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AICGS POLICY REPORT

PART TWO: INNOVATION IN THE UNITED STATES AND GERMANY: CASE STUDIES

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AMERICAN INSTITUTE FOR CONTEMPORARY GERMAN STUDIES THE JOHNS HOPKINS UNIVERSITY

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THE JOHNS HOPKINS UNIVERSITY

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FOREWORD

As two pillars of the global economy, the status and future of applied innovation in the U.S.-German partnership constitutes a long term challenge to decision-makers on both sides of the Atlantic, albeit for slightly different, if convergent, reasons. For the United States, a more robust relationship with Germany, and other EU members, in fostering technological innovation could prove to be the key to ensuring that the spectacular gains in productivity continue far into the future; absent such an impulse, the U.S. economy could once again—as it did in the late 60s and throughout the 70s—return to a low-growth path. But if a healthy innovation partnership with Germany and other EU members is important for the United States, it is, if anything, even more so for Germany. This is because the underlying dynamics of exploding social expenditures, spiraling deficits, and an aging population, combined with a dramatic shift in the global terms of trade in favor of low-cost Asian producers, have contributed to the slow growth of the German economy, which has only recently abated.

A less favorable environment in support of innovation will virtually guarantee another several decades of economic and social stagnation—to the detriment not only of Germany, but of the Trans-Atlantic partnership as a whole. An enhanced partnership in innovation, in sum, constitutes a major goal, and a major challenge, in achieving a more robust post-Cold War, post-unification partnership between Washington and Berlin.

The second volume explores how the United States and Germany, as preeminent industrial-technological powers, came to enjoy success in employing well targeted innovative strategies in the development and diffusion of key technologies. The case studies presented here look at the role of clustering and biotechnology, as well as the development of E-entertainment in both countries. By exploring several contemporary case studies of selected U.S. and German firms, drawn from the traditional, medium-tech, and high technology sectors, this volume uncovers the underlying principles and "best practices" that powered innovation in the United States and Germany in the previous century, and their potential relevance for an enhanced, mutually beneficial, partnership in the twenty-first.

Theo Dingermann, professor for Pharmaceutical Biology at the Goethe-University Frankfurt/Main, chronicles the rise of Germany from a gene technology no man's land to one of the leading countries in this field. He surveys both the strengths of the German system as well as some of the key barriers which still must be overcome if innovation in this field is to continue. Max Keilbach, of the Max-Planck Institute of Economics in Jena, provides an in-depth look at the clustering of innovative industries in Jena, which is becoming a mini-Silicon Valley in eastern Germany. He looks at the key factors which have fostered clustering in this region. While governments play a role in creating the conditions for innovative clusters, Keilbach stresses the importance of individual entrepreneurs in the success of these clusters.

Turning to the American context, Richard Seline and Yali Friedman of New Economy Strategies in Washington provide a concise but detailed study of the development of the biotechnology industry in the United States. They attribute the strength of the U.S. biotechnology industry as due to strong intellectual property protection, substantial financial support, and the development of entrepreneurial ecosystems. They argue that policymakers can provide indirect support and provide the political, academic, and commercial environments in which these industries can prosper, but the keys lie in the industries themselves.

Finally, Michel Clement of the University of Hamburg and Alexander Jahn of Bertelsmann in Gütersloh, look at the drivers of innovation in the E-entertainment industry in Germany, while Sean Safford of the Graduate School of Business of the University of Chicago and Dorothee Heisenberg of Johns Hopkins University look at innovation in hand held systems in Silicon Valley and E-entertainment in the U.S., respectively.

This project is undertaken as part of the AICGS Economics Program, which seeks to generate insights into the institutional, political, cultural, and historical factors that shape responses to deepening economic integration and the challenges of globalization. The three Policy Reports in this series explore the crucial role played by market-driven technologies in stimulating economic growth in the Trans-Atlantic arena.

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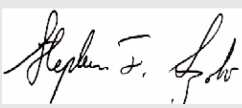

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RICHARD SELINE is the Founder and Principal of Washington, DC-based New Economy Strategies and has been working in the economic development arena for over eighteen years at the national, regional, and local levels. He has been recognized for his work in public-private partnerships, regional business climate analysis, and technology adaptation by numerous business organizations. Richard's work experience includes projects in Greater Washington D.C, Cleveland, Indianapolis, Pittsburgh, Philadelphia, Kansas City, and Texas, as well as on behalf of the Biotechnology Industry Organization, the U.S. Department of Commerce, the U.S. Department of Labor, and the National Alliance for Regional Stewardship.

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CHAPTER ONE
CLUSTERING OF INNOVATIVE INDUSTRIES

CLUSTERING OF INNOVATIVE INDUSTRIES IN GERMANY: THE EXAMPLE OF JENA

MAX KEILBACH

Spatial Agglomeration and Clustering of Industries are widespread phenomena that can be observed in all industrialized countries and for all kind of industries. Since Porter the reasons and impacts of this clustering have been studied widely.[1] The aim of this essay is to lay out the present state of the research on clusters and to illustrate this research with an example from eastern Germany, namely Jena in Thuringia.

The Types of Agglomeration of Industries

Most economic activity takes place in agglomerated areas, i.e., cities. But why does economic activity concentrate in one space? Generally speaking, firms or industries will cluster if they expect higher returns from being near other firms of their own or of other industries. Ohlin[2] considers three forces of agglomeration:[3]

Simple economies of scale, implying that firms concentrate their production in one location if large-scale production yields higher cost efficiency. Hence large-scale production automatically results in a spatial concentration of economic activity. This type of agglomeration is based on internal scale effects and agglomeration effects are related to transport costs. We will not investigate this type further in this paper.[4]

He speaks of localization economies if firms have an incentive to locate near other firms of the same industry. This type of economies arises from interaction between firms of the same industry. It will be discussed further in this paper

Urbanization economies create an incentive for firms to locate near other firms independent of their industry affiliation. These economies arise from interaction between firms of different industries and from the size of the local economy (i.e., the degree of urbanization)

While the third type of agglomeration economy is, in principle, independent of the type of industry and refers to mere returns to urbanization, the second type concerns interaction between firms of the same industry or of vertically related firms (supply chain relationships). For our purpose, we will denote the second type as clustering and the third type as agglomeration. In this essay, we will focus on clustering.

Why do Industries Cluster in Space?

Marshall was probably the first to investigate the phenomenon of spatial clustering. In the fourth book of his Principles he wrote:[5]

When an industry has thus chosen a locality for itself, it is likely to stay there long: so great are the advantages which people following the same skilled trade get from near neighborhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously.

While this quote illustrates well the attractiveness of specialized locations, it remains vague concerning the actual processes that are behind being near people of the same skill or of being where "something is in the air." In recent years, a large body of literature has emerged that has identified the following three forces generating localization economies: 1) Labor Market Pooling, 2) Spatial Concentration of Diversified Knowledge, and 3) Spatial Concentration of Industry Specific Knowledge. While it is useful to analyze these three forces separately, they often come together when we analyze real world phenomena, i.e., actual agglomerations. I will discuss these three forces and then suggest a synthesized approach to knowledge based clustering.

LOCALIZATION ECONOMIES THROUGH POOLING OF SPECIALIZED LABOR

In a region that hosts a number of firms in a certain industry, there is an incentive for potential employees to specialize in specific skills that are useful in these industries. This will make it easier for the specialized labor to perform on the local job market, i.e., to find a position in a local firm. On the other hand, firms in that industry have an incentive to locate in that region, since they gain access to a pool of specialized labor force. The proximity simplifies the screening process for both, workers and firms. What results is a self-reinforcing process in that firms in a specific industry tend to locate where specialized labor is located and vice versa. This process has been denoted labor market pooling in the literature.[6]

The spatial concentration of specialized factors is one of the four edges of the "Porter's National Diamond";[7] it can, however, be observed not only on the national level but also on the regional level. Examples are abundant. Some examples are the Hollywood filmmaking industry, car manufacturing in Detroit, shoe sector clusters in Italy (in Vigevano) and Brazil (in the Sinos Valley), or diamond manufacturing (in Antwerp, Netherlands). Examples for Germany are the watchmaking industry[8] (in the Black Forest and in Glashütte, Saxony), screws and bolts (in Künzelsau), print media editorial offices (in Hamburg and Munich), the banking sector (in Frankfurt), IT-technology (in Dresden), and biotechnology (in Mannheim / Heidelberg and Berlin).

As these examples illustrate, labor market pooling effects are independent of the innovation of industries, i.e., they can be observed even in very traditional industries that depend on a high level of necessary skills. While for established industries it is often advantageous to locate near specialized skills, this can potentially be an expression for very routine production processes. Innovation arises only through creation and acceptance of new ideas. The following two types of localization economies are related to the creation of new knowledge.

LOCALIZATION ECONOMIES THROUGH VARIETY OF KNOWLEDGE

Jane Jacobs argues that the discovery of new products or technologies will create a new kind of specialized job.[9] These new products will usually start as by-products and play an economically negligible role. Then, either the product is successful and a new industry will emerge or it is not, and the firms involved will vanish. The essence of her argument is that variety of existing products or technologies will inspire people and thus allow them to develop new ideas. Hence in Jacobs' view, it is variety that attracts creative minds and stimulates the creation of new ideas.

Jacobs mentions Detroit as an illustrating example. In the nineteenth century, this city was a regional center of production of agricultural equipment, with local presence of shipbuilding and machinery as auxiliary industries.[10] With the corresponding presence of specialized skills and the appearance of the steam engine and later the combustion engine, Detroit could emerge as the cluster of the automotive industry as it is known today.

While this example illustrates well the importance of variety in the evolution of new industries, it also illustrates that this process is mainly of importance for young industries. In that respect, this process is very important for the emergence of new industries and, hence, for industry clusters. Industries in later, i.e., more mature stages will rather benefit from local presence of specialized knowledge.[11] The following type of localization economies is centered around this phenomenon

LOCALIZATION ECONOMIES THROUGH CONCENTRATION OF SPECIALIZED KNOWLEDGE AND SPATIAL KNOWLEDGE SPILLOVERS

The further evolution of an industry is usually evidenced by the emergence of some form of dominant design.12 Correspondingly, firms who are active in that industry typically engage in routine processes of production and (very often incremental rather than fundamental) innovation. An illustrative example is the microprocessor, where a dominant design has emerged that can be produced in standardized production processes and that is improved incrementally, i.e., whose design of new versions builds on previous versions.

In that stage, firms create very specific knowledge on the technology and on the corresponding production process. In any industry this process implies a labor market pooling effect as discussed above. In innovative industries, i.e., in industries that focus on the creation of new knowledge, this process is accompanied by the creation and further development of specific technology oriented knowledge. In that situation, firms benefit less from the incorporation of a large variety of knowledge in the innovation process, but rather from a concentration on these very specific forms of knowledge.

Since new knowledge usually diffuses slowly over space this implies that innovative firms in a mature industry will benefit from being located near other firms of the same industry.[13] This creates a self-reinforcing process in the sense that firms tend to locate where others are already located and new firms of the same industry tend to be created in that same area. If this is the case, the industry will cluster in one specific region. This process of regional specialization is usually accompanied by the emergence of specialized suppliers, specialized regional institutions (such as universities), business organizations, and corresponding services (such as specialized consulting, public relations and venture capital firms). Hence, a local system of vertically and horizontally related firms and institutions can emerge that all revolve around a specific industry. Only if such a network of specialized firms and institutions has emerged, can we actually speak of a "cluster." Such a cluster simplifies the exchange of information and new ideas, fast communication between agents, and the screening of new business partners. Once such a system is established, it not only attracts existing firms but also simplifies the creation of new firms.

The archetype of such a cluster is of course the Silicon Valley with the creation of the IT-Industry.[14] Lucas[15] and Romer[16] have argued that if firms benefit from the knowledge of other firms (i.e., if "knowledge spillovers" exist) this implies that the pool of knowledge is used more broadly and can potentially generate strong economic growth rates. This would imply a self-reinforcing process where new knowledge can generate growth, which generates more knowledge through R&D, thus generating stronger economic growth. Again, the Silicon Valley can be given as an illustrating example for this argument.

However, the economic dynamics of a region that is specialized on a certain technology or industry depends of course on the dynamics of the industry itself. Only as long as the industry is able to renew itself, i.e., to generate new knowledge and to allow new ideas to emerge and get established, can these mechanisms work. Otherwise these self-reinforcing processes can turn from growth to shrinkage. Detroit is probably an example that turned from strong growth into downsizing.

Nevertheless, as much as the Silicon Valley is the archetype of innovative business clusters, it has turned into a role model for all regional policy makers (at least for Germany) who try to establish their own "Something Valley" in their region. However, it should be clear that clustering is not a "quick fix" for regional economic problems. Policymakers tend to neglect the fact that the roots of the Silicon Valley date back to the early fifties; it has grown slowly into what we know today and has been created by a few visionary scientists and businessmen rather than through policy measures.[17] The following section will illustrate this.

SYNTHESIS: THE CLUSTERING OF INNOVATIVE INDUSTRIES AS A SELF-REINFORCING PROCESS: THE ROLE OF ENTREPRENEURSHIP

Above, we argued that while it is useful to analyze the forces of industry agglomeration separately, it is difficult to identify either of these processes in its pure form when we analyze real world phenomena. Rather, all three processes usually play a role at different stages of the evolution of an industry (hence of an industry cluster) and can even work simultaneously in a region. To understand the creation and maintenance of an industry cluster, we should consider all processes together. Here, we aim to suggest a synthesized version of all three processes. Figure 1 summarizes this graphically.

Let us assume a region, which has no specific endowment in terms of natural resources or no specific industry concentration. Assume, further, that a person in that region develops a vision for a new product or technology that combines several pieces of existing products into a new one.[18] Typically, to introduce this new product, this person will create a firm, i.e., the person becomes an entrepreneur. If this new product is successful on the market, the entrepreneur will broaden his production and hire workers. These workers are not familiar with the product but they either have related skills from other activities or will be trained on the job. Hence, in this early phase, the entrepreneur benefits from a broad set of knowledge and of skills. With the production going on, workers develop related specific skills. A specialized labor force emerges.

If the product is successful and production will increase, traditional production methods will reach a limit in terms of output quantity and the necessary skills will become more and more sophisticated. This gap can be filled by R&D, i.e., part of the labor force will only deal with improvements of the existing product and corresponding technologies. This is also when universities come into play who might take on this function. A local set of skills and knowledge emerges.

Moreover, if the product is successful, the success will attract other entrepreneurs who either imitate it or try to offer slightly modified versions of the product. They tend to locate near the successful existing factory for several reasons: a) they are close to information about the new technology and their producer, b) they have access to a specialized pool of labor, or c) they used to work in the first company and then left it to start their own company (spin-off). A number of localized producers in the same industry emerge.

The more the industry-knowledge intensive, the stronger the risk that knowledge of a specific firm leaks out and will be used by other agents or firms. As a study by the Economist[19] has shown, this exchange of ideas happens not only in trade shows and fairs, but also in bars and other public meeting places. While this leakage of knowledge might be unwanted and disastrous for the firm, from the point of view of the economy, these knowledge spillovers increase the benefits from that knowledge. It might so happen that from this process, a new vision of another new product emerges from putting together the now new pieces of knowledge. From this, the process described here might start over again.

Admittedly, this process is described from the lens of entrepreneurship research. The idea that entrepreneurs are the agents responsible for combining the more uncertain parts of new knowledge and are taking the risk to create a new venture to bring a new product on the market is the essence of the "Knowledge Spillover Theory of Entrepreneurship" suggested by Audretsch, Keilbach and Lehmann.[20] This process could also be described starting with a university that develops potential innovations and thus launches the process illustrated in Figure 1. However, an innovation launched by a university will at some point still require entrepreneurial risk taking to bring the product to the market. The following section illustrates these processes using Jena in Thuringia, Germany as an example.

The Jena Cluster Approach to Innovation

BACKGROUND

With the fall of the Iron Curtain in 1989 and the subsequent unification of the two Germanys, the country was in an exceptional situation. Within one country, production facilities were either very advanced or completely outdated. Car manufacturing, for example, (which as of 2004 accounted for 21 percent of all exports and for one third of the producing sector's R&D expenditures) was technologically very advanced in the western part while the eastern part used production capital from the 1950s or even 1930s. Consequently, the production in eastern Germany was very labor intensive.

This situation was of course mirrored in the macroeconomic figures. With unification, Germany hosted the European Union's richest (Hamburg) and poorest (Thuringia) regions in terms of GDP per capita. Obviously, the demographic pressure and migration from eastern to western Germany was immense and led to a strong decline of (especially young) population in economically weak areas of eastern Germany. The pressure to create similar conditions in both parts of Germany was immense.

This was the hour of regional policy in Germany. As of now, the Institut für Wirtschaftsforschung in Halle (Germany) estimates that €1,500 billion have been spent in eastern Germany to rebuild infrastructure and housing, for economic subsidies, and mainly (roughly two thirds) for unemployment compensation.

Besides the recreation of infrastructure, the Bundesministerium für Bildung und Forschung (German Federal Ministry for Research and Education) launched a program (InnoRegio) in 1999 with the explicit objective to create regional innovative clusters, which were defined as links between SME's, financial institutions, universities, and public administrations and which were expected to revolve around a specific regional competence. The program has been endowed with €500 million and is still running. As of now, there is no scientific evaluation of this program; therefore, we cannot judge whether it has played an active role in the creation of innovative industrial clusters. The program shows, however, that the Federal Ministry tried to play an active role in the creation of clusters; hence, it understood that specialized clusters can potentially perform stronger in an industry.

While we cannot evaluate the impact of the InnoRegio program, we can still take a look at the present situation of innovative clusters in eastern Germany.

INDUSTRY CLUSTERS IN EASTERN GERMANY

Around 2005, roughly fifteen years after unification, the economic situation in eastern Germany is very diverse. While some regions still show a strong demographic decline, others show strong economic activity and—indeed—clustering of innovative industries. The strongest innovative clusters are

- Solar Cells: Frankfurt (Oder)
- Micro Electronics: Dresden
- Car Manufacturing: Eisenach, Zwickau, and Leipzig/Halle/Zschopau
- Optics and Precision Mechanics: Jena

Closer inspection of these clusters shows that they can all trace a longer history and are not results from simple post-unification regional policy.

From 1958 on, Frankfurt (Oder) was the base of VEB Halbleiterwerk where integrated circuits were produced. Hence, one of the bases of the now solar cell cluster was labor that was skilled but still about 20 percent cheaper than in western Germany. Nevertheless, the emergence of the market for solar cells certainly was due to a policy decision that obliged energy producers to pay very generous prices for electricity that had been produced by private solar installations and fed into their network. In that respect, one might argue that public policy is responsible for the emergence of this cluster. It is, however, rather by the creation of a market than by focused regional policy.

Dresden was also a center of microelectronic production, starting in 1961 with the creation of Zentrum Mikroelektronik Dresden (ZMD). Hence, the same processes as in Frankfurt have been at work. Nevertheless, one can argue that Dresden was more successful in settling international corporations such as Infineon, Qimonda, AMD, ZMD, AMTC, Toppan,

Short History of the Jena Optics Cluster

1558 Jena University founded

1800 Jena becomes a cultural center with Hegel, Fichte, Schelling, Voss and Schiller as University teachers.

1816 Carl Zeiss born in Weimar, Thuringia

1834 Carl Zeiss moves to Jena to study mechanics with Friedrich Körner at Jena University.

1840 Ernst Abbe born in Eisenach, Thuringia

1851 Friedrich Schott born in Witten, Westphalia

1846 Carl Zeiss starts up his factory and optical manufacture in Jena after being declined by official authorities in Weimar.

1860 Carl Zeiss employs twenty people. Production of microscopes is through a time consuming trial and error process with a high failure rate.

1872 Ernst Abbe develops the laws of optics in research for a more efficient way of optical production, upon request by Carl Zeiss.

from 1873 Increase in sales (of mainly microscopes) with increasing number of employees and demand for raw material.

1875 Ernst Abbe accepts an offer by Carl Zeiss and joins Zeiss company as an associate.

1882 Abbe and Zeiss convince glass producer Schott to move to Jena to meet the demand for specialized raw material.

1884 Start-up of JenaerGlas Schott & Genossen, manufacturer of specialized glass, by Abbe, Schott, and Zeiss.

1889 One year after Zeiss' death, Ernst Abbe founds the Carl Zeiss Foundation, which becomes owner of Zeiss company and of Jenaer Glas. The foundation supports local scientific research.

1932 Jena is the German center of the optical and precision mechanical industry.

1945 Management and CarlZeiss Foundation migrate to Oberkochen in the American Sector of Germany, forming what became later the Western-German optical cluster.

after 1948 Firms active in the optical and mechanical industries are grouped together to "VEB Carl Zeiss."

1988 VEB Carl Zeiss employs sixty thousand people, forming the largest Kombinat in GDR.

after 1990 Substantial downsizing of the optical industry and breakup of Kombinat into smaller companies. Significant diversification into optics-related fields such as laser production facilities for silicon wafers, Opto-Informatics, measurement, and control technology, etc.

Today Thuringia hosts 150 companies in the optical industries with nine thousand employees. Jena hosts eighty-one of these companies.

and Photronics, which employ nine thousand employees as of today. The region is sometimes named “Silicon Saxony.” However, it is not clear if this cluster is already self-sustaining. Dresden does, however, compete internationally with locations such as Singapore, New York, and Austin.

All the locations mentioned above were traditional sites for automotive producers with the Automobilwerk Eisenach being the oldest one (created in 1896). In 1928 it was incorporated into BMW. During the GDR period, it was the production site of the Wartburg car. Zwickau, Leipzig/Halle, and Zschopau were locations of different firms that founded Auto Union in 1932. This firm moved to Ingolstadt in West Germany after the war. The above locations were used to create IFA, the East German Kombinat that produced the Trabant car and MZ motorcycles. Today Opel and Porsche are located in these regions, building on a culture of automotive production that dates back to the late nineteenth century.

The optics innovative cluster in Jena will be presented in the next section.

These examples illustrate that what we know as innovative clusters in eastern Germany today date back to a (more or less) long tradition of production and innovation. Nevertheless, a recent study by Prognos AG provides evidence that regions with innovative clusters are among those with the strongest economic potential.[21] Figure 2 shows the regional distribution of “economic strength” on the level of counties (Kreise), which is a computed index from GDP growth, startup intensity, and innovation intensity. Here Frankfurt (Oder) ranks 266 and Dresden ranks seventeenth. Jena ranks amazingly high being ninth out of 439 counties (Munich is ranked second and Hamburg is ranked twenty-first). Indeed, today it is more difficult to find an apartment in Jena than in Berlin, a situation that is reverse to the one in the mid 1990s.

CLUSTERING OF INNOVATIVE INDUSTRIES: THE EXAMPLE OF JENA

The Jena optics cluster can probably be quoted as an archetypical example for emergence of an innovative cluster with the interaction between entrepreneurs, universities, research institutions, and the financial sector. The box on the next page gives a chronology of the most important events that lead to an emergence of this cluster.

The start was given by the foundation of Zeiss Optics Company through Carl Zeiss, who did his study in mechanics at the Jena University. As Zeiss was starting up his optical manufactory, the production of microscopes was through trial and error. A microscope was produced and simply destroyed if it didn’t show the expected characteristics. To circumvent these difficulties Zeiss contacted Ernst Abbe who was a Professor of Physics at Jena University.

Ernst Abbe developed the laws of optics that allowed a systematic conception of optical systems. This knowledge allowed the Zeiss company strong economic growth. Being grateful, Zeiss offered Abbe a position as company associate. The company experienced strong growth such that quality glass became a scarce resource. Zeiss and Abbe convinced Friedrich Otto Schott, a Westphalian glass producer, to resettle in Jena by promising him an institute for mineral research. Together they created the Jenaer Glas company, which subsequently became a market leader in specialized glass. This combination of knowledge and expertise—theoretical knowledge about optics, the capability of creating specialized glass, and the expertise in standardized production techniques set the cornerstone of the Jena optics cluster.

Although both companies, Zeiss Optics and Schott Glass, relocated to West Germany after the war (and gave rise to a West German optics cluster in Oberkochen), Jena—with the VEB Carl Zeiss—remained a center of optical production with more than sixty thousand employees in the late 1980s

JENA AFTER UNIFICATION: REEMERGENCE OF A SELF-ORGANIZED CLUSTER

While Jena remained a center of optical production during the GDR period, this phenomenon was of course determined by a centralized plan rather than by a self-organized process. Given that production processes were outdated at the time of unification, it was far from evident that Jena would remain a center of competence in optics. VEB Carl Zeiss is split into smaller units with Jenoptik and Carl Zeiss Jena GmbH being the two largest. The latter is subsequently incorporated into the West German Zeiss company, though remaining in Jena. Jenoptik specializes in laser technologies and corresponding measurement and control technology. The successful relaunch of Jenoptik and the incorporation of the eastern branch of Carl Zeiss into the western branch was probably critical for the Jena optics cluster.

Cantner and Graf investigate the emergence of innovation networks in Jena after the unification.[22] Using data on patents they investigate networks of researchers and their corresponding affiliations. Figure 3 shows the network of R&D cooperation and scientists' job mobility five years after the unification (grey ties denote cooperation while black ties denote job mobility).

We see that Carl Zeiss and Jenoptik are the central nodes in that network with a few smaller firms and the University (FSU) connected. The Fraunhofer Institution is also present but creates an isolated smaller network. The situation is different five years later. This is shown in Figure 4.

Here, Carl Zeiss is still the dominant company of the network. However, the university gains increasing importance; it is also connected to the Fraunhofer research institute. Overall, the degree of connection has significantly increased and the former Kombinate begin to lose their prominent role.[23]

Summary

Let us summarize the discussion in this paper as follows. Innovative clusters can emerge from the recombination of existing technologies into a new cluster from the combination of existing production techniques with new knowledge. In innovative clusters the knowledge creation and its diffusion can be faster. Therefore, regions can show superior rates of economic growth; however, these regions can also downsize quickly if the corresponding industry is declining. Increasing specialization generates the need for systematic research. R&D labs and universities then become more important. They can play an important role in the creation of a local knowledge pool. With specialization of production, workers develop a set of specialized skills. This makes the region more attractive for agents who aim to set up a new production in the same industry.

While this process has created a large number of specialized regions, it is hard to generate such a process through political initiative. For any cluster, at some point of its life cycle, there has to be some initiative from an entrepreneur who is willing to take the risk to develop the new technology or knowledge into a new product and to introduce it on the market. Hence, entrepreneurs are the agents of change who are the driving force behind the introduction of new products and behind the clustering of corresponding industries.

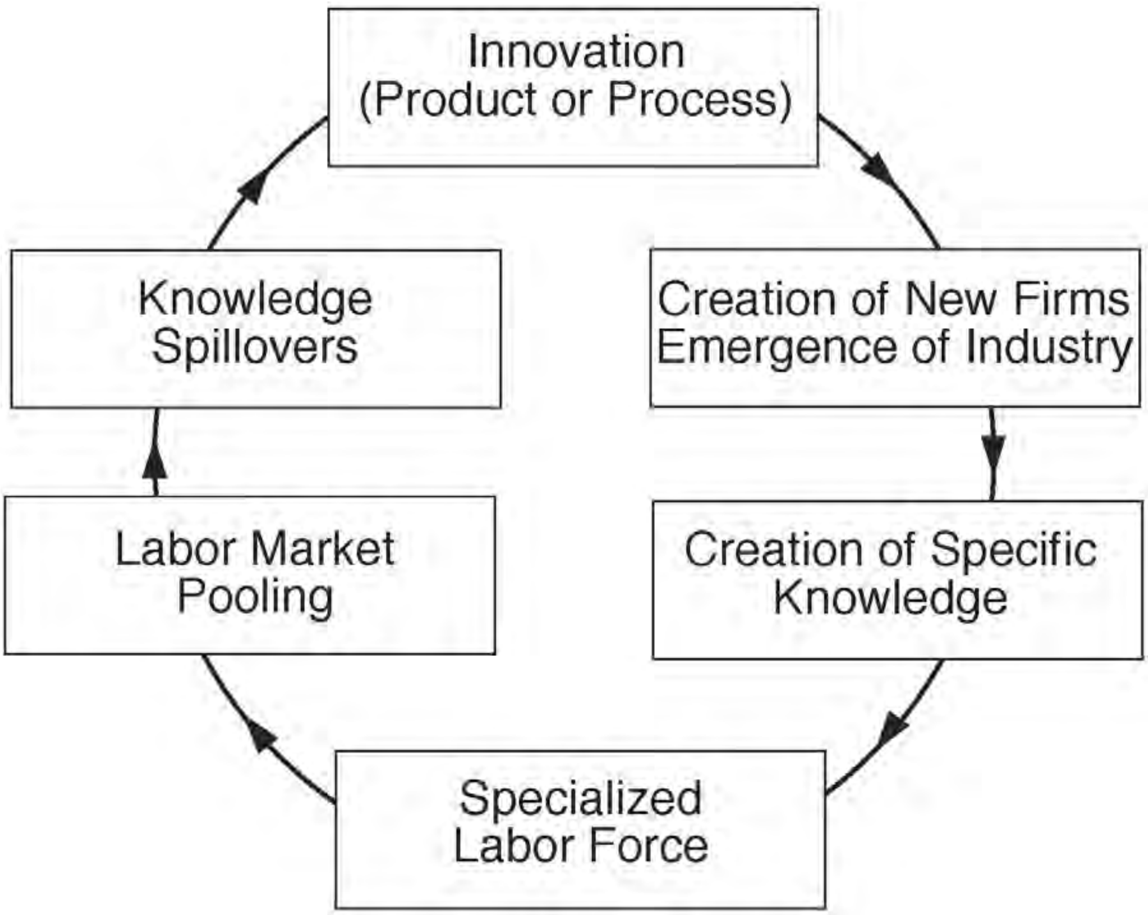

Figure 1: Circular Causation in the Creation of Innovative Clusters

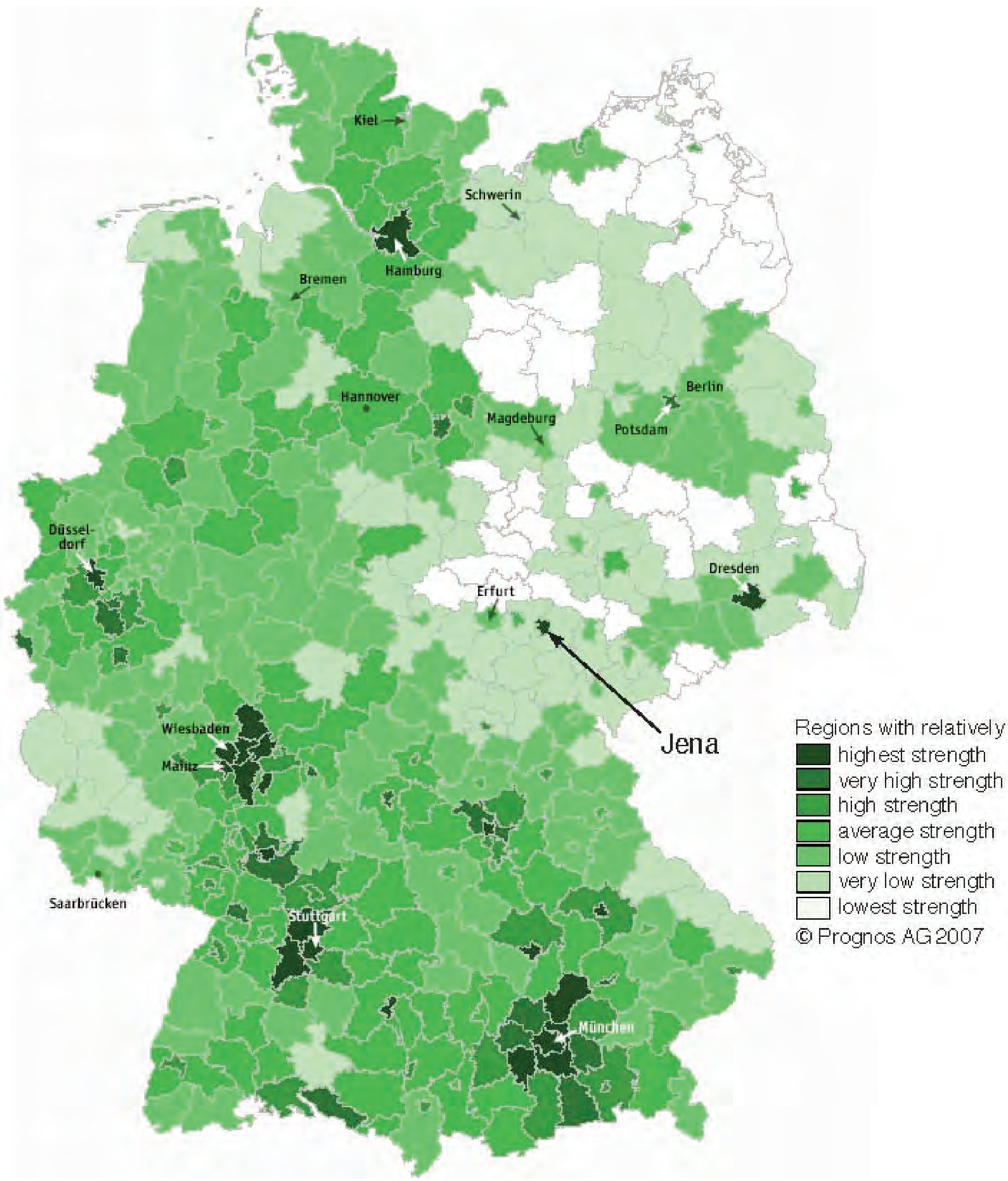

Figure 2: Regional Distribution of Economic Strength in Germany (From Prognos AG, 2007)

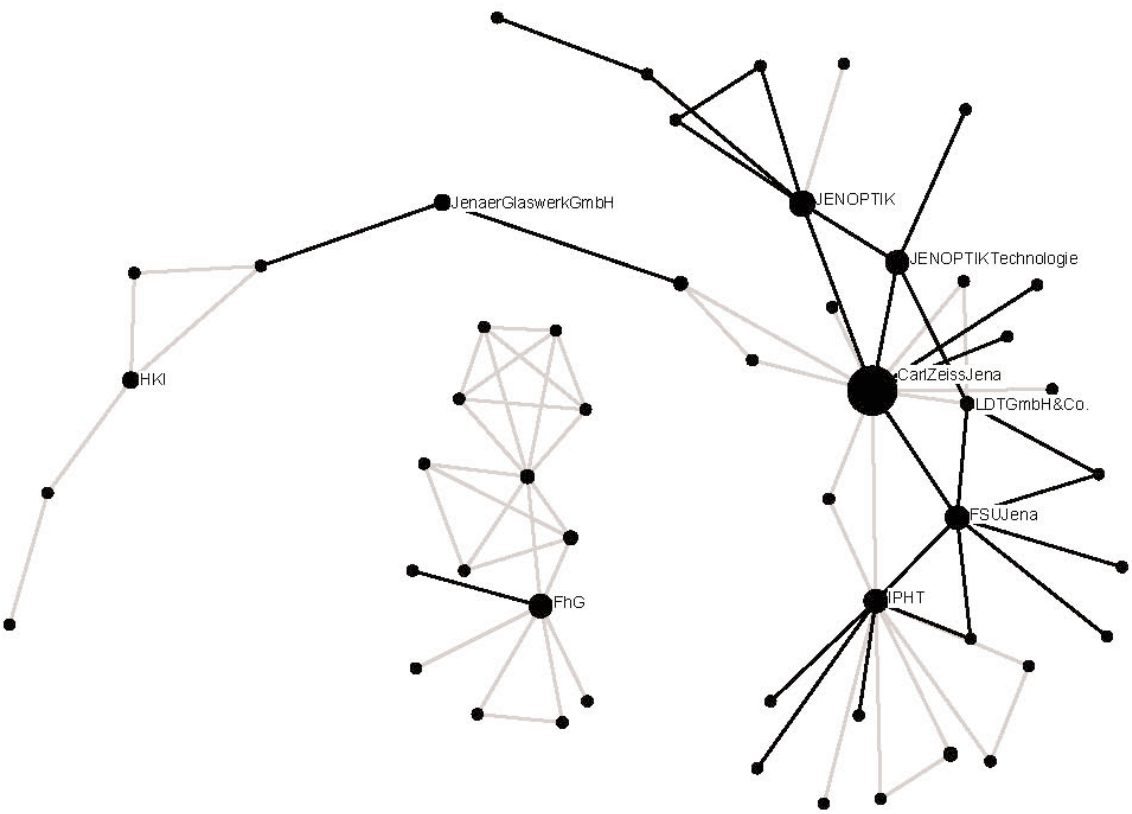

Figure 3: Cooperation and scientist mobility 1995-1997 in Jena

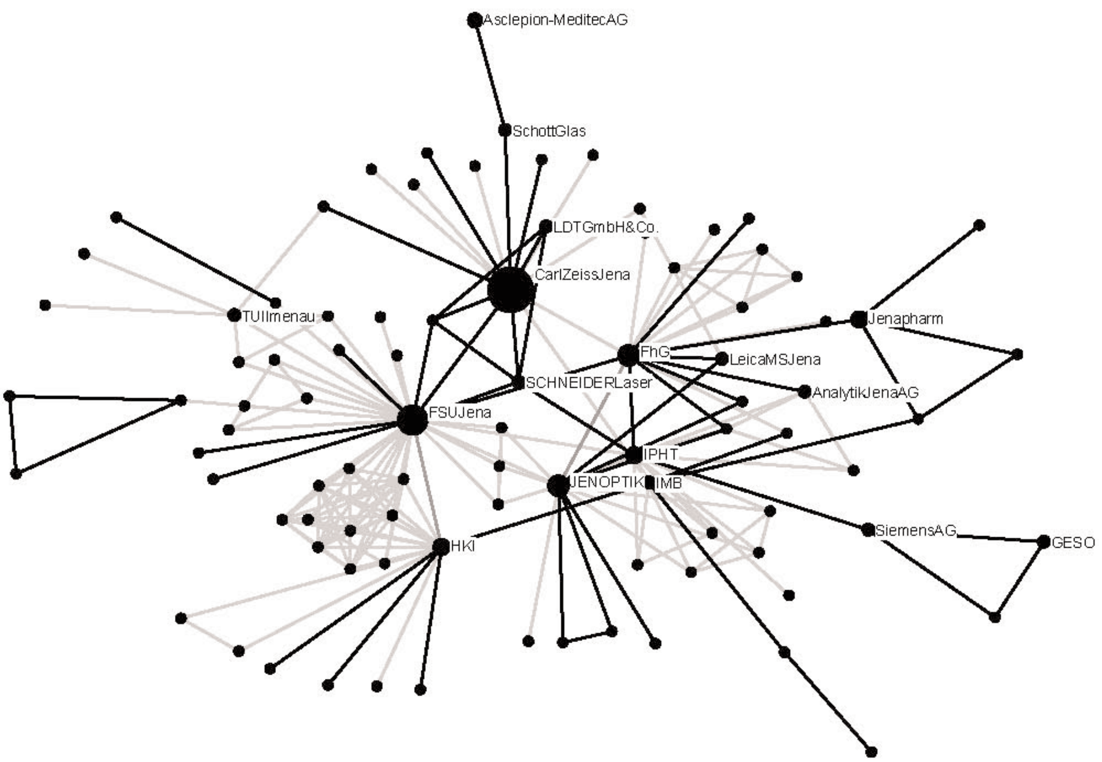

Figure 4: Cooperation and scientist mobility 1999-2001 in Jena

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1 M. Porter, The Comparative Advantage of Nations (New York: Free Press, 1990).

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6 See, e.g., J. Rotemberg and G. Saloner, Competition and Human Capital Accumulation: A Theory of Interregional Specialization and Trade, Working Paper No. 3228 (Cambridge MAL: NBER, 1990); and P. Krugman, “Increasing Returns and Economic Geography.” Journal of Political Economy (1991): 481-499.

7 M. Porter, The Comparative Advantage of Nations (New York: Free Press, 1990).

8 This is the German industry with the strongest clustering. See M. Keilbach, Spatial Knowledge Spillovers and the Dynamics of Agglomeration and Regional Growth (Heidelberg: Physica Verlag, 2000).

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10 E.g., the Detroit Edison Illuminating Company employed the young Henry Ford, who later founded the Detroit Motor Company and then the Ford Motor Company.

11 See, e.g., S. Klepper, (1996). “Entry, Exit, Growth, and Innovation over the Product Life Cycle.” American Economic Review, 86:3 (1996): 562-583.

12 See, e.g., R. Agarwal and M. Gort, “The Evolution of Markets and Entry, Exit and Survival of Firms.” Review of Economics and Statistics, 78(3) (1996): 489-498.

13 See, e.g., E.L. Glaeser et al, “Growth in Cities.” Journal of Political Economy, 100(4) (1992): 1126-1152.

14 See, e.g., A. Saxenian, Regional Networks and the Resurgence of Silicon Valley. California Management Review, 33 (1990): 89-111; and A. Saxenian, Regional Advantage. (Cambridge: Harvard University Press, 1994).

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18 Carl Benz, who mounted a combustion engine on a carriage to replace the horse, is an archetypical example.

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23 For a detailed statistical analysis of these arguments,see U. Cantner and H. Graf, The Network of Innovators in Jena: An Application of Social Network Analysis (Arbeits- und Diskussionspapiere No. 4). Friedrich Schiller Universität Jena. (2004).for a detailed statistical analysis of these arguments.

02

CHAPTER TWO
BIOTECHNOLOGY IN THE UNITED STATES

BIOTECHNOLOGY IN THE UNITED STATES: GENESIS AND CURRENT CHALLENGES

RICHARD SELINE AND YALI FRIEDMAN, PH.D

The biotechnology industry was born in the United States, and the United States is currently home to two of the largest biotechnology clusters in the world. We examine the origin of biotechnology in the United States, the factors which helped the industry grow to its present size, and investigate the emerging challenges stemming from internal and external factors.

The United States biotechnology industry has experienced tremendous growth since its origin in the late 1970s. According to the Biotechnology Industry Organization, there are 1,473 U.S. biotechnology companies, of which 314 are publicly held with a total market capitalization of $311 billion.[1] The United States is the birthplace of biotechnology, the home of the first dedicated biotechnology company, home to the largest biotechnology companies, and has a larger biotechnology industry than any other country. This paper traces the growth of biotechnology in the United States and investigates the underlying principles and best practices which powered this growth.

There are numerous definitions of biotechnology. Overly-broad definitions referring to crude fermentation and domestication of agriculture and livestock unnecessarily expand the scope of biotechnology beyond the recent revolutions in biology which are the root of the modern biotechnology industry. This paper adopts the Organization for Economic Co-operation and Development's (OECD) definition—The application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services—but limits biotechnology to modern scientific methods and technologies, such as gene splicing and similar techniques, and excludes traditional technologies, such as agricultural technologies, which have been in widespread use for centuries. These traditional technologies are based on different fundamentals than modern technologies and are impacted by different factors. Focusing on modern biotechnology permits a focus on the elements which have driven the bulk of recent growth in biotechnology.

In 2001 the United States Technology Administration's Office of Technology Policy conducted the first in-depth government assessment of the biotechnology industry in order to understand the characteristics of the biotechnology industry, to measure the contribution of biotechnology activity to the U.S. economy, and to identify barriers to growth and innovation. They found:

1. Biotechnology–related research and development accounted for about 10 percent of U.S. industry R&D in 2001. The ratio of R&D expenditures to net sales was 33 percent, almost three times as much as the next most R&D-intensive sector.

2. Average annual growth in net sales for biotechnology operations exceeded growth over overall business operations (10.3% v. 5.9% for 2000-2002).

3. The value-add of biotechnology business lines was at least $33.5 billion in 2001 or .33 percent of GDP.

4. Growth barriers identified by all respondents included the regulatory approval process and associated costs, access to start-up capital, the patent process and fees, and the complexity and cost of dealing with third-party intellectual property rights.[2]

Biotechnology in the United States

The current strength of the U.S. biotechnology industry can be attributed to three basic elements: strong intellectual property protection, substantial financial support, and development of entrepreneurial ecosystems. Other supporting elements such as a strong research infrastructure and a strong market for the products of biotechnology have contributed to the growth of biotechnology, but the aforementioned three basic elements were critical in helping to leverage the strong foundation provided by the supporting elements into a commercially significant industry. A notable exception, which will be discussed below, is proactive policymaking. While other countries seeking to duplicate American success in biotechnology industry growth are crafting proactive national policies, the United States biotechnology industry emerged prior to the implementation of many of the supportive policies which exist today.

Policy Timeline

The biotechnology industry was born from gene splicing technology, which was first demonstrated by Herbert Cohen at Stanford University and Stanley Boyer at the University of California San Francisco in 1973. In 1976 Boyer and venture capitalist Robert Swanson formed Genentech—arguably the first dedicated biotechnology company—to commercialize gene splicing. Genentech produced recombinant human insulin (a version of human insulin produced in bacteria) in 1978, later to become the first recombinant DNA-based drug approved by the Food and Drug Administration.

Genentech managed to produce the first biotechnology-derived drug before many of the current supportive funding vehicles and technology transfer policies were in place; the patentability of genetically-modified organisms was also not yet confirmed. While the policies which were developed since Genentech and the other early innovators saw their initial successes do play a vital role in the biotechnology industry today, the progress of these early innovators in the absence of these policies indicates that other supportive factors were at play.

1973	Cohen and Boyer demonstrate gene splicing
1974	National Academy of Sciences proposes international moratorium on gene splicing
1975	Moratorium lifted, safety guidelines implemented
1976	Genentech formed
1978	Genentech produces recombinant human insulin
1980	Cetus invents polymerase chain reaction
	Congress passes Bayh-Dole Act, permitting researchers to patent discoveries developed with public funds and to issue exclusive licenses
	Supreme court confirms patentability of genetically altered life forms
1982	Recombinant human insulin approved by FDA
	Congress passes Small Business Innovation Development Act, providing funding for translational research—research directed at exploring the commercial possibilities of basic research
1983	Syntex Corporation receives FDA approval for diagnostic test for Chlamydia trachomatis
1984	Congress passes Hatch-Waxman Act, establishing guidelines for generic pharmaceutical drugs as well as incentives for innovators
1986	FDA approves Chiron's recombinant DNA-based vaccine
	Coordinated Framework for Regulation of Biotechnology establishes more stringent regulations for recombinant DNA organisms than for those produced with more traditional techniques
1987	FDA approves Genentech's rt-PA for heart attacks
1988	Advanced Technology program established; provides cost-shared competitive grants to industry to support high-risk R&D

Strong Foundations

The growth of the semiconductor industry effectively set the stage for biotechnology. Semiconductors were discovered in Bell Labs on 23 December 1947 and eventually led to the creation of a new industry, creating a strong infrastructure for innovation development. Numerous existing and new companies converged on innovations in semiconductors and rapidly developed new products, establishing many of the paradigms in supporting research, development, and commercialization processes which enabled the genesis and the growth of the biotechnology industry.

New Economy Strategies developed the Innovation Lifecycle (Figure 1) to illustrate the relation between different elements necessary to drive innovation. The Innovation Lifecycle diagrams the elements involved in generating new ideas and developing profitable innovation ecosystems within regions. Regions with an alignment of economic, scientific, technological, and entrepreneurial resources are able to continually and collaboratively produce new ideas and new enterprises, ultimately leading to economic growth. In our model, funding granted to universities and research institutes is turned into knowledge (Figure 1, clockwise from upper-left quadrant), which leads to mature concepts and patents. These patents and concepts can be developed within research labs or licensed to start-ups and existing firms, which harden the concepts and patents into marketable products through additional research and product refinement. Many regions have abundant innovation assets (i.e., productive researchers, available funding, entrepreneurs, senior companies, etc.) but are ineffective in identifying and transferring technologies from research labs to developers. A key challenge in this “technology transfer” from researchers to developers is to compel researchers and developers to cooperatively identify valuable technologies and foster their development. As technologies are moved to existing or newly formed entities for development, a need for additional scientists, engineers, and technicians emerges, benefiting the local economy by creating new high-paying jobs.

In order for the Innovation Lifecycle to turn, the system must be “primed.” The most logical point at which to prime the system is knowledge development. Funding is granted to basic researchers who must compete for grants based on the merit of their research. In this way, the government is able to influence the direction of research and, consequently, impart some influence on the types of innovations which emerge.

The United States is the global leader in R&D funding, spending $285 billion—43 percent of total OECD spending—on R&D, greater than the EU (US$211 billion or 31 percent of the OECD total), Japan (US$114 billion or 17 percent of the OECD total), or China (US$85 billion).[3] This strong financial support directly impacts the country’s ability to produce the leading-edge basic science which sustains industries such as biotechnology.

Furthermore, in examining the Nobel Prizes, which were awarded to researchers whose discoveries laid the foundation for biotechnology (X-ray crystallography, elucidation of the genetic code, the polymerase chain reaction, etc.), it is readily apparent that many of the recipients are American.[4] This strong measure of performance stands testament to the ability of strong R&D funding to translate into valuable innovations.

Beyond simply indicating that many important discoveries emerged in the U.S., the abundant representation in Nobel Prizes indicates another strength: the workforce. Whereas smaller countries, such as Singapore, that are currently seeking to build their biotechnology industries must often import researchers from abroad, the U.S. already had a strong cadre of world-class researchers and technicians ready to seed the biotechnology industry from the outset. These trends have persisted for decades. In addition to the strong funding and workforce that were present when the biotechnology industry was spawned, mechanisms to transfer technologies from research laboratories to companies and to fund research and development were required. The mechanisms to transfer technologies from publicly funded labs to companies are described in the next section, and funding is described in the subsequent section.

Entrepreneurial Ecosystems

The first transition in the Innovation Lifecycle is the transfer of knowledge from basic research labs to entities who begin to develop this knowledge into commercially-viable products and services. Two impediments that had to be addressed for biotechnology to grow in the United States were social reluctance of basic researchers to pursue commercial applications of their research and the reluctance of universities to license exclusive rights to inventions. Exclusive rights are very important because many technologies require extensive investments to develop commercial technologies from them. In the absence of a mechanism such as an exclusive license to prevent competitors from capitalizing on the R&D investment of innovators, most companies have little incentive to make the necessary investments.

These two impediments, which still persist in many countries, have a profoundly negative effect on innovation, sequestering the extensive basic knowledge produced with government funding from the private sector which is well positioned to develop commercial applications. The mindset shift, which softened negative attitudes towards commercially-minded researchers, was supported at first by the great accomplishments of innovators in the semiconductor industry and later by the success of early biotechnology companies. The Bayh-Dole Act of 1980 permitted businesses and non-profit organizations to acquire exclusive rights to technologies emerging from federal funding and created incentives for universities to commercialize their intellectual property. A 2002 editorial in The Economist described the Bayh-Dole Act as “possibly the most inspired piece of legislation enacted in America over the past half-century.”

The impact of the Bayh-Dole Act can be assessed by examining technology transfer statistics. Prior to 1981, fewer than 150 patents per year were issued to universities. A decade later, almost 1,600 patents per year were being issued to universities. In 1978, only 5 percent of the government’s 28,000 patents had been licensed. Twenty-five years later, four thousand companies had been formed based on licenses from academic institutions. It is estimated that the economic benefits from university licensing activities add about $41 billion per year to the U.S. economy.[5]

Two important elements of the Bayh-Dole Act are central to its success. First, Bayh-Dole addresses a hurdle encountered at the earliest stage of commercialization: the transfer of innovations from government-funded labs to the private sector for commercialization. Second, the Act is inexpensive. By permitting inventors and the institutions in which they work to profit from licenses, the Bayh-Dole Act is able to use internal incentives to drive licensing rather than using further federal appropriations or other government support schemes.

Financial Support

In the United States medical fields, strong financial support correlates with strong leadership. While U.S. biotechnology firms lead the world in pharmaceutical and medical innovations, the relative difference between U.S. and international firm output in industrial biotechnology and agricultural fields is less. The relative strength in medical applications suggests that the significant federal funding provided through the National Institutes of Health has directed the development of biotechnology and related industries.

Funding is also inexorably linked with access to markets. The United States currently has the world’s largest pharmaceutical market, followed by the aggregate of the European Union and Japan. The ability to reach the entirety of the U.S. market through the relatively well-defined federal regulatory framework administered by a small number of agencies is a vital asset, as it increases confidence among innovators that they will be able to recoup R&D investments.

FEDERAL FUNDING

In addition to the aforementioned strong support for basic science, the federal government also supports translational research. The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs are dedicated to funding early stage commercialization and require a number of federal agencies and departments to reserve a portion of their R&D funds for SBIR and STTR awards. These programs are designed to stimulate technological innovation and provide opportunities for small businesses to partner with federally funded labs and to commercialize technologies emerging from those labs.

The importance of these programs cannot be overstated. They enable researchers to explore the commercial prospects of their inventions without abandoning their academic tenure and without the need to secure bank loans or to convince investors of the merits of nascent and immature technologies.

PRIVATE EQUITY

Private equity investors, such as venture capitalists and wealthy individuals called “angels,” invest in promising companies in the hopes of securing a return on their investment from a liquidity event—usually sale of a company on public markets or sale to a larger firm. These early-stage investments are critical components in helping to develop companies with meager or no revenue streams and to obtain funding in the absence of hard assets (which could otherwise be used to secure bank loans) or government funding (which generally only funds basic research).

Three criteria must be met for a private equity system to operate effectively. First, private equity investors with an interest in a given market opportunity must exist. Second, the potential for private equity investors to sell their equity in a relatively short timeframe must exist. Finally, attractive companies with the potential to appreciate greatly in value must exist.

The U.S. biotechnology industry was born in 1976 when biochemist Herbert Boyer and venture capitalist Robert Swanson partnered to start Genentech. Fortunately for Genentech, private equity funding already existed. Venture capital in the United States was a relatively mature industry, having been started in 1946 by General Georges Doriot. Liquidity also existed in public stock markets (when Genentech went public in 1980, it closed at more than twice its $35 opening price, setting an opening-day record). Most importantly, the basic elements for Genentech to commercialize gene splicing already existed. Ready markets for drugs which could be produced using gene splicing meant that Genentech was able to select which existing drugs it wanted to improve using gene splicing, and the existing and measurable market sizes could be used to clearly illustrate the company’s potential value. Existing regulatory procedures for biologic drugs also meant that Genentech could follow a defined regulatory path. These factors facilitated the process of raising capital and ultimately allowed Genentech to become a public company in advance of revenues from drug sales.

INDUSTRIAL PARTNERSHIPS

Genentech was not able to research and develop human insulin independently. To affordably conduct development and regulatory approval activities, the company formed a partnership with Eli Lilly and traded cash and development resources for the rights to future sales. Such partnerships are still paradigmatic of the biotechnology industry today, and the biotechnology industry could not have grown as it did without the support of senior partners. There were numerous large pharmaceutical companies operating in the United States as the nascent biotechnology industry grew, so emerging biotechnology companies had plenty of wealthy partners with the established skills and resources necessary for drug development, distribution, and sales.

Intellectual Property Protection

Intellectual property is paramount in biotechnology. While copying biotechnology inventions is relatively facile, much investment is required to develop inventions into marketable products. Companies therefore require market protection to justify the time and expense of R&D. While some controversy exists over the permissible scope of patent protection and the potential for some patents to serve as impediments, rather than incentives for innovation, innovation seldom flourishes in the absence of intellectual property protection. Without market protection, competitors would be free to copy successful products and, though not sharing the R&D expenses of the innovator, would be able to profitably sell them at prices that would deny innovators the ability to recoup their R&D investments.

The impact of exclusive licenses, granting companies sole access to a technology, is illustrated in the discussion of the Bayh-Dole Act above. In order for an intellectual property system to work, two criteria must be met. First, it must be comprehensive and cover a wide spectrum of inventions. Second, it must be robust and allow innovators to effectively protect their inventions and punish infringers harshly. The United States patent system excels in both these regards.

Monsanto Canada Inc. v. Schmeiser

Monsanto developed a canola plant resistant to their herbicide, Roundup™, permitting farmers to use Roundup™ to control weeds in canola plots. The terms for use of Roundup™ resistant canola required payment of annual license fees.

Percy Schmeiser, a farmer near Bruno, Saskatchewan, first discovered Roundup™ resistant canola growing on his land in 1997. Samples taken from Schmeiser's farm in 1998 showed Monsanto's patented genes in 95-98% of plants sampled from nine fields. Monsanto sued Schmeiser for intentional unlicensed use of their patented plants, and Schmeiser countered stating that the seeds had blown onto his fields from neighboring plots and that their spread could not be controlled.

The court was moved by the abundance of Roundup™ resistant canola on Schmeiser's fields and Monsanto's assertion that he had intentionally harvested and replanted their patents seeds without license, and held him in infringement of Monsanto's patents.

Some countries limit the subject matter of biotechnology inventions (e.g., Canadian patent law holds higher life forms unpatentable, until recently India protected processes but not products); U.S. patent law is broad in scope. Limitations on patent scope impede innovation in two ways. Firstly, they provide no incentive for companies to invest in unprotected areas and secondly, they discourage companies from developing innovations in uncertain patent domains for fear that these domains will likewise be deemed unpatentable.

The prospect of patents not being enforceable has a similar effect as limiting the domain of patents. Some countries openly favor local companies over foreign companies in patent disputes. While this policy may produce short-term domestic gains, it effectively communicates to foreign companies that they would be better off locating their investments elsewhere. A recent Canadian patent case demonstrated how interpretations of rulings can impact innovation even in countries with strong patent protection. In the case of Monsanto Canada Inc. v. Schmeiser, Monsanto was seeking damages from a farmer who had allegedly planted and harvested patented plants without license. The case drew worldwide attention in part because the implication of a ruling for Schmeiser might be interpreted, regardless of the underlying facts of the case, to indicate that Canadian courts did not honor biotechnology patents.

Emerging Threats

The U.S. biotechnology industry faces emerging threats from internal and external factors. As the biotechnology industry has grown, real estate and wage costs have continued to rise. Meanwhile, decreased patience among investors and industry partners have led them to increasingly focus on more mature biotechnology firms, to the exclusion of emerging firms. Federal regulations such as the disclosure requirements in the Sarbanes Oxley Act place onerous financial burdens on small public biotechnology companies and discourage private companies from seeking the liquidity benefits of listing on public markets. The U.S. and other advanced industrial countries and some emerging market countries are increasingly competing against one another to attract talent. Additionally, difficulties obtaining work visas for skilled workers are impeding innovation. These factors are combining to create opportunities for biotechnology companies to form elsewhere.

These internal pressures are intensified by the impact of globalization on the biotechnology industry, which makes it easier for discrete business operations or even entire companies in value-chains to be distributed globally. As described in the Innovation Lifecycle model, all the components of research, development, and commercialization do not need to be located in one region. The regions of the United States boasting the strongest concentrations of biotechnology firms do not excel in all elements of the value chain—they specialize in controlling knowledge value-add. Accordingly, a Massachusetts or California-based biotechnology firm, for example, may outsource discrete research elements to labs elsewhere in the country, to Europe, or to Asia; they may perform initial manufacturing and clinical trials in other locations, as well; and they may manufacture and distribute drugs overseas or domestically in a centralized location such as Memphis with transportation, rather than research, assets. The key theme in this distribution of activities is that the region which controls knowledge value-add is the region where the industry is rooted, but these regions can form hub-and-node relationships with regions better positioned to fulfill discrete elements of the value chain.

The dominant regions of the biotechnology industry will likely continue to be located in California and Massachusetts, but there have been opportunities for regions elsewhere in the United States and the world to excel in elements of the value chain. Some American companies are looking to issue shares on foreign markets to gain the benefits of increased liquidity while avoiding onerous domestic regulatory burdens. India and China are increasingly becoming partners of choice for early-stage manufacturing and clinical trials. Singapore is investing heavily in building a biologic manufacturing hub. Rather than trying to develop fully integrated life science clusters—a dated model—domestic and global regions are focusing on their regional competencies and seeking to integrate into established value chains.

Broad Lessons

The U.S. biotechnology industry was built on strong foundations provided by decades of federal R&D investment and a ready workforce which could be drawn from university laboratories and the pharmaceutical industry. The United States is not alone in having these foundations; the factors, which catalyzed the growth of biotechnology, were an existing entrepreneurial ecosystem, abundant availability of risk-tolerant financing, and strong patent protection. It is important to note that the biotechnology industry developed in the absence of a national policy and predates many of the current policies and incentive programs that currently support the biotechnology industry, indicating that while they may be necessary to sustain current growth, they were not essential for initial formation of the industry. A lesson can be drawn from the growth of biotechnology in the United States: the role of policymakers and stakeholders should not be to attempt to directly promote growth of biotechnology, but efforts should rather be directed at indirect support—focusing on developing regional competencies and ensuring that the political, academic, and commercial environments are supportive of biotechnology.

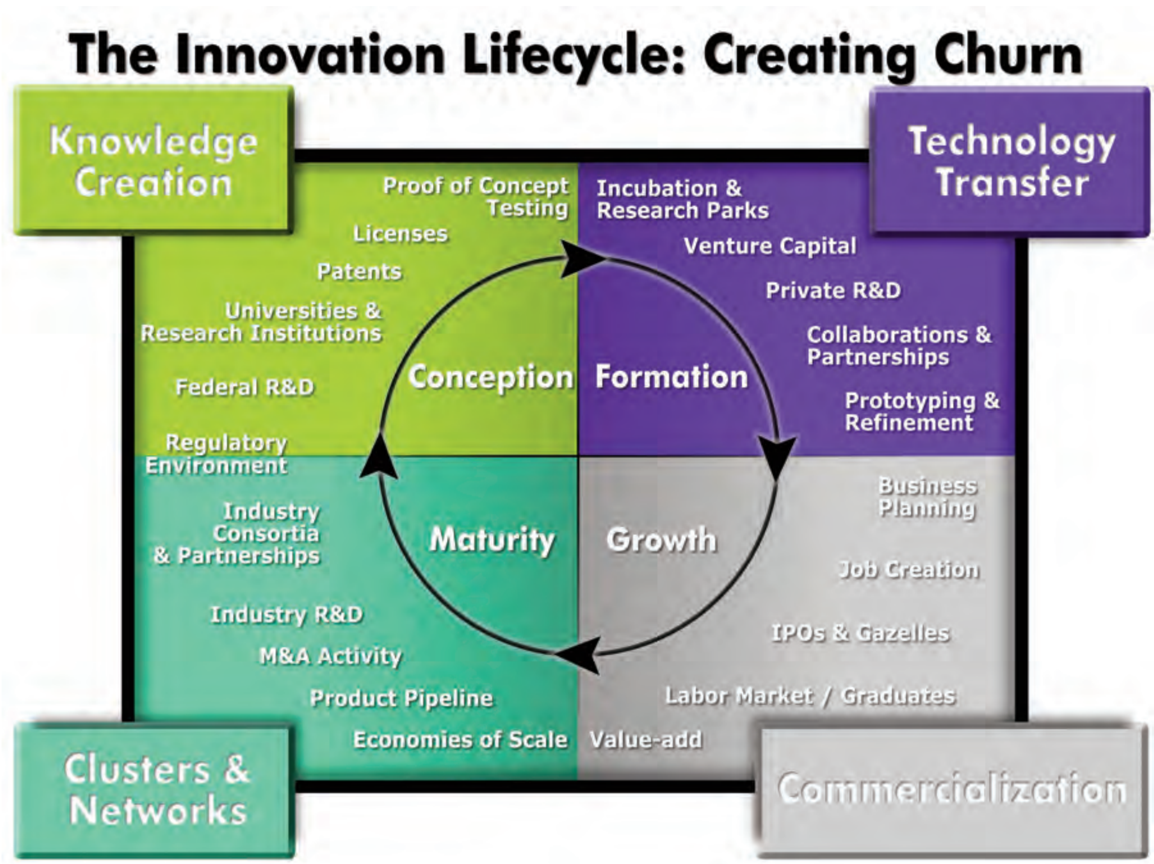


Figure 1: The Innovation Lifecycle

NOTES

1 Data from March 2004

2 A Survey of the Use of Biotechnology in U.S. Industry, United States Technology Administration, Office of Technology Policy. October 2003.

3 OECD figures from 2003.

4 See Yali Friedman, Building Biotechnology (Washington, DC: Logos Press, 2006): 8-10.

5 See Birch Bayh and Bob Dole, “Bay-Dole +25,” TechComm April-May 2005: 12, 29, 33.

03

CHAPTER THREE
BIOTECHNOLOGY IN GERMANY

BIOTECHNOLOGY IN GERMANY

THEO DINGERMANN

After a late start due to legal debates and great concerns of the German population towards genetic engineering, biotechnology research in Germany caught up impressively. Germany is now listed as the world's second largest producer of biopharmaceuticals. There are currently twenty well-established biotech companies in Germany that trade biopharmaceutical products, and more than sixty aspiring companies with innovative product pipelines. And more will come: Recent very effective support programs towards excellence in biotechnology research have changed the German research sector in biotechnology—and will continue to do so. Germany will undoubtedly become more attractive for firms from abroad and overseas.

There are, however, also drawbacks. A complexly structured and highly regulated healthcare system keeps permanently changing and the recently established NICE-like Institute for Quality and Cost-effectiveness in Health Service (IQWiG) handles innovations with respect to reimbursement rules by public health funds very restrictively. Germans still strongly oppose green (agriculturally oriented) biotechnology and stem cell research, whose importance for regenerative medicines is highly controversial.

Germany has never had an easy-going relationship with biotechnology though it eventually gained momentum and caught up impressively. There is good reason to believe that this will continue and, at the end of the day, Germany will be recognized as a strong player in biotechnology.

Biotechnology research's slow beginning in Germany.

The German Society for Chemical Engineering's Information Service (DECHEMA) published the following news on 16 March 1998:[1] "Hoechst now produces genetically engineered insulin. Fourteen years after their first application for a license, the production of genetically engineered insulin was started at a Hoechst factory on March 16, 1998, in the presence of the Federal Minister of Education and Research Jürgen Rüttgers. The first authorization procedure took six long years before the Higher Administrative Court of Hesse (Hessischer Verwaltungsgerichtshof) denied the license for a pilot operation on November 6, 1989."

Although German research and technological developments were up to international standards and although a German company was about to produce the first biotech product, when seen from a judicial point of view, Germany was a genetic technology no-man's land from 1989 to 1991. In 1991, a genetic engineering law, which had been demanded by German courts, finally entered into force. The law enforced the strict supervision of a whole branch of technology—a unique fact in the history of natural sciences—that ranged from fundamental research in biotechnology undertaken by academia to industrialized production. Nevertheless, most people affected by this legislation accepted it with relief as the law provided at least a legally binding framework, which had been missing before.

However, the damage for Germany as a location for biotechnology was enormous—in economic as well as in intellectual terms. The American company Eli Lilly and Denmark's Novo Nordisk had already divided up the market for genetically engineered insulin in the mid-1980s—a market that is worth billions of dollars today. Additionally, young German researchers started to develop their creative potential abroad, instead of in Germany (most went to the United States).

Irrespective of the complicated regulatory framework, the "public climate" towards genetic engineering at this time was also quite chilly in Germany. At an emotional, rather than a rational basis, a huge majority of the public saw genetic research as an unacceptable risk. Public opinion towards biotechnology remained critical even after the legislature and the courts had decided on regulation. People just did not understand what happened in the laboratories and, because they were living in the country of the Wirtschaftswunder (German economic miracle), they did not see a necessity to develop biotechnological products, which at this time even scientists could only vaguely describe.

"Snapshot" of the Most Recent Biotechnology Research in Germany

Within the last few years, public opinion of biotechnology has changed dramatically. Many of those who used to be vehemently opposed to biotechnology have become older and today are grateful users of the "new products"—or at least they can imagine becoming dependent on those products and benefiting from their potential some day in the future.

As a result, the acceptance of "red biotechnology" (biotechnology used for medical or pharmaceutical purposes) is rising and the consequences are evident: Germany is listed today as the world's second largest producer of biopharmaceuticals.[2] This result applies to the number of produced biotechnological active ingredients (at the moment, seventeen kinds of active ingredients are manufactured in Germany; only the U.S. produces a larger variety, currently forty-seven of such molecules) as well as to the fermenting capacity for genetically engineered products (Germany provides 430,000 liters for microbiological fermentation and 245,000 liters for mammal cell cultures).

There are twenty well-established biotech companies in Germany that trade biopharmaceutical products with a sales volume of more than €30 million (about one percent of the total sales volume of biopharmaceuticals). In addition, more than sixty aspiring German companies have developed their own innovative product pipelines—generating approximately the same sales volume as those established by distributing biopharmaceuticals—and gaining income from licenses. A third group of enterprises, which do not offer any product pipelines, includes almost three hundred small and medium-sized companies. These companies either develop and sell technology platforms or are very young enterprises that perform research on active ingredients but whose products have not yet accomplished the whole clinical trial phases of pharmaceutical products. Some suppliers are also part of this group.

The almost 370 pharmaceutical companies that dealt with red biotechnology in 2005 achieved a transaction volume of almost €3.9 billion, with above average annual growth rates of 10 percent in the years 2001 to 2005.

Important sales volumes are generated in the field of metabolic diseases (the main focus lies on diabetes), though oncology is also a focal point in the companies' portfolios. Genetically modified antibodies, however, are the "shooting stars" within the New Chemical Entities (NCEs).

The established, as well as the emerging, companies in Germany generate more than three-quarters of the total revenues of biopharmaceuticals in Germany (by selling the products, by licensing them, etc.) and provide more than 70 percent of the jobs in the field of medical biotechnology. The other employees work primarily for service providers.

New developments in biotechnology

In February 2006, a new biotechnology interest group was established within the German Association of Researching Drug Producers (VFA), named "VFA Bio" (Interessengruppe für Biotechnologie im Verband Forschender Arzneimittelhersteller e.V.). As its first official act, it commissioned the Boston Consulting Group (BCG) to do an inventory of the medical biotechnology research and industry in Germany. In their report, the consultants focused not only on economic data, but also on scientific data and on data that is relevant for medical therapy. The study also identified the key providers in Germany and the main foci and peculiarities of their enterprises.

The report shows that the research and development (R&D) departments of German biotech companies supply important and otherwise unmet medical needs in the sectors of oncology and infectious diseases. The focus here lies clearly on cancer therapies. Thirty percent of the active ingredients that are currently developed can be classified as cancer therapeutics. Another 20 percent of NCEs currently tested in clinical trials focus on infectious diseases.

Due to progressive (European Union) regulations of the development of so-called "orphan drugs" (drugs for the treatment of infrequent diseases), we can also find exceptional track records in this sector. Recombinant alpha-galactosidase A is one out of many impressive examples, and it shows the immense possibilities medical biotechnology offers to combat infrequent diseases due to its selectivity. In theory, about five thousand patients who are suffering from Fabry's disease in Europe, a disease that is passed on recessively, can profit from this success.

Fabry's disease belongs to a group of so-called lipid storage diseases, or the lipidoses, in which harmful amounts of fatty materials called lipids accumulate in some of the body's cells and tissues. People with these disorders either do not produce enough of one of the enzymes needed to metabolize lipids or they produce enzymes that do not work properly. In addition to Fabry's disease, enzyme replacement therapies recently became available for four other lipid storage diseases: Gaucher disease (Imiglucerase), Morbus pompe (Alglucosidase alfa), Mucopolysaccharidosis I (Aldurazyme), and Mucopolysaccharidosis VI (Naglazyme).

For Which Economic Sectors Will Biotechnology Be the Basis of Future Success?

Hardly any economic sector (pharmaceutical, agriculture, food, environment etc.) can escape the influence of biotechnology today. This is especially true for the booming health industry as it faces the challenge of demographic change. One of the urgent questions this sector has to deal with focuses on the enormous costs caused by modern and innovative biotechnological active ingredients. The costs for such therapies range from about €600 per year per patient for an insulin analog (e.g., Humalog, Lilly), over almost €6,000 per month per patient for one of several recombinant antibodies as part of a tumor treatment (e.g., Erbitux, Merck KGaA; Avastin, Roche; Herceptin, Roche, and others), and up to €250,000 per year per patient for a substitution therapy in case of a lipid storage diseases (e.g., Cerecyme, Genzyme). These enormous costs can only be absorbed to some extent by the so called "biosimilars," which are currently brought on the market after the first patents have expired. German companies, such as Sandoz-Hexal, Ratiopharm, and STADA, are going to be important participants in these markets. To what extent biosimilars might be able to reduce the cost of specific therapies is one of many questions related to this new development.

Nanotechnology, which is perceived as a booming technology, will also be reliant on and profit from biotechnological procedures. Nanobiotechnology is currently establishing itself in this interdisciplinary sector—a development that is supported by a dynamic upsurge of innovation. Nanobiotechnology bridges the gap between the inanimate and animate nature. It aims to understand biological entities fundamentally and to controllably generate minuscule modules in nano-size using technical materials.

Biotechnology, nanotechnology, and information technology will converge (e.g., “lab on the chip” and highly sophisticated diagnostics) and start a “revolution” of innovations, new markets, and applications in the twenty-first century. Being able to cope with these converging nano-bio-info-technologies will be of fundamental importance for many industries in the future.

What is the Current Political Framework and How is It Going to Develop?

A tight network of excellent biotechnology research through university-based and non-educational facilities, as well as very effective support programs, such as the national genome research and other medical expertise networks, give Germany an international advantage. A variety of highly competitive state-funded contests in the areas of “excellence-clusters” and “bio-regio-clusters” have changed the German research and biotech sector—and will continue to do so. Success in this area is already becoming visible.

Germany will undoubtedly become more attractive for firms from abroad and overseas. The “excellence initiative” successfully started by the state and federal governments has identified and selected elite universities, excellence clusters, and graduate schools of a highly competitive nature. The initiative will allow German academic and research institutions to become attractive for students and scholars from the international scene for the first time, introducing English as the spoken language.

On the other hand, the structure of the German health care system and its varieties, are very complex and hard to understand for people living outside this system. The same applies for the pricing and reimbursement system in Germany, which in recent years is permanently undergoing changes. The newly implemented NICE, like Institut für Qualität und Wirtschaftlichkeit im Gesundheitswesen (IQWiG—Institute for Quality and Cost-effectiveness in Health Service), is now in charge of proving the cost effectiveness of drugs and therapies. It handles innovations with respect to reimbursement rules by public health funds very restrictively. These restrictions cause globally active firms to consider leaving Germany as a place for research and development.

The ever-more-regulated health care market, ideally the main recipient of biotechnological innovation, finds itself in opposition to this development. The health care system appears to be moving away from economic competition, with unforeseeable consequences.

The report by the Boston Consulting Group also indicated that price formation in the German health care market could become one of the various ways to optimize the entrepreneurial environment and to secure the future of medical biotechnology in Germany as a whole. This has been negatively impacted by severe overregulation and is in need of urgent revision, as far as the consultants are concerned.

Moreover, federal initiatives allowing for key projects across state lines need to be promoted, while public research funds must be increased to align with international standards. The transfer of information between the knowledge centers and industry is slowly becoming more efficient, but should be enhanced by means of transnational research, creating accepted competition within and between centers of knowledge. Although approval processes have also become more efficient, there is still an inherent necessity for improvement, especially in reducing bureaucratic hurdles, which continue to be very high. Following successful consolidation, the following phase should then see the development of a new framework for venture capital, which will be fairly different in quality than former venture capital funds, which (among other factors) caused the failure of the New Market.

Biotechnology—A Janus-faced Topic for the German Public

It would not be in accordance with the “German spirit” had a certain degree of skepticism not remained amidst overwhelming acceptance of red (medically oriented) biotechnology. Today, such skepticism concentrates primarily on green (agriculturally oriented) biotechnology, which the larger percentage of Germans still oppose.

However, sooner or later concerned Germans will have to realize and accept that developments in green biotechnology cannot be avoided, especially in light of the advances of its red equivalent. Once the prophecies of doom yield to the inevitable establishment and presence of popular products, those boycotting the developments are ultimately going to be debunked. Thus, for a second time, Germany will lag behind current developments, trying to gain on what it has lost.

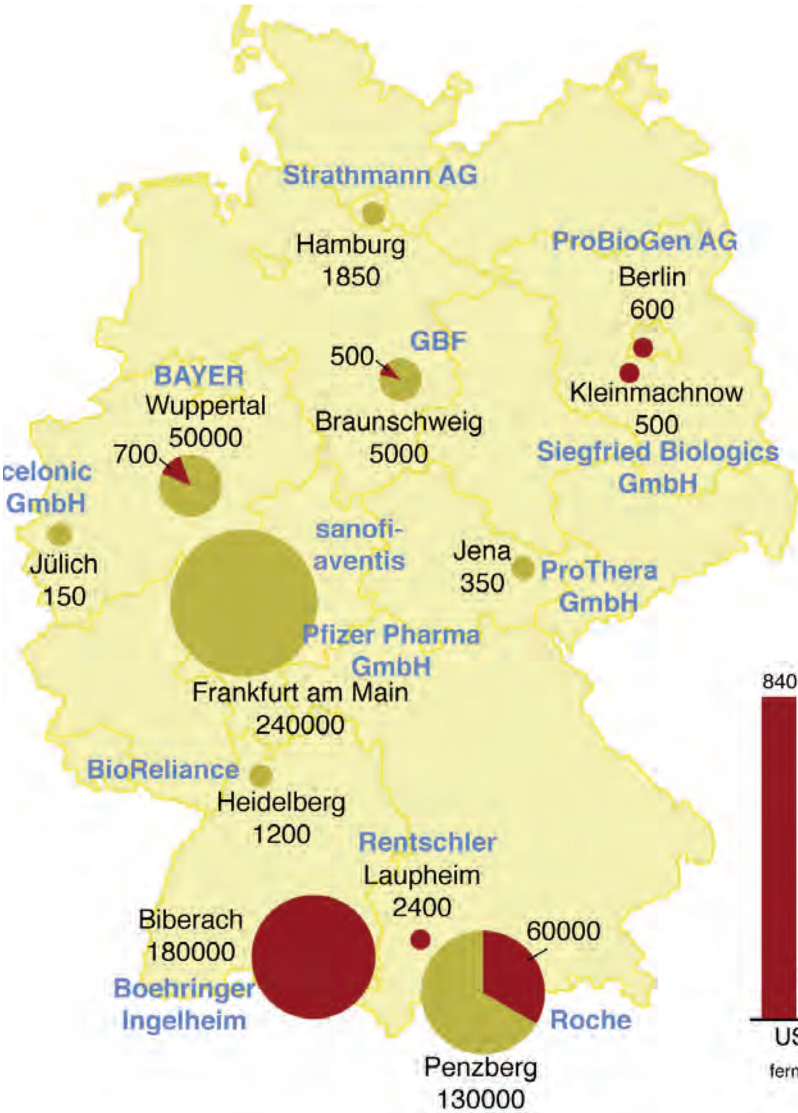
Preliminary signs of a readjustment towards agricultural biotechnology are already on the horizon, paradoxically drawing their support from the Germans' strong sense of environmental awareness. In the past, this sense has fueled strong resistance against green genetic engineering. Renewable energy sources are ever more central to the energy debate—a debate driven by an inherently contradictory argument: while stressing the necessity of preventing any reversal of the nuclear renunciation process, advocates are suggesting renewable carbon-containing sources as an alternative, despite their being environmentally harmful.

This field is now becoming the testing grounds for green biotechnology, albeit carefully, as it does not include the consumer's sensitive food sector. It appears as though critical issues such as the controversial introduction of genetically engineered plants into nature are losing momentum and are, to a certain degree, being accepted.

In a slow color-changing process, green biotechnology is moving to become white, as it is here that renewable resources are particularly present. White biotechnology (the branch applied to industrial processes) is drawing increasing attention in Germany, with big companies, like Degussa, and medium-sized companies, such as BRAIN (based in Hesse), stating very ambitious goals. On 1 January 2006, Degussa launched a new Science to Business Center called "Bio." The company has pledged to invest €50 million until the year 2010 in "Bio," with the goal of generating new biotechnological products and processes on the basis of natural resources. Degussa is the world's leading supplier in the "Building Blocks" domain, producing catalysts (alcoholates) that are indispensable to the production of bio-diesel.

Misrepresentations remain as to how biotechnology is perceived by the German public, with very real political consequences. In this regard, a relevant problem is stem cell research in Germany. While it may be a research branch that is of limited concern to contemporary production, stem cell research is of great significance to the technology atmosphere in Germany. This is a conflict that has not only manifested itself between society and the legislature, individual study groups, and companies, but also between German politics and the Deutsche Forschungsgemeinschaft (German Research Foundation), the latter being the nation's most important provider of public funding for academic research.

Other nations (including the U.S., although to a lesser extent) show a more limited degree of concern or engage much less in the exploration of feasibilities in this research field. This will grant these countries considerable advantages in the important field of regenerative medicine—advantages that the German research and development communities will have to catch up to again for a third time.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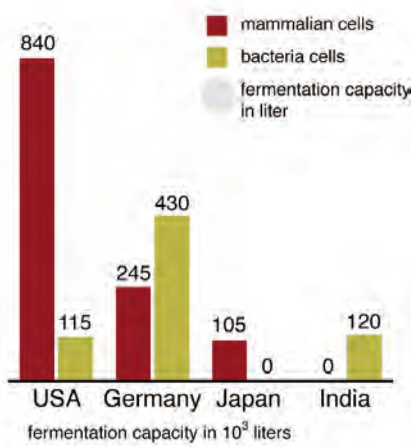
mammalian cells
bacteria cells
fermentation capacity
in liter
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115
245
430
105
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0
120
USA
Germany
Japan
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fermentation capacity in 10³ liters

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Due to significant investments Germany has now the worldwide second larges fermentation capacity for mammalian and microbial culture systems (fermentation capacity depicted as thousand liters, 2005).
Modified from The Boston Consulting Group: “Medizinische Biotechnologie in Deutschland 2006”.

1 The Boston Consulting Group: “Medizinische Biotechnologie in Deutschland 2006”

2 See http://www.i-s-b.org/aktuelles/news/archiv2.htm#hoechst

04

CHAPTER FOUR
GERMANY'S E-ENTERTAINMENT INDUSTRY

DRIVERS OF INNOVATION IN GERMANY'S E-ENTERTAINMENT INDUSTRY

MICHEL CLEMENT AND ALEXANDER JAHN

In the last several years we have observed a strong growth of entertainment services in the global online world. Innovative entertainment services, such as MySpace, YouTube, or Second Life, have entered the market, and some have been acquired for billions of dollars by global players (e.g., Google). These big deals initiated a new wave of entrepreneurship throughout the world, many of them under the modern label of Web 2.0.

Web 2.0 refers to a perceived new generation of user centered services on the Internet. These services are based on new technologies and include social networking sites that facilitate collaboration and sharing of content between users. The Web 2.0 evolution has included users in the creation, aggregation, marketing, and distribution of content and has formed not only new products or services, but also large communities. In addition, content owners (e.g., music labels) have increased their speed in entering the global E-Entertainment market by selling their content online. Thus, the online entertainment options for users and investors are growing, which pressures offline media and entertainment companies to compete with the respective online services.

Business Models in E-Entertainment

Interestingly, most new and successful online services are based on network externalities and, therefore, address the world and not only a certain region. Accordingly, traditional models of competitiveness of a country will not explain global network sizes, which are driving the value of the services due to international network externalities.[1] For example, YouTube is a global phenomenon where Germans, Americans, Chinese, etc. upload and consume content. This global scale is necessary to generate sufficient advertising revenue—revenue which is the foundation of many business models in the entertainment business. However, most of the new services have yet to reach profitability. Nevertheless, services such as YouTube are traffic generators that help their new mother corporations (e.g., Google) with strong global brands to generate more traffic and possibly more online advertising revenue than the traditional champions in the German media industry with strong, but rarely global, brands (e.g., Bertelsmann, Axel Springer Verlag, Pro7/Sat1). The traditional media giants see their established value proposition and, therefore, their business models increasingly challenged and sometimes even questioned.

Figure 1 presents the four business models that can be applied to media services. Interestingly, we observe a very slow innovation speed in selling content to the online end user market. Since the rights owners (such as music labels or film studios) are strongly connected to their traditional offline value chain and their international windowing strategy,[2] they cannot drastically switch their strategy and offer their content online for downloading. This leads to the phenomenon that the first music and movie download offerings typically start in the United States (e.g., on iTunes) and then gradually enter new markets. The content owners force the distributors to apply digital rights management systems to keep control of the content—a tactic recently critiqued by Steve Jobs in his open letter to the music industry. As a result, some songs or movies can be downloaded legally in the U.S. from iTunes, but not in Germany. The same is true for many music videos which are free to use for U.S. citizens on large Internet portals like Yahoo, but that are not available to Internet users outside of the U.S. However, German users are not willing to wait and, therefore, turn to peer-to-peer networks and download the pirated version of the music or movie file using BitTorrent or eMule. So whereas it is not really possible to differentiate online trends between Germany and the U.S. when it comes to advertising-based entertainment services (all interesting U.S. start-ups are quickly imitated by German start-ups or media corporations), we can observe strong differences in the end user markets due to varying licensing deals between the countries.

E-Entertainment business models can further be based on selling online and mobile rights or, finally, on government regulations and subsidies (Öffentlich-Rechtlicher Rundfunk). However, new businesses in the entertainment industry are driven by two key sources: new technologies and new market trends. Both strongly influence the traditional value chain of entertainment businesses, especially in the advertising and end user business. We will focus on these two drivers and analyze their impact on the E-Entertainment value chain.

E-Entertainment Value Chain

E-Entertainment products or services are based on text, pictures, audio, video, or games. The appeal of MySpace, iTunes, Yahoo, or Sony's PS3 is based on their offer of different content varieties. The production of content follows a general process (Figure 2).

Using music as an example, songs are produced by the musician and aggregated to an album by the musician, the label, or the online shop. The content is marketed by the label responsible for branding and selling the content to all relevant offline, online, and mobile channels. Finally, the music is distributed by download stores (e.g., T-Online's Musicload) or streaming services (e.g., Napster) to the user.

Focussing on text, we observe in the online market the strong market position of the traditional publishing houses that transferred their significant offline brands into the online channel (e.g., Spiegel-Online, Geo). Interestingly, they have hardly adjusted the value chain in comparison to the offline production. Mostly, they syndicate the offline content into the online channel. The market is dominated by newspaper and magazine sites and, therefore, mostly static as the publishing houses try to protect their traditional business model in the offline world. The same occurs with pictures, which are provided by nearly all websites (news, portals, etc.) that have been licensed by photographic or professional services (e.g., Corbis), or have been contributed by community users (View.de). Nevertheless, the offline markets are eroding and significant growth is currently only observed in the online advertising market; as such, almost all publishers are currently searching for innovative solutions to transfer their strong offline market position into the online world.

The market for music is much more dynamic. After years of distrust, the music labels started to license their catalogues to online services in 2001. Now, in 2007, we observe a multitude of different services offering songs, music videos, ringtones, etc. However, the labels failed to secure their own growth by building their own distribution channel. The main distributors in the online music market are T-Online, Apple, Napster, and AOL—none of which are related to labels. Only recently have the labels started to address the end consumer markets with new forms of marketing platforms like community sites around their singers (e.g., avril.de).

Compared to the music business, the movie industry lags years behind: the studios are very slowly starting to offer movies online simultaneously with the DVD release. Currently, we only observe a small fraction of movies available online in Germany (at least legally). For example, the Warner Bros. and Bertelsmann's arvato joint venture in2movies offers a certain number of movies for download. Further, ISP's and cable networks (e.g., Kabel Deutschland) offer streaming services on their movie platforms. Still, TV broadcasters like RTL Group and ProSiebenSat.1 have started their own VoD services by offering a selection of licensed movies and in-house developed TV formats. Nevertheless, we expect to observe the same structure in the online movie market as in the music market; that is, the innovations will be driven by outsiders (e.g., Apple) and not by the traditional players (cinemas, video rentals, or studios).

Like the movie industry, the gaming market in Germany is driven by international players who target the console and PC market. Yet with increasing broadband and mobile penetration, a beginning fragmentation of the market can be observed. Online games, like World of Warcraft, as well as mobile games are taking away market share from the classical platforms. In particular, casual games are becoming popular. T-Online and RTL, two strong platforms in the German market, aggregate casual games from national as well as international sources and distribute them through their online portals. Although today the predominant business models are download or subscription fees and online advertising around free-to-use games, publishers have started to experiment with new revenue sources like in-game advertising or the sale of digital items (e.g., Second Life), which is expected to further drive the online and mobile gaming market.

The value chain of E-Entertainment in Figure 2 is influenced by innovations targeting each element. The drivers of innovations are grounded in new technologies that provide new opportunities for supply and demand and, subsequently, changes in supplier and consumer behaviour that are market driven. We will address each of these points in the remaining sections.

Technology Drivers of E-Entertainment

Figure 3 provides an overview of key technologies that influence the general value chain of E-Entertainment. Each element and the respective market structure has changed significantly in the last few years due to new technologies that have reached significant diffusion within the relevant social system of suppliers (e.g., Digital Rights Management) or consumers (e.g., iPods).

The production of entertainment products has significantly changed with the diffusion of hard- and software that ease the production, digitization or modification of content. Thus, the production of high quality content is possible without expensive equipment, lowering market entry costs for entertainment newcomers. In addition to the simple production of content, it becomes easier to share the content via networks. Teams of creative talents all over the world can easily work together using networked software to create a song, movie, book, etc. Therefore, it is not only easier to create new content but also simpler to manage the production process with much lower costs. Sometimes the costs are low enough that users internalize the costs without being directly paid for the creation process (e.g., Second Life) as they are intrinsically or extrinsically motivated.[3]

Other new technologies substantially change the aggregation of content, leading to new market opportunities for new entrants. Standardized data definition (e.g., XML) allows for an easy handling of content on different hardware devices. Standards are extremely important because the production process is increasingly decentralized for a multitude of producers, requiring an aggregation for the end user. This aggregation can be carried out via recommendation systems (i.e., based on other user's opinions or actions, rules, or rating systems) or via new search technologies. For example, Microsoft currently focuses on new search technologies that could allow the software company to find the right entertainment bundles for the end user. Aggregation is a key element in the value chain of entertainment companies, one which is eroding more and more. For example, in the traditional sense, a TV station aggregates movies, shows, and advertising into a "program." This function can be taken over by digital VCRs, TiVos, or Vista's included media center. TiVo, as an example, selects shows and movies from the running program and stores the relevant recordings for the user. Thus, TiVo aggregates the shows into a TiVo channel based on personalization techniques.

Next to production and aggregation we further observe new technologies changing the traditional marketing of entertainment products. Whereas it is naive to believe that the role of marketing can be ignored along the value chain (network externalities lead to global trends, especially if the critical mass is necessary to obtain a high utility for the user—e.g., in networked games—and the role of stars will always be relevant),[4] the power of the current players responsible for marketing may change. Two new technologies are highly relevant for the marketing of entertainment products. First, we observe a strong diffusion of new technologies that allow for a more efficient interaction with and between users. For example, tagging tools for websites or rating systems for musicians allow the creation of new stars. However, marketing is driven by the users and not under full control of labels, publishers, etc. Second, new technological platforms enable and facilitate the advertising process by aggregating large numbers of low-traffic websites and offer advertisers easy and cost-effective access to these networks. These networks (e.g., contextual advertising networks like Google, affiliate networks like Zanox) monetize the "long tail" of Internet websites and realize large-scale effects that enable them to increasingly challenge the established players in the advertising industry.

The distribution has already been strongly influenced by new technologies. The rise of P2P networks such as Napster and later KaZaA has led to substantial power shifts towards the pirates and forced traditional players to enter the online market. Distribution will further change due to better compression algorithms allowing the distribution of high quality content via broadband connections and mobile networks to larger consumer bases. Due especially to the rise of small devices with network connections (WiFi, UMTS, etc.), users are able to access entertainment media whenever they like and wherever they are. With the increasing diffusion of GPS and other localization technologies, players like Google (Google Earth/Maps) will provide targeted services that will also include entertainment and community services.

The provision of the new technologies by media corporations, but also by other industries, has already influenced consumer's needs and created new markets. These new markets are affected by new market drivers that are progressively changing the media environment.

Market Drivers of E-Entertainment

The production of entertainment media has dramatically changed due to new incentives provided by communities to users.[5] Users become massively engaged in the creation or digitization of content. For example, the German newspaper BILD provides monetary incentives to users if they send in digital pictures and the picture is published by BILD. The campaign has led to a massive paparazzi effect because stars are now photographed almost everywhere by everybody.

Second, the Web 2.0 hype has led to a strong movement of user aggregated and user rated content. Thus, the value provided by professional editors can also be provided by users in such a way that they rank or tag content which can be interpreted by other users as a signal of quality. This can lead to market or chart mechanisms to support the selection of the "cherries" from the plethora of (low quality) user generated content.

Third, and most importantly, we observe a strong influence from the marketing side. Customer relationship management (CRM) tools are used within communities to attract and retain customers. However, one of the most challenging trends in E-Business for the entertainment industry is the fact that entertainment products are, on the one hand, heavily used for bundle offers (e.g., within triple play offers from ISPs or cable networks) and, on the other hand, serve as "add-ons" for marketing purposes (e.g., Coca-Cola gives away songs for free). Although Coca-Cola would have to pay a licence fee for the songs (creating a business to business market), consumers in the business to consumer market would perceive the price per song as zero. Thus, the perceived price of content is reduced by bundling content into larger packages. In addition, some companies subsidize content in order to sell hardware with a high margin. Apple uses this strategy by selling high margin iPods that can be filled with low margin music from iTunes. In the long run, both strategies will reduce the willingness to pay for content because content (e.g., movies in video on demand bundles) is used more and more as an add-on for DSL/cable-access or mobile phone contracts.

Finally, we observe strong challenges from the distribution side. Global demand will lead to substantial pressure on content providers to provide different language versions of their content, particularly with regard to texts. In fact, Microsoft's research lab focuses on the development of new translation services, and the demand for and from Asia is increasing for such services. Generally, we expect strong competition from different distribution channels leading to innovations. For example, mobile access can be provided by UMTS or WiFi/Wimax offered by Telcos or ISPs—or clever services such as FON.com which offer incentives for users to open their WiFi-routers to external guests.

E-Entertainment in Germany

The identified drivers of innovation are increasingly changing the market environment and exerting pressure on the media players. Consumers are changing their behavior and drifting away from traditional media towards new media-related services. Traditional media businesses have become more and more challenged by both technology developments as well as market changes. New media services are increasingly reaching a scale that forces the media players to adapt their strategies.

While the rights and government markets show only limited potential for growth to media players (content syndication is only a minor business, and public service fees and subsidies are only offered to a limited number of companies), media players target the advertising and end user markets via multiple means. Two basic strategies can be identified. First, media companies strengthen their organic growth by brand extension and innovations. Publishers or TV broadcasters open up their brand environments to user involvement. Communities are being built around media brands (e.g., STERN magazine's View.de) and user generated content gets added to professional content (clipfish.de, myvideo.de). The strategic rationale is to follow the customer and to increase reach within the Internet to counterbalance the increasing shift of advertising and end user revenue to new media markets. Although almost every offline brand already has a presence on the Internet, this strategy has yet to pay off as only few services show substantial scale and stickiness.

Second, strategic partnerships are becoming ever more popular in order to address new segments in the growing Internet and mobile markets early. Since many innovations are being generated in foreign markets (mainly in the U.S. or Asian markets), media players engage in early stage or minority investments, technology licensing deals, or by enabling acquisitions to drag on innovative ideas from the outside. Strategic venturing arms have been created (Bertelsmann Digital Media Investments, Burda Digital Ventures, and Holtzbrinck Ventures, to name a few) to identify and study promising business models that could later be incorporated in the mother company's portfolio. StudiVZ, a German Internet community based on Facebook in the U.S., had been an early investment by Holtzbrinck Ventures before it was bought by the venture entity's mother company, Verlagsgruppe Georg von Holtzbrinck, in January 2007. The strategic rationale of this partnership and acquisition strategy is not only to drag on ideas but also to test new business models. Recently, many investments have been made into services that rely on consumer spending. Here, we observe strong activity in the mobile and services sectors (e.g., online markets, personals, and classifieds) indicating that end user spending becomes increasingly important in addition to advertising as a revenue source for new media business models.

Although many of the new E-Entertainment ventures will not be able to reach profitability in the short or mid term (and maybe never), they lead to fierce competition for existing media corporations. Some of the new competition comes from companies that did not intend to enter the entertainment market; rather, they provided a platform which is now used by hundreds of thousands of users to basically entertain themselves.

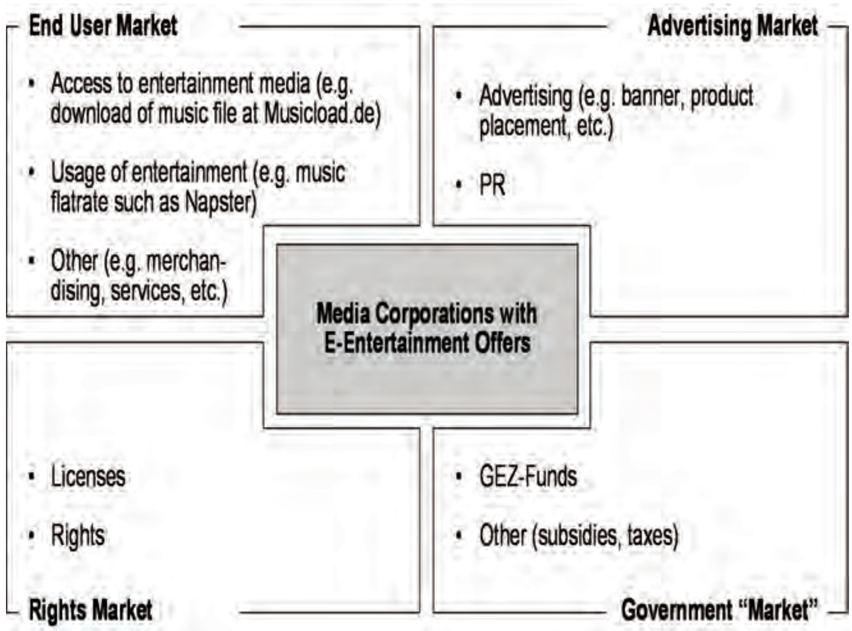

Figure 1: Business models in E-Entertainment

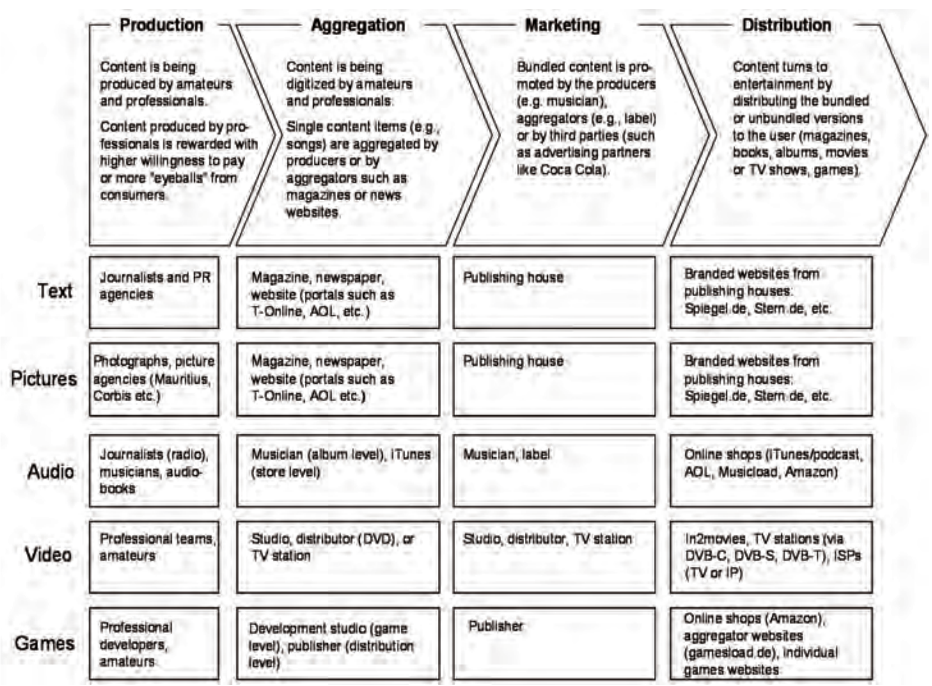

Figure 2: Value Chain of E-Entertainment

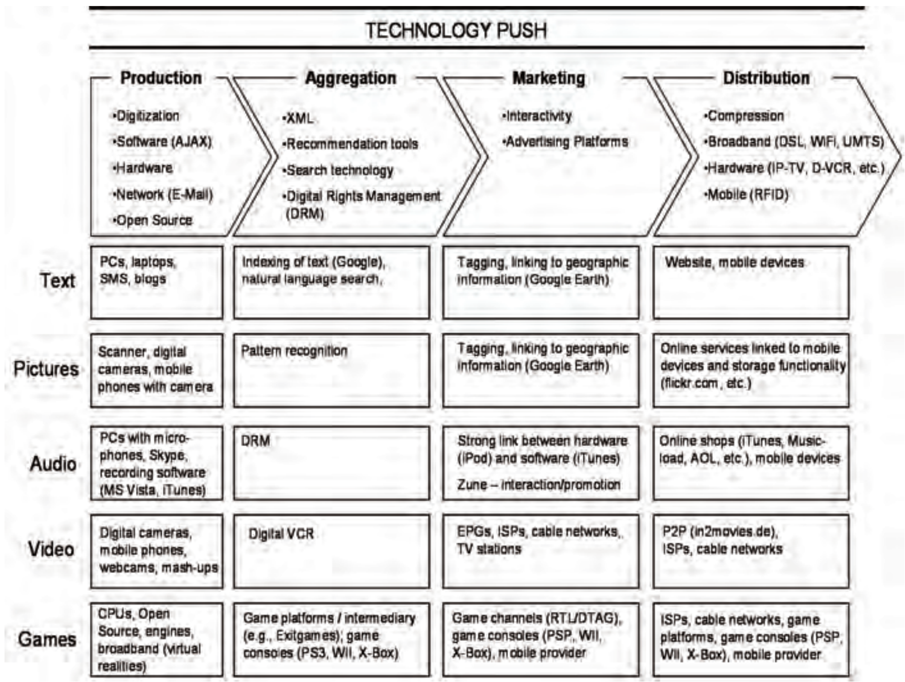

Figure 3: Technological Influences on E-Entertainment

Figure 4: Market Influences on E-Entertainment

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CHAPTER FIVE
E-ENTERTAINMENT IN THE UNITED STATES

E-ENTERTAINMENT AND INNOVATION IN THE UNITED STATES

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The field of e-entertainment is so vast and so quickly evolving that it is difficult to generalize a paradigm of innovation in entertainment. Academics are still developing ideas about the sector and there are few—if any—studies looking at this industry as a cohesive whole. This suggests that the factors making certain sectors dynamic, or reinvigorating dormant sectors, are not universal.

Here, the e-entertainment industry will be divided into four categories that have identifiable characteristics, and their somewhat distinct historical paths and legacies will be examined for commonalities and differences. The categories are:

- Computer and Console Games
- Video/Content on Demand (VOD)
- Broadcasting on the Internet
- Portable Entertainment

This list makes clear that the boundaries between these categories are sometimes blurred and different companies can move fluidly from one category to another. It is also apparent that the most important innovators of this sector are the businesses producing content, code, and new applications, and this case study will focus primarily on the business sector's role in innovating e-entertainment. It should be noted that this contrasts with other sectors in which different factors such as government, universities, or legal considerations were instrumental in shaping the industry. The venture capital industry is as important in e-entertainment as it is in other innovation fields, and so although it is not elaborated in conjunction with this sector, it is an important catalyst to innovation here.[1] If one looks at entertainment, the most striking feature is the extent to which it is determined by innovation and endowments in other unrelated fields. The rise of the Internet, the increased use of broadband connectivity, the free access to computers by college students, etc., were all important factors in the creation of some of the newest e-entertainment businesses. In general, it is not the case that entrepreneurs set out to build an entertainment empire. More often someone who had privileged access to something new tried out something selfishly that became interesting to others because of its inherent entertainment value. Moreover, it is clear that many of the biggest innovations were given away for free or sold cheaply, which led to early market adoption on a scale that made the enterprise commercially viable.

One other relevant distinction is that e-entertainment has two different types of innovation at work—social innovation and technical innovation—and these drive each other in a virtuous cycle of innovation but with different speeds. A new technology can exist for a long time, but without social adoption of the technology, it will not become a driver for further innovation until its limits have been met. Social innovation, the different ways in which people interact and consume entertainment, is slower on the whole because it requires changing behavior and beliefs. Because the United States has such a large consumer market, however, it is easier to find that critical mass of early adopters than, for example, in Europe, where cultural and linguistic divides delimit the internal market for entertainment.

Computer and Console Games

Computer and Console Games are perhaps the grandfathers of the e-entertainment industry. Beginning with Pong, progressive waves of ever more complicated computer games and systems have been brought to market by large manufacturers like Sony, Microsoft, and Nintendo, and their ancillary game makers. These manufacturers compete to be the primary platform for game makers to develop games. The competition between the PlayStation 3, Xbox 360, and Wii consoles is similar to standard setting wars between the operating systems of Microsoft and Apple in the 1980s, when not every program was designed for both operating systems as it is now. Market share creates programmer incentives for one platform leading to increased offerings which create market share for that platform.

One of the biggest changes in this industry was the use of the Internet to allow players to play against each other from disparate locations. Whereas the early 1990s games pitted the player against the computer, the new games—collectively called Massively Multiplayer Online Role-playing (MMORP) games—created opportunities for group playing. These games incorporated coalition building, AI-controlled virtual world enemies, and complicated social dynamics, making the games more sophisticated and real.

Yet, from the standpoint of general e-entertainment innovation, the computer games industry is less interesting than some of the other categories because it is relatively stable with fewer growth opportunities, largely because of its player composition. Yes, incremental advances in computer graphics and computing time have rendered the games more life-like and attractive to users, but the clientele of these games is overwhelmingly male (84 percent) and under the age of thirty (72 percent).[2] Accordingly, software is created with that market in mind, perpetuating the bias. Moreover, the incentives to broaden the offerings are minimal, especially as web innovations like Second Life compete for the older and more female audience.

Launched in 2003, Second Life is a virtual world game played solely on the Internet without the gaming consoles or ancillary costs to join. Individuals register on the website, pick an avatar, and do most things that one can do in real life in Second Life by chatting and instant messaging. Players are willing to spend real money to acquire things in Second Life, and the currency of Second Life floats against the dollar.

This MMORP game has generated a great deal of mainstream interest and has actually been able to turn that interest into real financial transactions. In addition to blurring the lines between the virtual world and the real world by having real parties set up shop in Second Life (for example, France's presidential candidates; Barack Obama and John Edwards' campaigns have set up headquarters there; the European Union is thinking of setting up an office there; and Reuters News Agency pays a real reporter to report on Second Life happenings), Second Life has managed to bring more people to a MMORP than any other game (five million registered users, with 100,000 active users, and 144,108 actually spending money there in 2006).[3] Second Life is also becoming more international, with more Europeans than Americans registered for the first time in 2006.[4]

In terms of innovation, Second Life is in the social innovation stage—with less technical innovation driving the product. The interest in Second Life may simply turn out to be a fad, but as long as people are logging on to play, making decisions, and spending real money for Second Life assets, the business has potential, and should be monitored by those who want to understand how these innovations evolve.

Video/Content on Demand (VOD)

Video/Content on Demand (VOD) was a natural follow-on idea to the investment in broadband infrastructure in the 1990s. VOD was an obvious choice for delivering movies and other content to users on their televisions and computers, but the technological problems of compressing the files to a manageable size continue to be the major stumbling block. Although most large cable companies have invested in the technology and have a strategy for VOD, the results have not been as successful as the industry had anticipated. Over time, more and more U.S. households have been connected to broadband (see Figure 1)[5] but the technology to provide quality streaming and the cost of acquiring the rights to the content have combined to make VOD uncompetitive relative to more traditional services like Blockbuster or Netflix. Many analysts see the growth in VOD to come "in the next year," but they have said this over the past six years since the streaming technology made it possible to create a widespread VOD presence, and it has not caught on in the U.S. In addition to technical issues, such as the length of time it would take to download a movie, there are legal issues of copyright protection of the content and business issues, such as stocking the movie selections, which have to be addressed before the mainstream audience will see a VOD industry take-off.

Broadcasting on the Internet

Although the CEO of Netflix does not believe that VOD will overtake its traditional DVD rental business in the near future, the company is experimenting with downloading videos in the Internet for its customers.[6] This new Broadcasting on the Internet is one of the most important trends in e-entertainment and also one of the more contentious. Made possible by the new technologies of file compression and Internet streaming developed in the late 1990s, the service provides access to music, radio, television, and even movies (courtesy of Apple, Amazon, and Netflix) for watching on a computer.

For sociologists, the rise of personal blogs and podcasts presents a (potentially) new way to interact and get information (the lack of gatekeeping) but the technical innovation potential of these applications seems limited to advertising revenue capture. The legal issues, however, remain paramount and continue to drive the developments in the Internet broadcasting arena.

Copyright issues are, in fact, the limiting factor for many of these businesses, especially as new sites such as MySpace and YouTube allow visitors to post content that may violate copyright laws. These issues are discussed in the context of music file sharing, below, but are equally applicable to the video segment. Several observers believe the recent $1 billion lawsuit filed by Viacom against Google marks the beginning of a legal battle similar to the one against Napster.

The legal issues—mainly the willingness of the new companies to say that traditional copyright laws did not apply to them—were important elements of the development of Internet e-entertainment venues. Beginning with music downloading in the late 1990s, and continuing to the present in applications like YouTube, the innovations were the result of network effects and the 1990s infrastructure investments by companies in the first Internet boom. As such, it is useful to recall the history of Napster, the popularizer of music filesharing and downloading.[7]

The music industry had its first Internet challenge when RealAudio was created in 1995, and two years later MP3.com was launched. Both of these companies were based on the technology to compress digital music files into smaller formats—an innovation, incidentally, that had been invented in Germany at the Fraunhofer Institute—that could be sent along the common 14.4Kb modem used at the time. A third audio company, LiquidAudio, also joined the emerging market in 1996, but its technology was based on a different, proprietary standard, which required buying the Liquid Music Player. All three of these companies, founded by young entrepreneurs who had worked in the industry before, instinctively worked cautiously around the legal issues of copyright, trying not to alienate the music recording industry and the powerful entertainment companies. Thus, they tried to market themselves as the new venue for independent artists and be unthreatening for the record labels. Of the three, MP3.com proved the most popular, using better technology and giving it away to users. The innovation of Napster was to add peer to peer (P2P) filesharing networks, which became so popular it undermined the economic basis of the recording industry.

In 1999, a semi-slacker from Boston became engrossed with the ability to trade songs with friends, and developed a program that networked all participants' music together and created a listing of their collective holdings. Anyone who wanted to could access the MP3 file on someone else's computer, with the only cost being the willingness to open one's own music holdings to the collective. The wider the network, the greater the utility—classic network economics at work.

The rise of Napster was facilitated by college students with unlimited access to broadband connections and well-endowed personal music collections. Napster itself called into question the entire music industry's ability to get more than one person to pay for music, and Napster immediately became the number one target of the music industry. Napster's inventors believed themselves to be blameless since they did not keep the songs in one location and give them away for free, but, rather, had individuals sending out the songs from their computers. The success of Napster also encouraged other sites, like Gnutella, and later, Kazaa, Morpheus, and E-Donkey.

At first, the recording industry went after the universities for enabling illegal music sharing, and in 2000 several large universities bought global licenses to allow their students to access Netscape. By 2000, the ongoing success of Napster meant that the recording industry had to sue Napster; by 2001 it had won, and it succeeded in shutting down Napster completely. The recording industry then went after individual downloaders, threatening to prosecute individuals, and succeeded in scaring most individuals to the paid downloading sites in 2003.[8]

Out of the ashes of Napster, however, the music downloading industry arose, alive and well. One of the salient effects of the Napster episode was the learning by a large mainstream audience of non-technophiles. Perhaps the adaptation to acquiring music on the Internet would have occurred nonetheless, but there is a reasonable argument that Napster compressed that learning interval and created a market for music downloads that Apple Computer capitalized on with the launching of the iPod.

Portable Entertainment

The Portable Entertainment segment of e-entertainment consists largely of the innovations generated by advances in wireless technology and streaming content. The iPod revolution was as much due to marketing as usability design (it was certainly not the first mp3 player). It was, however, a significant element of turning around the fortunes of Apple Computer, with revenues from the iPod and ancillary products accounting for half of all Apple revenues.

With the advent of portable entertainment technologies, more industries are creating content for the new portable devices. Juniper Research projects that the current $3 billion mobile gaming market will grow to $17.5 billion in four years as more and more customers use their phones for other purposes.[9]

Conclusion: e-Entertainment and Innovation

In terms of innovation, the e-entertainment sector can be characterized by two main styles: 1) those innovations stemming from an obvious problem (e.g., making computer game interfaces more realistic, streaming video technology) resulting in a race to discover a solution and often incremental advances, and 2) those innovations which "accidentally" create a new market, such as file sharing, which created attendant companies, technologies, and products. In the first category, more established companies invest in innovation and corporate R&D is concerned with finding the right technology as quickly as possible, yielding first-mover advantages.

In the second category, innovations are opportunistic responses to "free" resources that could be exploited for little cost. The model of music filesharing is perhaps the best example of that general path: audiophiles using university-sponsored broadband resources and putting together abstruse technologies. The fact that these companies were small and undiversified meant (paradoxically) that they were willing to develop a technology and product that confronted major industry players. It was an "all-or-nothing" gamble, which more established and diversified companies such as Apple, for example, would likely never have considered.

Yet the success of P2P networked technologies led to the widespread adoption of file downloading business models, creating a profitable market for established firms to capture, as well as new technologies for portable entertainment.

The feedback effects between the new technologies and new applications that have been sketched in this case study highlight a significant factor, the importance of geographic clusters in innovation. The cluster began by historical accident (Stanford University's role in the creation of the Silicon Valley cluster is the archetype of clusters in the literature on economic geography)[10] but the self-reinforcing properties of the cluster manifested themselves over time, leading to a virtual (geographic) monopoly over people and companies at the cutting edge of the industry. Each of the e-entertainment companies discussed in this report either began in, or soon thereafter relocated to, Silicon Valley to attract talent, meet the right people, get the name recognition, and find or venture capital. The e-entertainment sector is perhaps particularly predisposed to that kind of concentration because the entertainment industry is also primarily located in California, and so it is a Mecca for both types of entrepreneurs. However, the innovations that these companies have spawned have the dominant role in the world and the companies in the e-entertainment sector continue to shore up the leadership of the U.S. in the technological sector generally.

NOTES

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5 See http://www.websiteoptimization.com/bw/0607/

6 Eric Savits, “Netflix announces new video streaming service”, 16 January 2007. See http://media.seekingalpha.com/article/24224

7 This section is drawn from John Alderman, Sonic Boom: Napster, MP3 and the New Pioneers of Music (Cambridge, MA: Perseus Books Group, 2001).

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10 See for example, Timothy Bresnahan and Alfonso Gambardella, eds. Building High-Tech Clusters: Silicon Valley and Beyond (Cambridge: Cambridge University Press, 2004).

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CHAPTER SIX
INNOVATION IN HANDHELD SYSTEMS

MOTOROLA AND THE DEVELOPMENT OF A HANDHELD DEVICES ECOSYSTEMS

SEAN SAFFORD

The Motorola Corporation, headquartered in Schaumberg, Illinois, USA, is currently the second leading producer of mobile telephones globally. Motorola produced the first mass-market mobile telephone in 1983 and since then it has battled—mainly with its primary rival, Finland's Nokia—to maintain its prominence within this highly lucrative market through a combination of design excellence and manufacturing expertise. Yet the challenge it faces today is fundamentally different from the challenges it has faced previously.

The industry is currently embroiled in a turbulent and uncertain period in which multiple handheld technologies are converging. Mobile phones are no longer simply telephones; they are cameras; music and video entertainment platforms; they are organizers, calendars, pagers, messengers, email, and office document handlers; they are GPS devices, keepers of electronic money, alarm clocks; and they may become platforms for myriad other uses which have yet to be realized.[1]

In response to this uncertainty, Motorola has assembled a team of Silicon Valley veterans who are attempting to build a new approach to innovation for the company which is based on—and in some ways extends—prevailing best practice in the Valley. This case study examines three related shifts the team has embarked on towards this goal: (1) a shift from supply chain and toward an "ecosystem" approach; (2) a shift from proprietary control of intellectual property toward modularity and open source, and; (3) a shift from a problem solving approach and toward an interpretive orientation.

These changes at Motorola provide a window on how the approach to innovation practiced in Silicon Valley is infiltrating the rest of the American economy. Local and state leaders lave long attempted to replicate the Silicon Valley model on a local scale. But to do so requires companies to take on and internalize the model. This case study provides insight into the challenges companies face in doing so. Rather than simply (passively) tapping into the information flows which exist in an innovation system, Motorola is seeking to actively shape the landscape in which innovation happens. The paper discusses Motorola's current strategy and concludes with thoughts on the implications for the geography of innovation in the United States and globally.

Technological Convergence and the Challenge to Motorola's Innovation System

The convergence of these handheld devices has generated critical technological uncertainties that require Motorola and its competitors alike to develop new capabilities. Motorola's core strengths as a company have long been in superior solid state electronics engineering and manufacturing.[2] But the convergence currently underway has less to do with the hardware—the electronics and casing which constitute the physical form of the handheld device—

than with the software which runs on those devices. In particular, it requires the simultaneous development of a much wider and more sophisticated range software application which consumers are demanding, along with a new software operating system platform which is robust to the various directions that the market might go.

Motorola, therefore, faces the well-worn question of whether to develop those capabilities in-house or to look to outside providers of what is becoming an increasingly critical aspect of its competitive advantage. But the problem runs deeper: the nature of the convergence underway is fundamentally uncertain in the sense that the pace and direction it will take cannot be foreseen. This poses a significant challenge to Motorola's long established engineering culture, which leads it to approach innovation as a problem-solving exercise in which the capabilities it needs to develop are broken down, analyzed, and solved. Innovation in the context of the current period of convergence poses a very different challenge. Because the problems which need to be solved cannot be foreseen, the innovation this calls for is not that which responds to a definable problem to be solved, but rather to a direction which needs to be interpreted and reacted to.

In light of these challenges, Motorola has put together a highly innovative—and high profile—initiative located in Silicon Valley, California, which aims to accomplish several goals at once. The first is to lend its support to the development of a new operating system which it hopes will become the premiere platform for future software applications among handheld devices. This operating system will "open-source;" that is, rather than keeping the underlying code as proprietary intellectual property, Motorola plans to open the code to developers so they can both improve it and interface more deeply with it by changing it to suit their needs. Its goal in doing so is to shift the industry away from an integrated product design to one that is fundamentally modular in nature. Finally, the company is embarking on an effort to develop what has come to be known—particularly in Silicon Valley where Motorola has now established a new office to spearhead this new strategy—as an innovation "ecosystem." This suggests a radically different way of approaching relationships to suppliers.

Mobile Devices Platform and Supply Chain

It is expected that in 2007, over 1 billion mobile handset devices will be sold to end users.[3] These include three major categories of mobile telephone: basic phone (capable of voice and text messaging), enhanced phones (typically with cameras and possibly some geographic location capabilities), smartphones (data-enabled devices with advanced voice and data capabilities running on multitasking operating systems), and cellular PDAs (which function—in addition to telephones—primarily as personal organizers with processors that can handle advanced office document capabilities). Figure 1 presents a schematic diagram of the handheld devices value chain. This section outlines the relationships among major players in the industry.

HANDSET MANUFACTURERS AND SYSTEM OPERATORS.

The market for mobile telephones is highly concentrated among a few top producers. Between them, Nokia (36 percent of the market), Motorola, and Samsung control over 70 percent of global sales to end users. However, despite controlling the key consumer interface—the phone itself—device manufacturers are subordinate within the industry value chain to mobile phone operators (e.g., Vodafone, Verizon, NT DoCoMo, and T-Mobile) which are responsible for the distribution of mobile phones and their software platform to end users and control what mobile telephones their subscribers use, what software platform runs their phones, and what applications can be downloaded onto them. Network operators' brand identities are tied to the services they can provide to customers above and beyond reliable network coverage. As the bottleneck controlling access to the customer via its networks, network operators largely dictate the kinds of capabilities they want to see on mobile telephones and how those technologies interface with consumers; that is, the look and feel of the user interface. As a result, handset makers must negotiate a new—and often unique—look and feel to the phone, depending on which customer the phone will be sold through.

HANDSET MANUFACTURERS AND THE SOFTWARE PLATFORM.

In 1992, UK-based Psion, Inc. failed in an attempt to license an operating system to Microsoft for the handheld computing devices called “palmtops” or personal digital assistants (PDAs). Instead, Psion decided to develop a new version of an existing operating system aiming at a “lighter” and more battery-friendly system than Microsoft could have delivered at that time. Psion set out to license the software to competing PDA manufacturers. However, the first three licensees turned out not to be PDA manufacturers but rather cell phone makers Nokia, Ericsson, and Motorola. These manufacturers’ interest in Psion came from fear that Microsoft might make Windows the standard operating system for mobile devices as it had in the case of personal computers; an eventuality that would put device manufacturers, application providers, and network operators alike at strategic disadvantage. A joint venture, Symbian Ltd., was founded as a private independent company in London on 24 June 1998. Its initial shareholders were Ericsson, Nokia, and Psion. Motorola announced its intention to join the consortium within months of its establishment and several other phone manufacturers followed. Besides capital, each shareholder agreed to contribute personnel to work on the development of the Symbian operating system.

NETWORK OPERATORS AND SOFTWARE PLATFORM.

Symbian developed additional partnerships to include Matsushita Electric Company, Siemens and—following its merger with Ericsson—the Sony Corporation. Symbian also pursued agreements with major operators and software firms on adapting technological standards to allow interoperation across existing systems. NTT DoCoMo, for instance, became a key member of Symbian’s “Operator Review Board” which became a cornerstone on which Symbian ensured phones based on its operating system would meet the specification of different national networks.

HANDSET MANUFACTURERS AND APPLICATIONS DEVELOPERS.

Symbian maintained strong relationships with two of the key pieces of the mobile phone value chain: manufacturers and network operators. It has been less successful in the domain of application and content providers. This was a risk. Microsoft’s chairman, Bill Gates, had announced that applications developers were the “catalyst” that would create a future of seamless interfacing between desktop PCs and smart phones. But Symbian management believed that applications, though essential, would be less critical in the short term than they were for PCs. It nevertheless sought to widen its range into the developers’ arena, building—in 2001—strategic partnerships with three important applications firms: Opera, Real Networks, and Macromedia. That same year, Motorola developed a developer toolkit which would allow third-party content and application providers to enable automation of numerous tasks, from composing code to debugging finished programs. The goal in doing so was to attract applications developers to the platform.

Catalyst for Change: Motorola’s Exit from Symbian

Symbian was founded on three dimensions of “openness” among participating organizations: (1) open industry standards, in which all members of Symbian would pay for access to the same software; (2) design and manufacturing openness, in which third party software developers and device creators could “plug in” their applications to the operating system; (3) operator openness which ensured that system providers would have opportunities to craft identities which could be used across different hardware offerings, but with a unified “look” and feel to the software-based user interface. In addition to these principles, the consortium was organized in such a way as to ensure that no one member would dominate. Yet, despite this, Nokia took the lead, in practice, particularly with the development of its Series 60 user interface in 1999.

Nokia presented Series 60 as a self-contained “platform” comprising “key telephony and personal information management applications, browser and messaging clients, and a complete modifiable user interface.” The powerful attraction of such a package for manufacturers was evident. Matsushita announced that it would use Series 60 on its own smart phones, as did Siemens. The company also aggressively targeted the application developer community. Siemens and Nokia jointly sponsored a series of workshops for application and content developers while creating websites and contests to encourage developers. Games developers were courted through a contest called "Series 60 challenge."

In addition to proving a significant competitive challenge to Motorola, Nokia's moves with respect to Series 60 were perceived as violating the principles of openness on which its participation in the Symbian venture was predicated. Motorola announced on 29 August 2003 that it would leave the Symbian venture. While continuing to license and use the technology in its phones, Motorola announced it would also license Microsoft's operating system on certain phones while simultaneously moving toward the development of an open source platform to be developed in conjunction with Sun Microsystems.

In addition to the competitive concerns that Nokia's emergent dominance over Symbian posed for Motorola, the problems it faced interfacing with the application and content developer communities were indicative of a deeper problem in the industry: as technological convergence picked up pace, it has become apparent that the innovation model on which Symbian was based had become deeply flawed. With each handset manufacturer responsible for customizing software to meet the quickly changing demands of network providers, manufacturers remained responsible for customizing the operating system and sourcing applications to place on the device. This resulted in two primary problems. First, it means that the operating system—while sharing some major elements across manufacturers—was nevertheless also customized and, in some cases, that customization reached down to the level of different product lines as well. Developers therefore face a situation where they must develop applications and content that is robust across a much larger variety of environments—estimates put the number at over five hundred, taking into account different manufacturers and their various product lines—which represents a significant barrier for developers considering entering the handheld devices arena.

As a result, manufacturers rely on a very limited set of applications which meet only basic needs; a situation which undermines the incentive to develop new—innovative—applications. Manufacturers, therefore, face the need either to develop those capabilities in-house or reform the innovation model in order to do a better job of attracting outside developers to enter the arena. Motorola has chosen to take a leadership role toward achieving the latter. Doing so involves three fundamental shifts in the way the company approaches innovation, outlined below.

From Supply Chain to Ecosystem

What I'm told is that from the time Ed got here he said, "Where's my ecosystem, I want my ecosystem." They said, "What do you mean? We have a supply chain. It all works!" But a couple of things happened. We are developing our own platforms. We have been very vocal in mobile Linux. Mobile is 60 percent of our business so the software platform in our devices is very impactful. But if you look at building a platform versus buying a platform, one of the things you have to build is the ecosystem, the relationships around it.

Christy Wyatt,
Vice President for Ecosystem
and Market Development
Motorola Corporation

The "Ed" to whom Christy Wyatt refers in the preceding quote is Ed Zander, who took over as CEO of Motorola in January of 2004. Zander arrived at Motorola after serving as Chief Operating Officer of Sun Microsystems, the Silicon Valley-based company which developed Unix, the Java platform and, in championing the open source movement, has emerged as a leading challenger to Microsoft's hegemony.

Motorola's approach to supply chains was (and for the time being, remains) very traditional. A quintessential "not invented here" company, engineers look first internally for solutions to problems and then—only as a last resort—search outside for vendors who can produce to Motorola's specifications. The approach to outside vendors which prevails in Silicon Valley is fundamentally different. Rather than supply chains, the buzzword in the Valley today is “ecosystem”.[4] The philosophy of the supply chain is linear and engineered with goods and services negotiated up and down the chain. The philosophy of the ecosystem, on the other hand, is networked and organic. Actors come and go in loose coordination with each other. They are dependent on each other to the degree that they are producing complementary products that must interface and interact. But the relationships are not necessarily hierarchical. There is a more intricate dance by which coordination and control occur among industry participants whose products compliment each other. Coordination is not hierarchical. Rather, it is mediated through the adoption of common standards and protocols for their use among the various producers of products.

From Proprietary Control to a Mixture of Open Source and Modularity

We are going to try to leapfrog the traditional developer ecosystem program which has a conference and a paid tier system that attempts to be a gatekeeper to the products. You pay more money and you get better access to the business relationship. We want to get rid of that and create something that is more on a social networking model. Creates a community and allows people to interact and it allows people in Motorola to participate in that. We used to communicate by NDA and—we used to communicate by NDA and contracting—that was the medium of exchange with people outside the company. We want to get rid of that and that’s visionary. One of the reasons our community was stilted is we saw our products as closed—we didn’t want to lose control.

Bill Maggs
Ecosystem Evangelist
Motorola Corporation

At the center of that coordination and control structure is the software platform. The Symbian operating system is only one element in a complex structure that links mobile phone operators, handset makers, application providers, and software platform makers. But it is the central node according to which all of the main actors in the industry—application developers, equipment manufacturers, service providers and, indeed, customers—intersect. The software platform therefore shapes the industries and the business strategies in fundamental and important ways.

When Motorola left Symbian, it announced its intention to devote significant resources to the development of an open source platform for handheld devices. At the same time, its commitment to shifting toward an ecosystem approach implied a shift in the way that it interacts with content and application developers. The approach it has crafted to managing its ecosystem has become a mixture of open source at the bottom end of the software value chain and modularity closer to the user interface.

MODULARITY IN SOFTWARE DESIGN.

Outsourcing has long been a strategy employed by even the most hierarchical multidivisional firms. But the logic in doing so had traditionally been either to meet unexpected demand or to produce specialized goods that it did not make economic sense to produce in-house. In the 1980s, though, a number of companies began experimenting with a radical shift in their approach to outsourcing, particularly in the electronics sector. Many newer companies such as Sun Microsystems, Silicon Graphics, EMC, and Cisco Systems outsourced most of their production from the outset. Their rapid growth in the 1990s fueled further growth and generated a large wave of consolidations in the industry.

This shift, however, was not simply a separation of production and design. Outsourcing in Silicon Valley came to take on a qualitatively different organizational form which has been referred to in the academic literature as “modularity.” Modularity is defined by breaks in the value chain where information regarding product specifications are highly formalized.[5] Within functionally specialized value chain nodes, activities tend to remain tightly integrated and based on tacit linkages. However, between those nodes, linkages become highly codified. This allows for arms-length relationships across nodes—i.e., at the level of systems—but encourages rich flows of information and collaboration between firms within nodes.

OPEN SOURCE IN SOFTWARE DESIGN.

The concept of modularity is related to—but in important ways, fundamentally different from—the concept of open source software platforms.[6] Most commercial software producers consider source code—the raw instructions that determine how a program works—to be valuable intellectual property and therefore do not make it available to users or the general public. The key difference between open source software and commercial is in the access to source code. When the code is a closely guarded product, innovation is limited to the author. The original author is the sole entity with the ability to make changes to the software. There is a clear demarcation between roles of author and user. Open source software design empowers users to make changes to the product. Users can create customized solutions for their needs, adding features or improving existing ones.

THE MIXTURE AT MOTOROLA.

In the handheld devices industry, the software content of the phone is dictated by the Network Providers; it is one area of differentiation separating, say, T-Mobile's Razr telephone (manufactured by Motorola) from Verizon's version of the same phone. In order to meet what are sometimes very swift changes in specifications demanded by network providers, Motorola—like most traditional electronics companies—employs a certain number of developers to craft software which is then handed off to a group of testers who work with the product to make sure that bugs are worked out. Then the program is launched onto the market. Motorola employs several application program developers who both develop simple programs (e.g., the alarm clock on the phone) and also test software applications sourced from external vendors (e.g., the simple games which are loaded onto many phones) which are loaded onto phones in line with network operator specifications.

As it shifts toward a new footing for software development and innovation, its emphasis is moving outside the firm. Its goal is to take on a role facilitating the development of the open source code while at the same time actively managing the context in which modular application production takes place.

The open source starts low down and moves up and the proprietary stuff we control moves down. The kernel, the real time operating system, the way it interacts with hardware. Those are things that will interact with the open source approach. But when it comes to things—what—you know—I guess the user interface. Those are the kinds of things that need to come from an artistic person with artistic control, not from a community.

Bill Maggs

From Problem Solving to Interpretation

We host a VIP party where we invite who we think is the coolest and most influential and we put them in a room. My job is the society matron saying, "You know who would be really interested in your stuff is…" I can't ask them the right set of questions—I can't tell the database the right schema that will capture our future product needs because I don't know who our competitors will be five years from now.

Christy Wyatt

The mixture of open source at the bottom and modularity at the top requires a fundamentally different approach to managing within the ecosystem. It requires giving up proprietary control in terms of the operating system, managing the interface between that system and the developer community and, perhaps most importantly, shifting its emphasis away from simply reacting to the demands of network operators and toward encouraging innovation among a dispersed and unwieldy community of software application and content developers. Rather than taking on the task of innovating on its own, Motorola has positioned itself to observe and make judgments on the quality and direction of innovation as it is unfolding within the developer community. If it succeeds, it will be the first to see and comprehend the value of new combinations of capabilities happening within the developer community which it can then either acquire or improve on in order to generate value for its primary customers: the network service providers.

This represents a fundamental shift in the way

Motorola thinks about innovation. Rather than being a problem to be solved, innovation is seen as a direction—a trajectory—to be interpreted and reacted to.[7] To accomplish this, Motorola is shifting toward a facilitator model. It lays the groundwork and—more importantly—it is creating a social and technological context in which innovation happens through the interaction and intersection of small, specialized developers who bring different core capabilities to the table.

The metaphor one might have in mind to think about this approach (invoked in the quote from Christy Wyatt above) is of a society party in which the hostess hopes to marry her daughter. She cannot simply announce her intention; that would result in some very uncomfortable guests. Rather, she throws a lavish party where she skillfully circulates, encouraging conversation. It is out of this mix that new combinations—in this case, romantic couples—are generated. Bringing the metaphor into the realm of technology innovation, the model one has in mind is of separate specialized companies who do not realize the combinatorial possibilities without the aid of a knowledgeable, socially skilled society matron who can create the context in which they find each other. Being the skilled observer she is, the hostess of the party will know where the best and most interesting conversations are taking place giving her a window—not only onto the best technologies—but also where the most promising candidates for combination lay.

Motorola is accomplishing this through the creation of a new Internet-based interface modeled on social networking programs like MySpace and LinkedIn which encourage users to create profiles containing their interests and capabilities and then creates mechanisms (electronic and otherwise) that allow users to find others with similar or complementary interests. By providing this context, Motorola hopes to encourage innovation while at the same time observing the combinatorial patterns that emerge, placing it in a position to interpret more quickly and more accurately where innovation is headed. It will also then be in a position to quickly acquire companies or combinations of individuals that emerge from this process or replicate and improve upon them internally.

By combining this process approach with a powerful set of developer tools built around the emerging open source operating system, Motorola hopes to retain and build on its strong position in handheld devices to capture significant market share as technological convergence in the industry builds pace.

Concluding Thoughts on Implications for Spatial Approaches to Innovation

It has become de rigueur to call for policies aimed at encouraging a Silicon Valley-like culture within clusters of technologically related companies at the local level. The draw to do so has been particularly strong among older industrial regions which are—by definition—populated by traditionally organized, older industrial companies. Yet often the interpretation of what a “Silicon Valley” culture is has been reduced to simple clusters of related companies who share a common—highly mobile—labor pool. But, as this case illustrates, applying the lessons of Silicon Valley requires going beyond such platitudes toward understanding how the Valley actually works and confronting the challenges companies face in incorporating those lessons into practice.

Silicon Valley is populated by large companies—Cisco, Intel, Sun Microsystems, and others—which are as much the backbone of the its economy as major industrial firms of the past were in their respective home clusters, such as General Motors and Ford were in Detroit, or U.S. Steel was in Pittsburgh. The shift that has occurred has less to do with the size and clustering of companies than with the way in which the companies at the centers of these clusters coordinate the innovation process within them. While in the past clusters were coordinated hierarchically, in Silicon Valley firms coordinate through a combination of facilitation and leadership within disaggregated—networked—ecosystems.

Tapping into knowledge spillovers and tactic understanding is often cited as one of the main reasons companies re-locate research and development capabilities to certain geographic clusters which are thought to be hubs of knowledge flows.[8] And Silicon Valley is often seen as the non plus ultra of knowledge-based economies globally. Yet, often, the conception and execution of such efforts is cast in essentially passive terms. Concepts such as knowledge spillovers and absorptive capacity suggest that simply being in such a place—and being prepared to comprehend and utilize available knowledge—will bring benefits to companies. This case study suggests both that firms seeking to benefit from ecosystems need to be far more proactive by organizing the ecosystem itself and also points toward the internal organizational changes which need to accompany such efforts.

This notion of ecosystem leadership—particularly in the context of "modularity"—also stands in marked contrast to forms that coordination and control take in other parts of the U.S. and Europe. Gary Herrigel and Volker Wittke's discussion of the de-verticalization of supply chains in Germany, for instance, suggest that model form of coordination in what they refer to as "sustained contingent collaboration" as a long term relationship between suppliers and original equipment manufacturers which is marked by constant negotiation over roles with each side tussling over issues such as cost reduction and product design.[9] The negotiations—and the rules which emerge from them—occur between individual parties, albeit embedded within broader social and economic systems at the industry and national levels. The ecosystem model discussed here suggests a more distant relationship between customer and supplier, but one that is nevertheless mediated by a more explicit set of rules which reside at the level of the industrial community or "ecosystem."

The roles of the ecosystem platform leader—in this case Motorola—are multiple. If it succeeds in capturing the leadership role, Motorola will of course become a primary customer of suppliers' goods. But it will not be the exclusive customer. Perhaps more important than the role of customer, Motorola will assume a separate role as watch-dog of the ecosystem itself; shaping and, more importantly, enforcing the rules by which the ecosystem operates.[10] The two roles—customer and watchdog—are not mutually exclusive; its role as a central customer gives it the power and legitimacy to play this watchdog role. Achieving (and maintaining) that coordinating role requires a delicate dance but only time will tell whether the company can navigate its way to success.

If it does succeed, this new approach to organizing innovation has significant advantages for companies in terms both of innovation and production. As the pace of technological change quickens, product specifications are changing far more rapidly and direction of those changes cannot be as easily divined or dictated as they may have been in the past. The core of the Silicon Valley approach has been to decentralize the design and production process—while maintaining a core coordination and control capability—which can both generate radically new innovations and react quickly to those innovations bringing them to the market place.

One thing this particular case study illustrates, though, is the importance—and difficulty—that older industrial companies face in attempting to shift gears toward these new models of innovation and production. Motorola has done so by bringing in a highly skilled—high profile—team of professionals who are deeply entrenched in the Silicon Valley ways of doing business. But this approach has significant risks as the team—which is based in Silicon Valley—attempts to convince the rest of the organization to follow its lead. Much of the team's evangelizing is directed not at external vendors, suppliers, complementors, and observers, but at the company itself which remains wedded to its traditional ways of doing business. Motorola's is an interesting, illustrative, and important example. But its success is far from certain due mainly to the internal barriers it faces in changing course.

This holds lessons not only for company leaders, but for policymakers as well. Older industrial regions and the companies that populate them are desperately seeking solutions to help place them on a footing to compete effectively in the twenty-first century. Silicon Valley offers a model, but it is not one that can be implemented over night. Rather, it must be seen as a destination requiring a process of gradual change and adjustment.

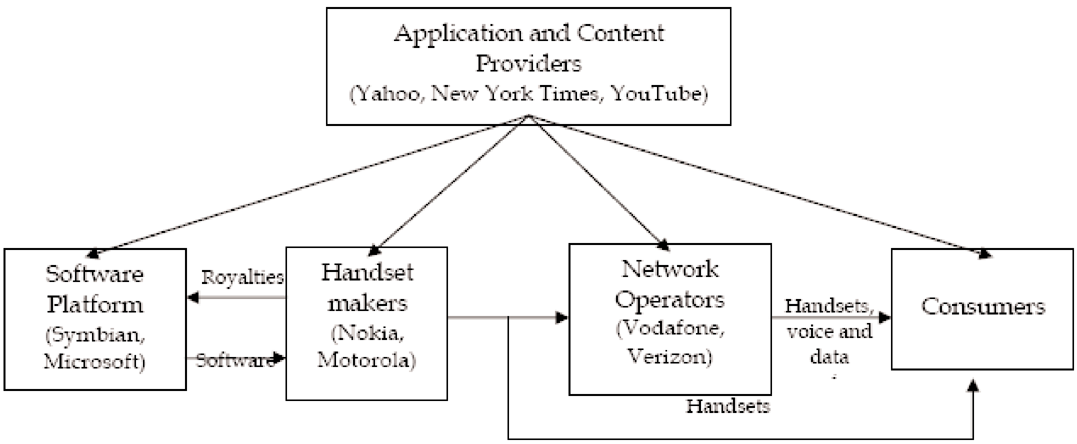

Figure 1: Schematic of the Mobile Devices Value Chain

NOTES

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