge deepening, and policies for the Interpersonal World must devote themselves to promoting the capabilities of specialist communities to deepen knowledge in concert with its dedication to the needs of users. Mission-oriented policies are unlikely to be very helpful for developing such products; diffusion-oriented policies, structured to encourage horizontal relations between government and firms will be most appropriate. Moreover, such policies should provide collective goods (services, especially) for clusters of products and producers, at a focused territorial level (e.g. the region). Finally, because

of the tendency toward organizational decentralization but territorial focus of the production system, such policies often need to address the tendency toward the formation of regressive coalitions, the downside of interpersonal relations, where solidarity turns into protectionism, exclusionism and closure.[20]

This is just part of the issue of capacity formation, however; the rest concerns capacities in production technology. The economic contradictions of the Interpersonal World have one great solution: major increases in scope-variety of production which offset the costs of production and the problem of capacity utilization. The problem here has to do both with finding technologies appropriate to such increased scope-variety, and with finding management techniques capable of realizing its benefits without destroying the community of specialists and its interpersonal character. Greater scope-variety and larger production units would imply greater internal hierarchy and increasingly formal external relations of production units which tend to depersonalize the production system, substituting bureaucratic knowledge for personal knowledge. If this destroys the ongoing deepening of practical knowledge and conceptual frameworks which are key to action in this world, it merely returns us to the problem noted above: instead of making the Interpersonal World more viable, it substitutes a world based on standardization, and a new set of economic constraints replaces the old one. Mission- and diffusion-oriented policies may both be appropriate here, as production technologies often require sustained economic and research resources and cover many different particular, but cognate, final output sectors. Mission-oriented components, however, need close and ongoing contact with final output users, both in terms of defining needs and in terms of determining economic feasibility. Rather than the pure form of a centralized (both organizationally and territorially) mission-oriented program, then, we may think here of a new, sectorally- and

territorially-focused, hybrid mission structure.

Innovation in the Market World centers on the degree and pace of product dedication. Innovation may also involve new conceptual frameworks for dedication such as closer ties to clients, faster changeovers, greater scope-variety to offset costs. Examples of the Market World include the central city garment or furniture complexes in the USA. Here, competition leads to something approaching spot market pricing with low levels of formal contracting and hierarchy. These complexes can respond rapidly to the market and subcontractors survive or die on this response capability. Innovation lies largely outside of the production system, in the Interpersonal World communities of designers, who themselves are subject to extreme levels of uncertainty. The economic constraints we pointed out earlier, i.e. the fact that downstream order-giving firms can place their suppliers into competition with each other because the inputs are based on standardized components or skills, make life extremely difficult for all concerned. The result is a tendency for severe downward pressure on subcontractor and supplier prices (i.e. wages); and, in general, product innovators must either find ways to increase the generic quality of their products in order to survive (the compromise found by Benetton) or become more specialized (moving toward the Interpersonal World). The pure "liberal" version of the Market World is a hard life for all concerned.

Apparently more stable and highly innovative versions of the Market World -- or we might call them compromises between the Market World and the Industrial World -- have been organized, via creation of institutions which reshape ecomomic coordination in these sectors. The mechanical engineering industries of southern Germany have used such institutions to reshape expectations, blending attentiveness to the market with the capability to mobilize long-term,

expensive labor and capital resources otherwise not available under the conditions of uncertainty characteristic of this world. The social "cement" which allows this to happen seems to have an interpersonal character: communities of persons in which voice is exercised over time, binding them to each other.[21] We may say, then, that collective action leading to innovation in capital-intensive products in the Market World rests on a paradox: the need to underpin the market with forms of social commitment. Thus, in development of high volume flexible production in the Market World, both mission-oriented and diffusion-oriented policies can be found: the former for certain kinds of basic capital goods, the latter for sector-wide assistance; but neither is fully hierarchical. Critical to this world are organizational forms which underpin progressive coalitions -- this includes both firm- and group organization (as in Japanese keiretsu) and contracting procedures -- so that volume, flexibility and learning are reconciled.

The problem of innovation in the Industrial World is clear and classical: formal corporate R&D to invent new generic product qualities compatible with standardization. Product innovation is a great deal more mysterious than process innovatio n in this world. In effect, such innovation has little to do with the rationalization of production processes. It is a form of intellectual work, applying standardization to new generic knowledge, crystallized in the product. It is now understood that this form of innovation is not contained within this world nor its firms, but involves a host of extremely complex external relations, to other worlds and to the public and private R&D infrastructure. Moreover, the breaking-in stage for truly new standardized-generic products -- the first few years when massive quasi-rents are earned, markets are shaped, brand- names created, and technological trajectories for the product set into motion -- often requires high levels of territorial proximity, between producers, Intellectual World innovators, production engineers,

customers, and service support agents.[22] After that, increasing codification of all these processes permits greater and greater territorial distance between them.

We know from hard experience over the past two decades that the Industrial World -- once heralded by Chandler, Galbraith, and others as the leading light of innovative activity, because the big corporation could plan its technology development programs -- no longer allows high-wage high-cost countries to get ahead. The advantages once possessed by the Industrial World's firms have been chipped away on two sides: the Japanese and German versions of the Market World combine standardization and dedication with more rapid changeovers of products, while consumers turn toward products of the Interpersonal World. Moreover, Industrial World firms in the developed countries are imitated by, or move to, cheap Third World production zones.

The ground for economically-viable innovation in the Industrial World is thus very narrow. Policy for innovative Industrial Worlds must truly identify new generic-standardizable products as its target. This means discovering such generic qualities which are not likely to be subject to rapid dedication and thus to easy imitation by firms in the Market World, and which are durable enough to not be subject to cheap Third World competition before investments are amortized. It is extremely difficult to protect such investments via legal means (patents, copyrights) today. Innovation in the Industrial World must also not be analytically confused with mere imitation of state-of-the-art products or production technologies; here, the constraint of very high capital costs and price competition will impede innovative quasi-rents, and subject high-cost developed country producers to Third World competition or, worse, competition from more flexible Market World producers. The travails of General Motors, attempting to imitate every Japanese product and process invention a few years after, comes to mind here; clearly, for at least a decade, they failed

to understand that the Japanese were operating in the Market World and not in the Industrial World. Though General Motors' performance is satisfactory in themid-1990s, it must be remembered that it suffered a large and probably permanent loss of market share in the 1980s.

This suggests that the main hope for the Industrial World on the production side is in the Market World and on the product side is in the Intellectual World. In the latter, innovation means invention of new generic qualities through the deployment of specialized resources. This is very costly and producers must operate via a paradox: in the face of high levels of uncertainty, they must proceed "as if" the latter did not exist, i.e. by going forth with methodologically coherent programs of R&D.

R&D in the Intellectual World involves three main groups of actors and their interdependencies. First are the "internal" agents of a given firm, i.e. its scientific-engineering-conceptual workers. The firm must invest in them and give them appropriate incentives. The society must create them and give them an appropriate identity. If these workers belong to large companies whose main activity is in the Industrial World, how are they to be given the culture they need to perform in the World of Intellectual Resources, whose principles of identity and collective action are so different from those of the Industrial World?[23]

For any given firm, such workers are specialists, coming from specialized milieux in some cases, dependent on interactions with specialists external to the firm in all cases. This is the second group: such communities of specialists are always, to some degree, based on interpersonal ties. They are frequently highly territorialized. This is why we find even the big firm technological partners to multinational strategic alliances often "sourcing" their inputs to those alliances from well-known technology districts in their own countries.[24]

Such workers, in turn, are inserted into alliances with their partners in other Intellectual World firms or units: this is the third group. The specialized workers in such firms must relate to each other through formal, traded inter- dependencies. The thorny question of the "terms of trade" now arises: how to execute contracts and other agreements with the correct ex ante incentives and ex post payoffs; here, it appears that there is a standoff between transactions costs and property rights (appropriation by agents): if we minimize transactions costs ex ante, then ex post rewards are not always correct; and vice-versa.[25] There is no way around the need to create appropriate conventions by which rewards are shared out, and it is doubtful that either contract law or formal management practice can resolve the question. How could policy intervene to create such "virtuous" social conventions about the rewards to innovators? Inducing firms to participate in formal and virtuous inter-firm relations might rest on the provision of certain kinds of collective research resources (mission-oriented research policies), but such provision would have to be carefully balanced with mechanisms to prevent closing ranks for protectionism and it would have to be carefully balanced in order to resist technological closure. Such policies would, in any case, have to be complemented by the standard fare of a highly performing private and public R&D structure: the university system, patents and property rights, internal R&D organization of firms, and so on.

This question might apply not only to the formal traded innovative relationships of the Intellectual World, but also to the frequently informal and territorialized technology-development relationships of the Interpersonal World. What sorts of conventions should policy attempt to develop for communities of specialists, if contracts and property rights alone cannot do the job efficiently? I venture a preliminary suggestion: the society's distribution of income to these

communities of people is critical. It has to provide them incentive to survive as communities, for their members to avoid exit.[26] Beyond such economic incentive, such communities -- as the producers of key innovative inputs to the Intellectual and Industrial Worlds -- must have their place in other mission- and diffusion- oriented policies. They must have their place as communities, and not simply as representatives of firms, whose interests are frequently too narrowly identified with particular product lines, and not with whole technological spillover fields. We have barely begun to think about the "community" quality of these groups of actors and the particular mechanisms by which they could be incorporated in systems of innovation and policies, as such.

Conclusion: the Different Territorialities of Innovation

There is a diversity of possible systems of innovation, where both the collective action problem of a world of production is involved, and the supply architecture appropriate to resolving that collective action problem by enabling the development and exercise of correct action capacities.

In addition, each demand architecture has a distinctive locational logic; there are many such logics in today's complex economy, ranging from highlly localized components to far-flung, organizationally-internalized networks; there is no single emergent formula that fits all products, all worlds of production. Corresponding to such locational logics, the ideal supply architectures of systems of innovation are many, with different degrees of territorialization, and mixes of qualitatively different territorial components, as is suggested in Figure 2. If we were to view things from the starting point of supply, or from the standpoint of particular territories, we would need to take these relationships into consideration. In any case, the subject of systems of innovation involves

no simple choice between different all-purpose "models of innovation," but rather a recognition of the fundamental diversity of modern economies as a starting point. Policy, in coming to grips with this diversity of coherent combinations of the basic elements -- products, collective action problems, actors' capacities, supply architectures -- must be oriented toward the substantive content of innovation in each world of production; their organizational and territorial architectures must enable actors to realize this substantive content, and to keep doing so over time.

NOTES

1. Dosi, Pavitt, and Soete, 1990; Arrow, 1962.

2. See, *inter alia*, the country studies in Nelson, 1993; and: Lundvall and Johnson, 1992; Porter, 1990; McKelvey, 1991; Powell, 1990; Haas-Lorenz, 1994; Feldman and Florida, 1994; Feldman, 1993; Andersen, 1992.

3. The term is from Borrus in Tyson, Johnson, and Zysman, 1989, although it is employed somewhat differently here.

4. For definitions of these terms, see Storper and Harrison, 1990.

5. Amendola and Gaffard, 1990.

6. But we do make an attempt in Storper and Salais, 1997.

7. Greater detail can be found in Storper and Salais, 1997, chapter 3.

8. Knight, 1921.

9. See, inter alia, Scott, 1988a.

10. The literature on this subject is so vast as to not need citation here. There are many contending characterizations of the ideal-type "Japanese production system." My choice of "high volume, flexible production" is deliberate.

11. See, especially, Bagnasco, 1977; Becattini, 1987; Cappecchi, 1990a,b; Piore and Sabel, 1984.

12. Scott, 1988b; Saxenian, 1994.

13. Storper and Salais, 1997.

14. Enany, 1991.

15. de Vet, 1990, 1993

16. Again, these issues are dealt with in detail in Storper and Salais, 1997.

17. Richardson, 1972.
18. Mytelka, 1990.

19. Dunning, 1988.

20. Recently debated for the case of Italy. See Forlai and Bertini, 1989.

21. For Japan, a central point in Aoki, 1989, 1990, as well as that of Dore, 1987; for Germany, see Herrigel, 1995.

22. There are no historical examples of an industry <u>not</u> having a close territorial core in their early years. See, on a theoretical level, Scott and Storper, 1987; Arthur, 1990b. For the story of the semiconductor industry, see Angel, 1994.

23. As suggested by the voluminous literature on different management styles, as in Intel versus IBM. See Saxenian's (1994) study of different firm practices in Route 128 and Silicon Valley.

24. See, inter alia, Mytelka, 1990; Dunning, 1988; Storper, 1992 (and Chapter Eight of this book).

25. Seravalli, 1992.

26. Exit as suggested in Storper and Salais, 1997 or Florida and Kenney, 1990.