

University of Michigan–Dearborn

Report from the First Event in the Viscogliosi Economic Leadership Series

November 16, 2005

The Viscogliosi Economic Leadership Series was launched on November 16, 2005, with a presentation by Professor Philip Scranton. Scranton is the University Board of Governors Professor, History of Industry and Technology at Rutgers University and the author of *Endless Novelty*. This report provides a review of Scranton's presentation and the discussion that occurred with participants at the session. It also includes responses from two University of Michigan–Dearborn faculty members discussing the implications of the presentation's topics for innovation and development in southeast Michigan. Professor Marie Waung provides a viewpoint from the discipline of industrial and organizational psychology, and Professor Lee Redding applies ideas from economics.

The goal of this report is to provide a rich summary for people who participated in the evening and others who are interested in learning about the discussion. Some of the ideas presented here are complex, but we believe they are worth the effort required to read them because they offer new ways of thinking about the situation we face in southeast Michigan today. One of the major tasks we face as a region is changing the way we think as individuals, and as Professor Waung notes in her reaction statement below, also changing the way we think collectively in our business culture.

Since the goal of the Viscogliosi series is to have an ongoing conversation about the current and timely lessons available to us in the history of technology, we encourage readers to interact with this material. The document includes wider margins to allow you to write thoughts and comments as you go.

I. Review

By Joy Beatty, Assistant Professor of Organizational Behavior, School of Management

The title of Scranton's presentation was ***Technology, Science and American Innovation***. In this presentation, Scranton offers a view of the history of innovation that runs counter to the usual narrative of American innovation. His view encourages us to change our focus as we seek creative ways to address the challenges we now face. Scranton offers four propositions based on 20th century innovation, which at their center challenge four myths about the sources of innovation. These myths are that:

- mass production and the drive for efficiency have been the main source of continuous innovation
- basic science is the source of technological advances
- the prime motivation for innovation comes from problem sets offered by the open market, and
- state efforts to cultivate innovation are generally unsuccessful.

The first myth is that mass production and the drive for efficiency have been the main source of continuous innovation. As producers seek new ways to achieve efficiency, they are required to innovate, and they are motivated to do so by market forces. This is the legacy of Henry Ford. However, Scranton argues that mass production has been given too much credit for American innovation. As mass production has become commodified, managers have focused more on wringing out excess costs, for example moving to offshore production to reduce labor costs. These cost-cutting strategies help us produce known goods more cheaply, but do not lead to technological innovation.

Instead of efficiency, Scranton suggests that *efficacy* is the critical capability for innovation. Efficacy involves acting with confidence under conditions of uncertainty, rather than refining the known and familiar. Efficacy is rarely efficient because it requires many costly iterations of trial and error as innovators learn from their failures. This approach is also part of our history, an example being the legacy of Thomas Edison. The message here is that reducing our focus on efficiency affords us more resources to put toward experimentation, which is a better source of innovative ideas.

The second myth is that basic science is the source of technological advances. Under this myth, basic science is done first, then the technologies we develop are based on that science; our technology supposedly rests on a foundation of scientific certainty established by the basic research. The model here is that of the Manhattan Project in which scientists innovated to create the atom bomb, following the rational and linear process of scientific experimentation.

Yet this does not match the actual process seen in the field. Scranton proposes that the actual process of innovation is led by engineer-practitioners who through trial and error find new ways to apply technology. As they encounter new unexplainable problems in these applications, the problems get kicked back to the scientists to do basic research. With this pragmatic approach, the basic research is done when, and *only* when, it is needed. Science lags rather than leads technology, as we are not inclined to wait for the science to catch up. The message is to embrace trial-and-error practitioner-based learning as a worthy complement to basic or pure research, as both have their strengths.

Everyday practitioners also contribute to innovation through the daily adaptations they make to unreliable new technologies. Complex systems become

unstable when many components are interdependent; systems can crash. Operators must respond with quick adaptations to address the problems that occur at the system interfaces. Employees in environments with new technology must deal with a more permanent kind of uncertainty – will the technology work today? This requires our employees to have different cognitive skills such as the ability to imagine and infer what’s happening in processes that are not well understood. Scranton refers to this as a state of “permanent uncertainty,” noting that there are hazards in all our technology that we are not aware of.

How should we respond to permanent uncertainty? One way is to do what we already do, which is to solidify the underlying science to address the problems. This is what happens when the practical problems get kicked back to the scientists. Additionally we can launch smaller scale pilot tests before putting things into the market. This gives us an opportunity for trial-and-error learning. We can also implement litigation restrictions so there is more freedom from risk of failure.

Returning to the example of the Manhattan Project, a unique element that was critical for its success was the fact that it was state sponsored. The Manhattan Project’s mission was defined and funded at the federal level. This point is related to the third and fourth myths that Scranton discussed. We have a tendency to believe that the prime motivation for innovation comes from problem sets offered by the open market, and that the state presents barriers to innovation by imposing policies and regulations that limit businesses’ creative freedom. Scranton suggests that this was true in the 19th and early 20th centuries, but is not so today.

He proposes that it is an error to see the state as an impediment because the state has played a significant and unrecognized role in setting the innovation agenda. Government organizations, especially those focused on national security, have created and funded opportunities for innovation when no commercial markets exist. The government has the resources to provide the massive amounts of funding necessary for large-scale trial-and-error learning. Thus the government should be seen more properly as a patron of technology. History shows that the nation can make strides in technology when we have a clear focus on key problem sets, defined from above, and when we have a big checkbook ready to pay as needed.

At the same time, relying on the market to innovate is misguided because the market does not provide incentives to innovate. If the incentive is supposed to be shareholder value, then innovation will not occur because it is too risky. The culture of short-term dividends does not support endless iterations of trial-and-error learning. Continuous innovation is scary for stockholders because you might disrupt or destroy industries. This fear of short term losses is an impediment to innovation. The problem with relying on markets to guide innovation is that markets are for exchange; they do not plan or think ahead. Without such vision, exchange relations cannot handle the innovation.

A concept Scranton discussed that resonated with session participations was the distinction between “solid and liquid modernity.” According to the logic of solid modernity, the business model is to invest deeply in plants, existing technology and personnel. The rational, orderly behaviors of strategic planning and prediction guide our investments, which have a permanent and solid character. This approach has lots of sunk costs. In contrast, liquid modernity is responsive, investing in ideas and not things. This is the model of globalization which makes different, more fluid assumptions about place, people, institutions and investments. Everything is short-term: nothing is fixed, including costs. In the global market, being solid is a liability because it limits our flexibility to respond. The crisis we face in large-scale manufacturing today is a crisis of solid modernity, as we are unable to shed our substantial prior investments and jump into the next big thing.

Implications

The overall implication is that the social narratives we tell ourselves are not aiding our search for new technologies. The version of history we believe has us approach innovation by seeking efficiency, pursuing basic science, and looking to market opportunities to define our problem sets. This is the standard American toolbox of innovation, based on stories about American ingenuity we’ve been told since childhood. The problem is that our standard stories cause us to look in the wrong places and use the wrong processes to spark innovation. Scranton’s ideas cause us to question this social narrative and consider that perhaps we have missed important parts of the story. Many innovations have come from other sources via other processes, so why don’t we revisit these alternative sources and processes for some new ideas?

A recurring theme of Scranton’s message is the importance of trial and error as the primary source of innovation. This means we need to allocate resources to trial and error, and that we should welcome failures as a necessary component of the learning process. This also means we need to take more risks, for example trying an experiment that we know has a low probability of success, just so we can reap the learning from it.

Participant Reactions

A major discussion topic was the role of government and the limits placed upon us by market ideologies. Participants expressed frustration that our government is not active in shaping the technology agenda or providing funding, and drew comparisons with other countries. They shared examples of commercial aircraft (for example, Airbus is subsidized, but Boeing is not), and the influence of MITI in Japan in developing their automotive industry. China has been subsidizing the development of its technologies. China, Japan and Korea have also been working together, reaping the benefits of collaboration.

In the U.S. we do not get governmental support for technology because we are so capitalistic. The free market mantra does not support this type of government activity. Organizations are so focused on squeezing out costs to remain globally competitive that they don't have the resources to be innovative. Further, we get competition for economic development from neighboring states offering tax incentives to lure businesses to their region, so competition ends up damaging revenue for all local governments.

Scranton noted that the countries that have strong government investment also collect much more in taxes than the U.S. Thus we have individualized our consumption of and investment in technology while other countries have socialized theirs. In overdoing our ideal of individualization we have undermined our ability to cope with big problems. If we are to support big state-funded investment, our taxes must increase, which is not consistent with the current political environment. In response to the idea that our highly individualized capitalistic model is a barrier, Scranton notes that other countries with more interventionist market strategies actually "do capitalism" quite well. He points out that there are no truly "free" markets: There are always rules that determine market practices. We could learn from looking at these other approaches to economic regulation instead of thinking our "free" market approach is the only way.

He agrees that the structure of the American polity which encourages regions to compete with each other is a problem. He asks us to consider which elements must be locally sited? In other words, which elements are "locationally powerful"? These elements are the ones that will allow us to be competitive.

Scranton was asked if he thought the auto industry could become liquid. He replied that it could, but it appeared that no one is yet thinking this way. Our current solution set doesn't allow this kind of response. Scranton noted that major innovations in the auto industry occurred during the Great Depression out of a certain desperation led to greater risk taking. The current competitive market does not allow for this kind of risk to be tolerated. Participants wondered what our hopes for economic development can be if we have a loss of place. If innovation is liquid, it can leave. Our infrastructure here in southeast Michigan, a symbol of our solid modernity, hinders our ability to respond.

Marc Viscogliosi noted that history is written by the winners, and that we ought to imagine what it would be if it was instead written by the losers. There could be a lot of value in learning what *didn't* work and why. Scranton agreed that when winners tell their own stories, you don't learn very much. He believes that studying failures and re-studying success as an outcome that is contingent on failures gives us a sense of the issues they had to overcome. These failures are the factors that get forgotten. We must recover the contingencies to see what happened.

Marc also stated that our economy is more service-based now. The influence of the service-based thinking and mindset has a major impact for our time. We now have the “consumerization” of everything, including information. This gives a whole new way of thinking about investing in ideas, instead of buildings and projects. Scranton concurred, adding that our understanding of the service economy is not very good. We all learned traditional theories of economics based on land, labor and capital—traditional solid modernity. There is no theory of the service economy to replace it. Manufacturing-based models are not generalizable to service.

Scranton suggested that we need to rethink the problem. In our current environment, we sit around and ask, “How could this happen to us?” We whine about it. But he notes that we’ve had a 100-year run, and now others are taking over. Dean Bublitz from the School of Management, who was given the final word, notes that there have been many failures from change efforts and that we are afraid to fail. Do we have enough people who are willing to fail? He asserts that we need to fail more often.

II. Reaction from an Industrial and Organizational Psychology Perspective *By Marie Waung, Associate Professor of Psychology, College of Arts, Sciences and Letters*

After attending Phil Scranton’s talk on *Technology, Science and American Innovation*, I’ve pondered how business people might translate the idea of innovation into practice. From my perspective – that of an industrial-organizational psychologist – there are several focal areas that seem particularly relevant to this goal. These areas are:

- understanding what motivates individuals to innovate;
- determining the characteristics of organizations that are linked with innovation and;
- examining the kinds of tacit knowledge that develops when operating in the face of uncertainty and considering ways to transfer that knowledge.

With regard to innovation and creativity, motivation plays an important role. Specifically, employees must possess a belief in fair play on the part of the organization to be motivated to innovate on behalf of that organization. Organizational Citizenship Behaviors (OCBs) refer to spontaneous and innovative behaviors that employees engage in without receiving any type of formal reward, but that in the aggregate are vital to the functioning of the organization. Given that we cannot include every necessary behavior in an individual’s job description, managers must rely on employees to engage in these extra-role behaviors. However, if employees feel distrustful of management or feel that they

are being treated unfairly, then they will reduce their OCBs, sticking much more closely to in-role behaviors (i.e., behaviors defined in job descriptions). Research indicates that OCBs are more likely to occur when employees are conscientious, when they are satisfied with their jobs, and when management is perceived as being fair in how they make decisions.

My impression based on informal conversations over the years with members (albeit cynical ones) of several larger, mature organizations is that there is often a culture of fear, a belief that mistakes will be punished, and a sense that no one wants to know the truth, because it will make everyone look bad. Clearly, such a culture is unlikely to foster creativity or innovation. Organizational culture consists of the assumptions and values that determine behavior in organizations, along with communication patterns, style of dress, office space, etc. In less academic terms, culture is “The way we do things around here.” It perpetuates itself because job applicants that fit with the existing culture tend to be hired and these new hires are then socialized to think and behave in ways that are consistent with that culture. Ed Schein, an expert on organizational culture, discusses the difficulties of trying to change an organization’s culture, noting that these difficulties are especially great with mature organizations. Selecting a “hybrid” CEO – one who understands the current culture, but who has experiences and views that are different enough from the current culture – is one possible strategy to bring about cultural change in mature organizations.

In the paper that Phil provided for us, he discussed how those working in uncertainty must “conjecture, imagine and infer what’s happening with/in technological artifacts and processes that are inadequately understood, consistently changed, or inordinately complex.” He then goes on to state that this involves an “intensified mental workload.” An interesting question is how people learn to deal with uncertainty and whether or not this learning may be captured and taught to others. Several years ago, I had a conversation with an engineer who worked for one of the Big Three regarding how new engineers might be taught the acquired knowledge that the more seasoned engineers possessed. This idea of a sort of shared mental model might also apply to working in uncertain environments. The goal would not necessarily be reducing uncertainty, but rather, to consider how others have reacted to uncertainty and whether or not these reactions have been effective.

Tacit knowledge refers to knowledge that experts may possess, yet may have difficulty articulating or conveying to others. For example, a physician may be an expert at diagnosing patients yet may have difficulty explaining why in one case a certain diagnosis is favored over another. Research indicates that tacit knowledge is difficult to transfer smoothly. Interestingly, when two parties have developed a strong relationship prior to the transfer of tacit knowledge, the time and effort required to transfer this information is reduced. Such research on tacit knowledge may be applicable to teaching employees how best to deal with uncertainty.

Organizations that seek to innovate will likely face a precarious balancing act between providing some degree of structure, while also allowing flexibility within the design of products, work and the organization itself. With too little structure, members of an organization may lose sight of its mission and purpose, but with too much structure, innovation is stifled. Given designs that allow for flexibility, managers might motivate innovation in their employees by ensuring satisfactory working conditions; fostering fairness in the workplace; working toward a culture of learning, rather than one of fear; and measuring and teaching employees knowledge and strategies for working with uncertainty. As I am a psychologist, you shouldn't be surprised that each of the strategies that I've selected for fostering innovation hinge upon interpersonal relationships. Trust, openness and strong relationships are likely to be key factors in fostering a climate of innovation.

III. Reaction from an Economics Perspective

By Lee Redding, Assistant Professor of Business Economics, School of Management

Based on my background as a research economist, Scranton's presentation sparked many interesting ideas for me which I share with you here. Scranton presented four propositions in both the paper and the seminar to guide our inquiry and thinking about innovation today. These ideas, as mentioned above, are:

- I. "Continuous Innovation" was just as important as refining mass production during the 1890-1960 period.
- II. Technological creativity spurs scientific knowledge more than the other way around.
- III. Technological innovation moves ahead of scientific knowledge, which creates "permanent uncertainty."
- IV. From approximately 1940-1990, the national security state drove innovation.

Economists speak of growth in "total factor productivity" (TFP), which refers to an increase in the amount that can be produced with the same amount of capital and labor. TFP is driven by things such as R&D spending and time to innovate. From a macroeconomic viewpoint, TFP growth could come from refining existing techniques or developing new techniques. The Proposition I on continuous innovation asks us to focus on the portion of innovation that is distinct from the refining of mass production techniques.

Consistent with this idea, participants discussed continuous innovation as a redefinition of the product itself, as distinct from changes in the production process. They pointed out that redefining the product is often not in the interest of the market leaders in the "old" product. These companies have large specialized

investments in producing the “old” product, and the “innovated” product is likely to take sales away from their “old” product. For example, producers of current-technology cars have less incentive to develop cheap and efficient fuel cell cars since this would reduce the demand for current-technology cars. However, participants noted that this view is myopic; the choice is not between a new product and the status quo, but rather between a new product you control and a new product your competitors control.

All four propositions are intertwined. The picture is one in which technology (the design and production of products) runs ahead of science—the rigorous understanding of the mechanisms that make the technology work. At the same time, the science forms a sort of “solid ground,” allowing engineers to reach forward to create new products. While this creates the “permanent uncertainty” of Proposition III, basic science is still an important contributor to business innovation and thereby to economic growth. This becomes even more valid when the basic science that we fund guides us to “solid ground” in those areas where engineers most need it.

Economists believe that something like basic science (or for that matter, college education) should be subsidized if it has a positive *externality*. A positive externality in this case is the growth in technology that is made possible by the improvement in basic science understanding. The value of this growth is not captured as wealth to the basic scientist, but is captured by society as a whole.

The Proposition IV addressed the importance of the state in determining the project agenda that led to innovation in the 1940-1990 period. The state is important because only it had the scale and the patience to undertake these large endeavors. Economists refer to this patience factor as having a low discount rate. A low discount rate means that you are more willing to wait for an investment payoff, and therefore more investment projects are considered profitable for the government than they would be in the private sector.

Indeed, participants pointed out that even as innovation is critical to the economy as a whole, it may not be in the interest of the shareholders of the innovating company. This could be true if the investment in innovation takes too long to pay off. This is different from a common concern in economics, in which the private sector might not take on a project because its risk is too high or because the benefits of the project do not accrue entirely to the project managers. Indeed, the fact the benefits of innovation flow to people other than the innovators (an externality as discussed above) has been the economic basis for such things as tax credits for research and development. If Proposition IV is valid, then we might want to focus these tax incentives on those who are willing to *wait* for a project to pay off rather than simply those are willing to face the *risk* that the project might or might not pay off.

This difference between the government's low social discount rate and an individual's private discount rate might also apply to the investment in college education. Several participants noted Michigan's low college graduation rate. Individuals might be unwilling or unable to make an investment in college education. Even though the investment generally offers high returns, these returns take substantial time to appear. The government has historically subsidized education in part to overcome this private reluctance to invest in human capital. Increasing the college attendance rate in Michigan will likely require a corresponding increase in funds from the state government, which is challenging in today's environment.

Participants discussed the problems that many industrial companies face due to large legacy costs from retiree pension and health care benefits. Many foreign competitors do not have these costs. This is an interesting question from an economist's viewpoint. The principles of both economic analysis and accrual accounting suggest that these legacy costs are not a cost of today's production, but a cost of production in decades gone by. Many businesses chose (or negotiated) in previous decades to pay their employees not completely in cash, but instead partially in cash and partially in current and future health care benefits. A financial view of this is that they took a short position on future health care costs – that is, betting that health care costs would either fall or not rise too quickly. This bet was almost impossible to hedge, and therefore when the companies lost their bet, there was no recourse.

Thus the retiree health care costs are somewhat akin to a “natural disaster” – something that hurts the company today but is not really a cost of this year's production. Using this metaphor, the choice to pay employees partially with something of uncertain value (future health care) rather than cash is similar to building a factory on an earthquake fault line. Like a natural disaster, this health care problem can damage the financial viability of the corporation without affecting the economic viability of the underlying business plans. An illustration of this is the steel industry, in which some firms have thrived after dropping their legacy costs either on the retirees themselves or the federal government.

The focus of the seminar was naturally on the metropolitan impact and significance of innovation, but we can also gain perspective by viewing the economy at large. Productivity growth over the last decade has been markedly improved in the United States. At the same time, we have seen a “disindustrialization” of the economy as we shift from producing goods to services. This shift is rooted as much in the personal and political decisions of Americans as it is in a decline in the American ability to innovate. Understanding how this shift affects the economy of Metro Detroit can help us determine which sectors are most fruitful for our innovation efforts.