Strategic Asset or Vulnerable Commodity?

Manufacturing in a Digital Era

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Manufacturing in a digital era, for companies and countries, can be either a strategic asset or a vulnerable commodity. For companies the question is: "When can production serve to generate and maintain advantage? Under what circumstances is the lack of in-house world class manufacturing skills a strategic vulnerability? When is it simpler and easier to just buy production as a commodity service? For the nation, or the region perhaps, the question becomes, "What can be done to make this country/region, an attractive location for world class manufacturing, an attractive place for companies to use production to create strategic advantage?

This paper develops three arguments. *First*, we resituate the argument about production in a digital age by revisiting the argument that a service economy will follow on a manufacturing economy. As we shall see, there was in fact an evolution and reorganization of production hidden within the statistics. *Second*, we put the emergence of the digital era into an historical context. *Third*, we consider the place of production in value creation and market position in three different types of sectors.

I. Manufacturing Matters: The Original Argument:[i]

The sense that we are living through a digital revolution suggests that as a national economy, we can safely exit manufacturing. The implication is that there will be a secure economic life doing software, developing digital applications and providing services, a whole array of activities that do not involve making things.

This logic is an extension, almost a translation into the 21st century, of the argument of 20 years ago about services and manufacturing. Because we were supposedly moving from an industrial society to a post-industrial or service economy, it would be all right for the American economy to lose manufacturing production and jobs. We had moved from agriculture to industry and now would undergo the next transition. But the agriculture into industry metaphor is itself misleading. The agricultural sector didn't disappear. When you fly across country from California to Washington you fly across the agricultural heartland of America. There is a lot of agriculture between California and the east coast. Farm production was reorganized, and the process of how you grow things in Nebraska and California evolved. Labor went away from the land into the inputs in the form of fertilizer and machinery. If Nebraska farmers stopped growing grain, the spraying companies in Nebraska would be out of business. They would be unlikely to fly down to Argentina each day to sell their services abroad. Pesticide free agricultural production in Denmark with limited workforces is possible with the use of GPS systems that allow marking of weed infestations for systematic monitoring.

Hence the original story about agriculture was never about the vanishing of a segment of the economy, farming and food production. Similarly, it turned out that the manufacturing story was not about the exit into services, but about the reorganization of production. It was rather a story about its reorganization and the change in the production supply chain and distribution channels.

I. Categories, Statistics, and the Myth of a Service Economy[ii]

Before turning to the digital story, let us consider why there was an enduring confusion about the supposed transition from industry to services. The overall notion is that manufacturing as a portion of the economy had dropped precipitously and the portion included in the category services had risen. **The precise numbers depend on what is counted and how. The conventional categories show private goods producing industries in the US declining toward 20%. Durable goods manufacturing fell below 8%. Private service producing industries have risen over 67%. Depending on how government is counted in (some would argue that no government expenditures are services) will determine the precise balance of services in the economy as a whole..**[iii] As we disassemble the numbers, the notion of the overwhelming importance of a "service" economy replacing an industrial economy will slowly dissipate. Let us consider the steps in the process.

Chart 1
The Source of the Confusion: Services

Personal and Social Services	Business Services
	Upstream vs. Downstream
	Strong Linkages vs. Weak Linkages

Let us separate business services from personal and social services. In the category of personal/social services we would put teachers and prison guards. Cynically put, personal and social services includes a whole series of caretakers, including valets in the old British days.

Then, let us divide business services, the remainder, into two categories; those activities upstream from production and those downstream from the point of production. What is the difference between downstream and upstream services? Go to an auto mall near where you live and look for a car. In many cases the same auto dealer structure will sell you a Ford or a Lexus. The dealer is downstream from production and doesn't depend on where the product was made. The downstream activity is not linked to where the good is manufactured. The dealer certainly does not care where the car was made, whether the Ford was produced in Brazil or Michigan, or the Toyota in Japan or the United States.

By contrast, the upstream activities are the ones going into manufacturing, supporting the production activities. The question is how tightly linked the services are to the manufacturing operation; whether they can be separated from the production and moved elsewhere. Those that cannot be moved are tightly linked; those that can be separated are loosely linked. There are the activities on the production line, things we obviously call manufacturing. There are services that go into that production line activity. There are ancillary activities such as window washing and those that are supportive such as back office activities or customer relation phone services.

There are two points that need noting as we disassemble these categories. First, consider the statistics. If the window washer, or phone service personnel, or billing service personnel work for General Motors, then those folks are manufacturing sector employees. If they work for Ace Window Washers, Back Office Temp Services, or Phone Service Outsourcing, then they are service sector employees. Whatever the firm, the employees are engaged in the same activities; but they fall in different statistical categories. So the statistic, services, is a confused measure that blurs *what* is being done, the activity, with legally *where* it is being done, its corporate location.

Next, consider the tightness of the linkages between the services and the underlying manufacturing activity. If General Motors moves to Brazil the window washers won't go with it. The Detroit window washer cannot wash windows in a Toyota plant in Japan. On the other hand many back office services can now be performed overseas. The back office activities and the customer support services are much more mobile than window washing; window washing is locationally tied. Even before the manufacturing moved to Brazil, the back office might have moved to South Dakota and the phone services to Bangalore.

Hence we must ask, what links these activities together? What strengthens or weakens these linkages. For this discussion, the question is the distinction between strong and weak locational and organizational linkages, which activities must geographically or organizationally stay together. And what is the glue that binds them? Indeed, in a digital era with easy communications, including data document transfer, these various back office and customer support services become even more mobile. Is a mastery of English and a sophisticated telecom infrastructure with global links, even if it has limited local ties, is all that is needed? Certainly, the ability to communicate fluidly and collaboratively over distances loosens the locational linkages, alters appropriate organizational structure, and changes control structures amongst other kinds of activities, as a distributed system of open source software development suggests.

In summary, we were never moving in any simple way from manufacturing into services. Not everyone became McDonalds' employees or a Lazard Freres investment Banker. And now not everyone will begin programming for Microsoft.

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II. The Digital Era in Historical Perspective

How then do we situate production in the emergence of a digital era? Let us try to put the digital era in historical perspective.

Chart 2

Production and Competition: The Evolving Model
Dominance -- Mass Production
Challenges -- Lean Production / Flexible Specialization
Comeback --Wintelism
The Digital Era

A. American Dominance: Fordism and Mass Manufacture

Mass manufacture, Henry Ford and all that, was the first twentieth century production revolution. Mass manufacture in the popular mind comes with the Model T and mass consumption. And that civilian production innovation, mass manufacture, also made possible the volume deployment of the tanks and planes that provide American and Allied forces an advantage.

What is mass production? Mass production is broadly understood to mean the high-volume of standard products made with the complete and consistent interchangeability of parts that could simply be connected using machines dedicated to particular tasks that are manned by semi-skilled labor.[iv] A range of features is hung on to that basic definition. The features include:

- the separation of conception and execution—managers design systems that workers, slotted into rigidly defined roles to match them to machine function, operate;
- the "push" of product through these systems and onto the market;
- large-scale integrated corporations, whose size and dominance reflected mass production's economies of scale, dominated the markets.

Scale implied rigidity, and the economic management counterpart of that corporate rigidity became the policy question of how to avoid business cycles. Booms and busts implied worker dislocations, and the social/political management counterpart of business cycle management became the political debate about how to use a public policy to cushion not only the economic dislocations but also the political dislocations. In any case, Fordist mass production was associated both with American industrial development, military success, and post-war hegemony.

B. Challenges from Abroad

Producers abroad, often with support of their governments, tried to imitate the American mass production model. Most failed; but some efforts at in imitation generated new rounds of production innovation, a second phase in 20th century manufacturing. In the 1960s the American automobile industry considered itself dominant, and the Cadillac was, due deference to Ford Motor Co., the exemplar of position and prestige. The dramatic Japanese innovations in production in the 1980s methods gave rise not only to lower cost higher quality production in everyman's cars, but to an entirely new set of luxury cars such as Lexus. The Lexus was built on the corporate base of the production of cars for everyman, but it also represented a challenge to the luxury market segment of specialty producers such as Mercedes and BMW. Some specialty producers adjusted; others did not. Mercedes and BMW understood that they had to do two things to keep their market position: keep their advantage in driving quality and improve the underlying comfort and amenities in the cars. They did both, aided by marketing that generated considerable pricing discretion.

The challenges to American manufacturing came from two different directions.

<u>Lean Production:</u> Let us consider the interconnected set of Japanese production innovations loosely called flexible volume production or Lean Production.[v] Japanese producers created an entirely new approach to volume production that culminated in lean production models.[vi] The mechanisms and sources of the Japanese flexible volume manufacturing system attracted intense attention because of the stunning world market success of the Japanese companies in consumer durable industries requiring complex assembly of a large number of component parts. Japan's automobile and electronics firms burst onto world markets in the 1970s and consolidated powerful positions in the 1980s.

The innovators were the core auto and electronics firms who in a hierarchical manner dominated tiers of suppliers and sub-system assemblers; the production innovation was the orchestration and re-organization of the assembly and component development process. The core Japanese assembly companies of the lean variety have been less vertically integrated than their American counterparts, but they have been at the center of vertical Keiretsu that have tightly linked the supplier companies to their clients. Characterizations of the Japanese production system emphasize that it provides flexibility of output in existing lines as well as rapid introduction of new products, which permits rapid market response. High quality measured in defects has come hand in hand with lower cost.

This distinctive approach to volume manufacturing, however labeled and characterized, emerged in Japan during the years of fast growth and was firmly in place by the time of the first oil shock in the early 1970s. The developmental strategies of Japan were essential to its production innovation. The distinctive features of the Japanese production system were a logical outcome of the dynamics of Japanese domestic competition in the rapid growth years making this a nationally distinct innovation[vii]. Indeed protected domestic markets and exports were decisive and generally misunderstood or, oddly, understated in the accounts of the emergence of the distinctive system of lean flexible volume production. [viii] Thus while the Fordist story highlights national strategies for demand management, this Japanese story of lean production and developmentalism highlights the interaction among the markets and producers of the advanced countries in international competition. Lean production was the focus of policy and corporate attention because it represented a direct challenge to both mass manufacturing and assumptions of American global economic policy.

<u>Diversified Quality Production/Flexible Specialization</u>: A second alternative to the classical American mass production model had little to do with the volume production strategies emerging in Japan. No single label or instance captured the popular mind. Different versions of the story have variously labeled this collection of innovations as Diversified Qualify Production and Flexible Specialization.[ix] The "Third Italy" and the Germany of Baden-Wurttemberg were the first prominently displayed examples of an approach in which craft production, or at least the principles of craft production, survived and prospered in the late twentieth century. The particular political economy of the two countries is shown to have given rise to distinctive patterns of company and community strategies. [x]

This second set of innovations, came from firms with diversified product ranges competing often with quality not price involves smaller runs of higher value added production. Competitive position rested on skills and flexibility, not low wages. These challenges often in high valued added niche markets came often from small and middle-sized firms rooted in particular industrial districts. "Craft production or flexible specialization", argue Hirst and Zeitlin, "can be defined as the manufacture of a wide and changing array of customized products using flexible, general purpose machinery and skilled, adaptable workers."[xi] Communities consisting of groups of small companies, organized in what are perceived as Twentieth century versions of industrial districts, are argued to be able, in at least some markets and some circumstances, to adapt, invest, and prosper in the radical uncertainties and discontinuities of global market competition more effectively than larger, more rigidly organized companies. "These districts escape ruinous price competition with low-wage mass producers," Sabel argues, "by using flexible machinery and skilled workers to make semi-custom goods that command an affordable premium in the market."[xii] The emphases in these discussions are the *horizontal connections,* the connections within the community or region of peers. This community of peers is certainly distinct from the *vertical or hierarchical connections* of the dominant Japanese companies.

C. The American Comeback: Wintelism and the Emergence of a Digital Era.

Wintelism is the transition moment out of an electro-mechanical era into a digital age. Twenty years ago it seemed that American firms were being beaten in international markets. It seemed that a flood of innovative entertainment products like the "walkman" and the VCR were joining traditional electronic products like televisions. The problem was not simply wages, we were discovering, but firms outside the United States also had the capacity to turn ideas into competitive product. As the semiconductor industry joined consumer electronics and autos as a sector under intense competitive pressure in the late 1980s, it seemed that the fabric of advanced electronics was coming unraveled. . ((Dates)) Then suddenly, it seemed that American producers were back. But we had not reversed the decline of production in elecro-mechanical products. Rather a new sort of electronics product had emerged, a new segment of the industry.

What is a consumer electronics product? [xiii] . A consumer electronics product is anything you can buy at a store in Berkeley called the Good Guys. They sell consumer electronics. You can walk in, buy a product off the shelf, with a three year return guarantee. If it doesn't work, you bring it back and have a new one.. There was the moment when consumer electronics sector went from being about TVs to being about digital communication and computing technologies. The world changed. At that same moment spin-off technologies became spin-on technologies (as leadership technical in may of these products moved to the consumer side.)[xiv] What is a new consumer electronics product. The "New" consumer electronics, as Michael Borrus has argued are networked, digital, and chip based. They involved products from Personal Computers through mobile devices. The nature of manufacturing and the sources of functionality change dramatically. The engineering skills moved to chip-based systems given functionality by software.

The process of creating value and the role of production changed as well. Consider the PC, the personal computer. Where in the value chain would you want to be? Do you want to be the producer of the final product, the box, even if, like Gateway or H.P., the box carries your logo? Or would you prefer being the producer of the constituent elements, the components of the system such as the chip, the screen, and the operating system. The value added is in the components, the subsystems, and in that sense that standards to which they must be built. Much of the value is in the Intellectual Property, formally in the components, often in partially opened but owned standards that create defacto IP based monopolies, or dominant positions. You have a big chunk of property in the chip, you have a big chunk of property in the screen. The result was a vertical disintegration of production. Outsourcing, a tactical response usually aimed at cost savings with a decision to procure a particular component or service outside the organization, evolved into cross national production networks (CNPNs) that could produce the entire system or final product. Then that discussion of cross national production networks morphed into a broader business discussion of how you manage the supply chain.

Let us state it formally: "Wintelism" is the code word Michael Borrus and I use to reflect the shift in competition away from final assembly and vertical control of markets by final assemblers.[xv] Competition in the "Wintelist" era, by contrast, is a struggle over setting and evolving de facto product-market standards, with market power lodged anywhere in the value-chain including product architectures, components and software. Each point in the value chain can involve significant competitions among independent producers of the constituent elements of the system (e.g., components, subsystems)—not just among assemblers—for control over the evolution of technology and final markets. CNPN is a label we apply to the consequent dis-integration of the industry's value-chain into constituent functions that can be contracted out to independent producers wherever those companies are located in the global economy. This strategic and organizational innovation, what we might now call supply chain management, means that production of even complex products can become a commodity service that can be purchased in the market. The nature of those chains, now often labeled Global Value Chains, varies with the complexity of the transactions, the codifiability of the knowledge involved, and the competence of the suppliers.[xvi] The strategic weapon for companies such as Dell moves from the factory to the management of the supply chain. And the supply chain itself is extended both into the marketplace and back into development.

Wintelism, though, was the transition from an electro-mechanical era into a Digital Age.

III. The Digital Age.

We have moved into a digital era in which communications and computing are central, in which many of the products and processes rest on digital technology. The era rests on digital tools for thought. "Information technology builds the most all-purpose tools ever, tools for thought. The capabilities created to process and distribute digital data multiply the scale and speed with which thought and information can be applied. And thought and information can be applied to almost everything, almost everywhere."[xvii] These tools for thought "amplify brainpower in the way the technologies of the Industrial Revolution amplified muscle power."[xviii] Certainly these tools permit the reorganization of production as communication and data exchange becomes easier. But more importantly, how do these tools alter the significance of manufacturing in a firm's strategic choices?

Digital tools affect the core process of creating and sustaining value. They permit the market to be segmented and then attacked with functionally varied product. *First*, a fundamental feature of the digital era is that analytic tools of data base management permit the consumer community to be segmented into sub-components, each with distinct needs and wishes. At an extreme, individuals and their particular needs can be targeted. Early on the insurance industry moved from using computers exclusively for back office operations to using them to create customized products for particular consumers.[xix] Thus collecting that information in a variety of forms, credit cards or grocery store purchases are obvious examples, is a critical matter. The result, of course, is a policy struggle about what information can be gathered, shared and combined. The wishes of companies and governments to assemble information from diverse sources into consumer profiles or threat assessments is set against individual rights for privacy and community needs for the integrity of the individual. *Second*, digital tools help respond to these now defined market segment; they help create functional variety in product. Standard product can be given diverse functionality. The coffee maker that automatically turns on at a particular time in the morning depends on simple digital functionality. The difference between many higher speed, higher price, printers and their slower, lower price, brethren is in the software that tells the printer how to operate.[xx] Let us overstate the conclusion. Electro-mechanical functionality of the Sony walkman or a Bang and Olufson high end CD system rested on proprietary manufacturing skills. The digital functionality of the coffee maker and an MP 3 player largely on commodity chips in products that can be assembled by commodity production services. This package of market segmentation and digitally based functionality makes production into a commodity.

New problems are created. When market advantages rests on proprietary product and market knowledge, protecting that knowledge, that intellectual property, is a central issue. Digital information makes product and process knowledge explicit and permits it to be stored in easily replicable forms. This is the case whether the firm is a media company, a company building routers, or Microsoft. When surgical technique can be formally expressed, the surgeon can be replaced by a robot. The surgical program becomes essential as hip surgery becomes a form of high end machining. It is plausibly easier to transfer, or lose control of, formalized knowledge than intuitively held know-how. Often what might have previously been embedded in an organizational know-how, as the accumulation of individual understandings, shrouded from view in final product, is now potentially transferable as a data file. Suddenly Intellectual Property, a creation of law and social agreement if there ever was one, becomes central to company strategy.

Finally, in our brief review, let us note that the line between service and product, which concerned us at the beginning of this essay, becomes blurred even more deeply in a digital era. Consider accounting. Accounting is a person-based service, a personal service provided by hordes of accountants depending albeit on tools from the original double entry bookkeeping system through computers. But if you create a digital program and put it on a disk or CD, put it in a box, and call it Quicken, and allow its unlimited use by the purchaser, then you have a product.[xxi] If you put the program on the web for access with support for use on a fee basis, then statistically you are likely to have a service, an ASP, an Application Service Provider. Next, consider pharmaceuticals. If NextGenPharma sells a drug to be dispensed by a doctor or hospital, or sold in a pharmacy, it is producing a product. With gene mapping and molecular analysis, we are moving toward the possibility of a service not product model of therapies adapted to particular physiologies. If NextGenPharma really is a data base company with a store of detailed molecular level drug information and a store of detailed genome functionality, it could sell an online service to customize drug or therapy. Slowly the distinction between product and service empties of meaning; we are left instead with the question with which we began. If what is being sold is a service, does that imply that sourcing the physical product as a commodity in the marketplace makes sense, that manufacturing skills are no longer critical?

IV. Production: Strategic Asset or Commodity

When is production a strategic asset, and when a commodity that can be purchased in the marketplace? There will not be a single answer, but rather answers that are specific to particular industries. Here we consider three different sectoral groupings, based on the sector's relation to digital tools and to production.[xxii] At an extreme some products can at once be digital and exchanged in entirely online marketplaces. At the other extreme there are products which remain physical, that are usually best evaluated in person (textiles and cars), and must be delivered. In the case of a car or refrigerator the IT instrumentality creates distinct controls and adds value. Yet, the underlying purpose and the source of functionality, transportation or refrigeration is something physical and not digital.

A. Digital Goods/Digital Markets[xxiii]

Let us begin with the most extreme cases, sectors such as finance and media where both the product can be a digital representation and the marketplace, even delivery of the product, could be on line. If production still matters in this extreme case, then we know the production questions will endure into the digital era.

What does it mean to make or produce an entertainment or financial product for delivery? Evidently, there is the creation of the underlying entertainment content or financial instrument, and then the digital construction, the programming or development of the digital product. Even pure software products, be it a Windows operating systems or the web structure for delivering an accounting service, are built.

Moreover, that digital product is part of a system; it rests on a server and is delivered on a network of digital equipment. More generally, for computers or telecom equipment, the core functionality is the information or data processing. The hardware is a simple instrument for the digital material. Digital processing lives in a hardware house. The digital functionality expressed through the hardware differentiates the products. The issue, which is distinct from our pure software products, is what hardware knowledge is required to effectively implement the software solutions.[xxiv] Is the semiconductor a commodity, as it is for Dell in a PC, or a proprietary chip as it may be for some telecommunications applications, or a specialty chip shared with other producers? That answer, commodity or proprietary house for digital IP, depends on the particular product and the particular hardware environment. And there is no consistency to the answers. Dell outsources its actual manufacturing and assembly, making its supply chain management into a strategic weapon. Dell's market link is the key; it has limited distinct product knowledge. Cisco likewise outsources production, but its distinct product knowledge is in the development of generations of equipment in which functionality is expressed through electronic hardware but determined by software instructions.

While manufacturing implies manipulating things and materials, its definitions in my on-line dictionary more generally talks of "the organized action of making goods and services for sale" and putting something together from components and parts.[xxv] Certainly our example, Quicken, qualifies as manufacturing by this definition, as does the creation of the Yahoo web site, and the assembly of the software tools that allow that web site to function.

But the word manufacturing implies smoke and factories. We require a new word, stripped of the grime of 19th century manufacturing. It may not be possible to fit the concepts we are developing of a word, manufacturing, already loaded with centuries of accumulated meaning. But why not just talk of production as the general case, and manufacturing as the specific case of physical production? In that case, production – the know-how, skills, and mastery of the tools required -- is absolutely central to the products in the digital sector. All the arguments about the linkages and mastery of groups of activities that we developed in the first section of the paper then would simply be revisted.

In sum we must broaden the meaning of a production worker from someone in a factory to an array of other activities. But when we do, the traditional questions, what should be produced or built in house, which can be outsourced, do not disappear. What skills are required to produce the digital product? Is the quality influenced by outsourcing? The question remains. They are just posed in a new context.[xxvi]

And the new context poses entirely new issues. CNPNs were precursors of global value chains, and supply chain management emerged alongside factory management. Data networks permit and facilitate these networked production systems, systems of a variety of different flavors. [xxvii] But the most dramatic evolution comes with distributed product development of software. It is not simply collaboration across distances of traditional software developers. Rather entirely new production systems have emerged in the Open Source Community.[xxviii]

Indeed, open source software may be the archetype of the digital era, a system of distributed innovation where tasks are self-assigned and where even the management of the innovation is voluntary.[xxix] It is quite a contrast to the archetype of the industrial era, the division of labor in Adam Smith's pin factory. Here the production of the classic good, the pin that had been made by a craftsman is now made by an "industrial" process. The capitalist sets the process and the divisions of labor, assigning tasks that subdivide the process. The two systems of political economy – Adam Smith's pin factory and Open Source -- rest, moreover, on quite different notions of property. Perhaps the enclosures were the archetype of property in the great transformation to a market economy that evolved into industrial era. Property was the right to exclude others from using what had been a commons. By contrast in a distinctive style of the digital age, open source software hinges on a different notion of property. Steve Weber writes:

> Property in open source is configured fundamentally around the right to distribute, not the right to exclude. If that sentence feels awkward on first reading, it is a testimony to just how deeply embedded in our intuitions and institutions the exclusion view of property really is.[xxx]

B. Sectors Based on New Processes and Materials.

At this other extreme from digital functionality, let us consider as a separate case emerging sectors based on new processes and new materials. An emerging sector such as nanotechnology is all about how you make thing. Biotechnology, likewise, is about how you make things. In these sectors the question of production, product innovation, value creation, and market control remain entangled. And, indeed, we would include here semi-conductor industry in which the underlying production process and materials evolve radically as transistor size shrinks, In this sector the question of production, product innovation, value creation, and market control remain entangled.[xxxi] A generation ago the industry was threatened when its ability to develop and source leading edge production equipment was weakening. The capacity to retain an innovative edge in product seemed endangered. (Now, the cycle comes full) after a generation in which design has often become separated from production, with foundries producing for pure design houses. Once again the question is whether product position can be held if the underlying technologies and their implementation in production systems cannot be maintained.[xxxii]

The strategic place of production is evident if we ask, who will dominate the new sectors? Will those who generate or even own, in the form of Intellectual Property rights, the original science based engineering on which the nanotechnology or biotechnology rests be able to create new and innovative firms that become the significant players in the market? Or will established players in pharmaceuticals and materials absorb the science and science based engineering knowledge and techniques, by purchase of firms that have spun out from a university or alternately by parallel internal development by employees hired from those same universities?[xxxiii]

There is an on-going, critical interaction among: 1) the emerging science-based engineering principles; 2) the re-conceived production tasks, and 3) the interplay with lead users that permits product definition and debugging of early production. Arguably that learning is more critical in the early phases of the technology cycle. Can a firm capture the learning from that interplay if it outsources significant production?

For the firm, the question is whether that interaction is more effective, the learning captured, within the firm or possible at all through arms-length marketplaces? As new processes or materials emerge, it is harder to find the requisite manufacturing skills as a commodity. Certainly, with new process and materials, new kinds of production skills become essential. Will outsourcing risk transferring core product/process knowledge, developing in others strategically critical assets. For the nation or region, the question is whether ongoing production activity is needed to sustain the knowledge required to implement the new science and science based engineering. In other words a regional or national government may not care if the learning goes on within a specific firm, as long as the learning is captured in technology development within its domain. Those intimate interplays have traditionally required face-to-face, and hence local and regional, groupings. With the new tools of communication, what happens to the geography of the innovation node is an open question.

In this second big category, it is evident that if a firm, or a national sector, loses the ability to know how to make things, to use production as a strategic capacity, then it will lose the ability to capture value. Whatever goes on in the labs at Berkeley, if you can't capture it in a product you can make and defend, then the science is not going to translate into a defensible position in terms of jobs and production.

C. Conventional Products with Digital Functionality and a Physical Function:

Certainly traditional markets will be altered by market segmentation addressed with digital functionality, as we noted above. Digital tools permit new answers to the fundamental question of how much people are will to pay for which products. Firms have new ways to identify who will pay how much for what, that is create products people are willing to pay more money for. But the story goes beyond that.

Digitally rooted online sales/marketing and supply chain management alter the links between a firm and its customers as well as suppliers. The Dell story how innovative uses of the net that tie customers from sales through to product build can create dramatic advantage.[xxxiv] And, as development and production processes are woven together to speed time to market and improve design choices, the lines between production, design, and development blur even more thoroughly. Then because the firm is constructing and evolving a complex evolutionary system not just procuring a set of defined components, more of the system – a larger portion of the value added – must be kept inhouse and not outsourced. More generally, if production becomes characterized by rapid turnaround and custom activity is the decision about where to locate production within the firm changed? Are the lessons of diversified quality production/flexible specialization that custom production and rapid turnaround imply tighter geographical and organizational links between production and development?

The range of products in this category is in fact too great to be put into a single set. Questions that must be answered in each case, though, are

1. What is required to implement the digital functionality?
2. Is a proprietary position required and can a propriety position be developed with outsourced digital development of hardware and software?
3. How much knowledge is now derived from production? Is it possible for rivals to enter the market based on their learning from producing?

Without production, how is innovation in the core product affected? How much production knowledge is required for next generation efforts?

But even these questions are conventional. We might ask an altogether different set of questions; when do the new tools alter fundamentally the underlying business models on which firms operate? When does market knowledge and new communication tools transform a product business into a service business.

IV. Conclusion

The digital era is defined by a set of tools for thought, tools, data communication and data processing technologies, that manipulate, organize, transmit, and store in digital form information, with information defined as a data set from which conclusions can be drawn or control exercised. The emerging digital tool set and networks mean that information in a digital form becomes critical to firm strategies to capture value and market position.

Business strategies and organization, the business models that define the links between objectives and implementation, have all evolved in response to and in implementation of these tools. And with that evolution, the meaning, not just the role, of manufacturing has evolved as well. The term production, as the act or processes of producing something, can encompass a range of products, digital as well as physical, and also delivery platforms that provide services. One implication clearly is that both matters of software and supply-chain management must be understood as questions of production as much as of service.

For a company the question is how to use production as a strategic weapon. For a country the question is how to be the most attractive location for strategic production.

When production changes very rapidly, jobs can be dislocated or altered. However, if production doesn't change, then those jobs become commodities and are vulnerable to innovation abroad or to moving abroad. For both company and country the question, differently framed for each, is how to adapt to the changing logics of production.

Does production matter? Absolutely, but production can either be a commodity that is vulnerable to relocation or closure or it can become a strategic asset. As corporate strategist and national policy makers, we must help make sure that production capability is a strategic asset that we control, not one that is used against us.

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[i] Stephen Cohen and John Zysman. Manufacturing Matters: The Myth of the Post-Industrial Economy, (New York: Basic Books, 1987)

[ii] ibid

[iii] Robert E. Yuskavage and Erich H. Strassner "Gross Domestic Product by Industry for 2002" http://www.bea.gov/bea/ARTICLES/2003/05May/0503GDPbyIndy.pdf (May, 2003)

[iv] James P. Womack, Daniel T. Jones and Daniel Roos. The Machine that Changed the World. (New York: HarperPerennial, 1991). See also Paul Hirst and Jonathan Zeitlin "Flexible Specialization: Theory and Evidence in the Analysis of Industrial Change" in J. Rogers Hollingsworth and Boyer (eds) Contemporary Capitalism: The Embeddedness of Institutions. (Cambridge: Cambridge University Press, 1997).

[v] Stephen Cohen and John Zysman. Manufacturing Matters: The Myth of the Post Industrial Economy. (New York: Basic Books 1987). Benjamin Coriat, "The Revitalization of Mass Production in the Computer Age" paper presented at the UCLA Lake Arrowhead Conference Center, Los Angeles, CA. March 14-18 1990; Ramchandran Jaikumar, "From Filing and Fitting to Flexible Manufacturing: A Study in the Evolution of Process Control" Working Paper 88-045 (Boston: Division of Research, Graduate School of Business Administration, Harvard University, c1988); James P. Womack, Daniel T. Jones and Daniel Roos. The Machine that Changed the World. (New York: HarperPerennial, 1991).

[vi] Chalmers Johnson, Laura Tyson, & John Zysman (Ed.). Politics and Productivity: The Real Story of How Japan Works. (Ballinger: 1989).

[vii] John Zysman and Laura Tyson, "The Politics of Productivity: Developmental Strategy and Production Innovation in Japan," Politics and Productivity: The Real Story of How Japan Works, Chalmers Johnson, Tyson, Zysman, eds. (Ballinger: 1989).

[viii] John Jay Tate. Driving Production Innovation Home: Guardian State Capitalism and the Competitiveness of the Japanese Automotive Industry (BRIE: Berkeley, 1995).

The argument is simple. The relationships of production and development in these productions systems are, at best, delicate. Just-in-time delivery, subcontractor cost/quality responsibility, and joint component development push on to the subcontractor considerable risk in the case of demand fluctuations. True, there were techniques to continuously reappraise demand levels and indicate to 'client' firms their allocations so that the client firms could in turn plan. This reduced unpredictability throughout the system. But if demand moved up and down abruptly, those techniques would not have mattered. True, government and corporate programs to reduce the capacity break-even point in small firms helped. Nonetheless imagine that Japan's emerging auto sector had to absorb continuously the stops and starts of the business cycle that typified Britain in the 1950 and 1960s. Would the trust relationships that are said to characterize Japan have held up? Could the fabric of small firms have survived to support just-in-time delivery and contractor innovation? Simply a smooth and steady expansion of demand typified the Japanese market in sectors such as autos and facilitated these arrangements and developments.viii The high growth rates--combined with the need to re-equip Japan in the post war years--created the basis of the continuous expansion. But domestic growth did fluctuate and the rivalries for market share led consistently to over-investment, or excess capacity, in the Japanese market. The story about Japan told by Yammamura and Murakami, Tsuru, Zysman, and Tyson, and by Tate in the case of the auto industry shows that the excess capacity was "dumped" off onto export markets. Seen differently, these exports permitted a steady and smooth expansion without which the production innovations outlined here would not have emerged. The developmental strategies of Japan were essential to its production innovation.

[ix] Wolfgang Streeck. On the Institutional Conditions of Diversified Quality Production; , Michael Piore and Charles F. Sabel, The Second Industrial Divide: Possibilities for Prosperity. Robert Boyer and J. Rogers Hollingsworth, Contemporary Capitalism: The Embeddedness of Institutions (New York: Cambridge University Press, 1997). Robert Boyer and Yves Saillard. Regulation Theory: The State of the Art (New York: Routledge Press, 2002).
[x] Charles F. Sabel, Horst Kern, and Gary Herrigel *Collaborative Manufacturing: New Supplier Relations in the Automobile Industry and the Redefinition of the Industrial Corporation*. (Cambridge, Mass: International Motor Vehicle Program, Massachusetts Institute of Technology, 1989); Charles Sabel Work and Politics (Cambridge: Cambridge University Press, 1982); Suzanne Berger and Michael J. Piore Dualism and Discontinuity in Industrial Societies (New York: Cambridge University Press, 1980). Paul Hirst and Jonathan Zeitlin "Flexible Specialization: Theory and Evidence in the Analysis of Industrial Change" in J. Rogers Hollingsworth and Boyer (eds) Contemporary Capitalism: The Embeddedness of Institutions. (Cambridge: Cambridge University Press, 1997)

[xii] Charles Sabel, "Flexible Specialization and the Re-Emergence of Regional Economies" in *Post-Fordism: A Reader*. Ash Amin, ed. (Blackwell Publishers: Oxford, 1994)
[xiii] Michael Borrus. "Left for Dead: Asian Production Networks and the Revival of US Electronics." BRIE Working Paper #100 (Berkeley: BRIE, April 1997.)
[xiv] Steve Vogel et al. The Highest Stakes: The Economic Foundations of the Next Security System, (Ed.). 1992. (New York: Oxford University Press); and Jay Stowsky. "Secrets to Shield or Share? New Dilemmas for Dual Use Technology Development and the Quest for Military and Commercial Advantage in the Digital Age" BRIE Working Paper #151 (Berkeley: BRIE, April 2003)
[xv] By vertical control we mean both *vertical integration* from inputs through assembly to distribution as in the case of American auto producers, and the *'virtual' integration* of Asian enterprise group as when Japanese producers of consumer durables effectively dominate market relations with semi-independent suppliers through the Keiretsu group structure. See Masahiko Aoki, *The Japanese Firm as a System of Attributes: A Survey and Research Agenda* (Stanford, CA: Center for Economic Policy Research, Stanford University, 1993). *The Japanese Firm: the Sources of Competitive Strength* Masahiko Aoki and Ronald Dore eds. (New York: Oxford University Press, 1994); Masahiko Aoki, *Information, Incentives, and Bargaining in the Japanese Economy* (New York: Cambridge University Press, 1988); Michael L. Gerlach *Alliance Capitalism: The Social Organization of Japanese Business* (Berkeley: University of California Press, 1992).
[xvi] http://www.globalvaluechains.org/, visited in May, 2003.
[xvii] John Zysman, Steve Cohen, and Brad Delong. "Tools for Thought: What is New and Important about the 'E-conomy'. (Berkeley: BRIE, 2001).
[xviii] Ibid
[xix] Barbara Baran "The Technological Transformation of White Collar Work: A Case Study of the Insurance Industry." (Dissertation, University of California, Berkeley: 1986)
[xx] Carl Shapiro and Hal R. Varian. Information Rules: A Strategic Guide to the Network Economy (Boston: Harvard Business School Press, 1999). (p. 59 refers to the versioning of IBM printers)
[xxi] Certainly downloading the program would also be sale of a product, but it confuses the presentation.
[xxii] Francois Bar. "The Construction of Marketplace Architecture." From Tracking a Transformation: E-commerce and the Terms of Competition in Industries" edited by the BRIE-IGCC E-conomy Task Force. (Washington, DC: Brookings Institution Press, 2001.)
[xxiii] This categorization follows Bar's, previously cited.
[xxiv] Clearly, the meaning of manufacturing, or production, changes as software becomes more important. At one point a central office switch cost tens of millions of dollars to develop and several thousand workers to manufacture. Then by the early 1990s, the development costs became a billion dollars, but with semiconductor, board stuffing, and automated assembly the manufacturing could be done with a few hundred people. Early versions of routers and Internet access equipment were really honed when the product was already in the field in the hands of very sophisticated early users, universities and early Internet Service Providers. And there were serious mistakes with stories of early product catching fire because heating problems were not resolved. In any case, if the product must work first time out for more conventional users such as telecom companies, the lines between development, production, distribution, and support vanish. Consequently, the manufacturing solution can be workable at the beginning. Is

assuring the product will work at the beginning of the cycle a design and development problem which can then be handed over to contract manufacturing folks, or does that design and development expertise require hands on internal production of the hardware?

[xxv] It seems appropriate to use the definition from an online dictionary. Wordweb Online Dictionary http://wordweb.info/

[xxvi] The critical question, once we acknowledge that software production is a form of manufacturing, is what are the most effective ways of organizing software production. For this discussion, the list begins with the conventional questions of whether to outsource, of where, geographically, to locate software development. The story becomes interesting when we ask whether to choose conventional hierarchical production structures typified by Microsoft or new alternatives such as the commercialization of Linux products developed in an open source model.

[xxvii] Niko Waesche. Internet Entrepreneurship in Europe: Venture Failure and the Timing of Telecommunications Reform (Northampton: Edward Elgar, 2003)

[xxviii] Steven Weber, *The Success of Open Source*. (Boston: Harvard University Press, 2002).

[xxix] ibid

[xxx] ibid

[xxxi] Michael Borrus, Jim Millstein, and John Zysman. "US-Japanese Competition in the Semi-Conductor Industry" (Berkeley, Institute of International Studies: 1982.) International Production Networks in Asia: Rivalry or Riches*?*, edited by Michael Borrus, Dieter Ernst and Stephan Haggard, (Routledge: 2000).

[xxxii] National Research Council, Charles W. Wessner, Ed. "Securing the Future: Regional and National Programs to Support the Semiconductor Industry." (Washington, DC, National Academies Press: 2003)

[xxxiii] What happened in semi-conductors development was that at a moment of new technology development, the when two major dominant established players – IBM and ATT – were restricted by Anti Trust competition concerns from producing semi-conductor products for sale in the merchant markets. But the Anti Trust ruling was critical to that outcome, and to the emergence of the merchant semiconductor firms. That merchant sector changed the course of the Information Technology evolution worldwide.

[xxxiv] Gary Fields. "From Communications and Innovation, To Business Organization and Territory, The Production Networks of Swift Meat Packing and Dell Computer" BRIE Working Paper 149 (Berkeley: BRIE, March, 2003); Martin Kenney and David Mayer, "Economic Action Does Not Take Place in a Vacuum: Understanding Cisco's Acquisition and Development Strategy." BRIE Working Paper 148 (Berkeley, CA: BRIE, September 2002).