

## THE MANAGEMENT OF GLOBAL TECHNOLOGY IN THE NEW MILLENNIUM

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Ladies and Gentlemen, to make sense of our subject, which Dr. Walter Henslee, IFPAC 2000 Conference Chair, has so well introduced, we first need to begin with a notion of the causal and intervening conditions that might affect your and your company's choices, in the global management of technology.

### CAUSAL CONDITIONS

Though most of us know that the new millennium is really measured from next year, popularly it is known as a new millenium. It is sufficient to say that a new age is upon us. In the new millenium, there is certainly going to be an increase in globalization of industry. Some of the areas that Dr. Henslee has already referred to will help drive it, namely:

- The changes brought about by computerization;
- The changes in the cost structure of production activities you are concerned with;
- Changes in cost structures in other, commercial areas of your businesses;
- Businesses that are linked to you in the value-chain — firms that supply you with raw materials and services; and
- People that consume your intermediate goods, in some cases, or your final product in others.

Additionally, you're seeing in the news changes in telecommunications costs that are filtering through — diffusing, to borrow an engineering model — into other areas of activity. Those changes are coming along with changes in trade liberalization. Globalization allows these improvements in cost structure and improvements in internal business structures and practices to take place not only in large national markets — such as the U.S., or in semi-unified markets such as the EU — but also across national boundaries, potentially in South America, throughout East Asia, and other areas.

With these changes in company cost structures, in value-added chains, in international relationships that carry with them the potential to allow these cost improvements to come through, you also have increasing competitive pressure on companies. The pressure is to make better use of these opportunities. Not too surprisingly, we've seen — certainly in the business functional areas — changes in the ability of firms to learn from their

environment. And so we see changes in the structure and function of many areas inside firms:

- Marketing;
- Purchasing;
- Cost-management;
- Facilities management; and of course,
- Changes in the ability of firms to learn from their R&D efforts.

These changes — including the increased used of organizational forms such as strategic alliances — are all over the news. Today's broadcast of the National Public Radio news program "Morning Edition" — heard as I came here this morning — discussed the proposed merger between the music providers EMI in Britain and Warner Music in the context of the even larger Time-Warner-AOL merger. So we see an example of a "nested" merger or merger-within-a-merger. The pressure on firms to consolidate is only going to continue. Mergers are not always necessarily done well, but they do create new winners and losers, just as changes in technology do. These changes don't occur though, without resistance.

### RESISTANCE AND RIVALRY

You know that as a new technology, such as NIR [Near-infrared measurement and analysis], is introduced it faces opposition [Leonard-Barton, 1987: 14]. One technology manager in a computer manufacturer said to me, "...anytime you bring a new technology on board, you've got a lot of forces fighting you. You've got the old technology that refuses to die. Technologies just don't roll over and die."

At the company-level of analysis, increased rivalry between firms is an outcome of these kinds of changes. Increasing rivalry happens, once enabled, because of competitive spirit within firms and because countries are actors here too and they have national interests, and because capital and labor interests will all push firms to resist these changes. You are going to have increased rivalry in and between national markets.

You see inter-firm rivalry all the time. You see it in price competition. Some fellows behind me here at the conference were just talking about the effects of price competition and its impact on the readiness with which

customers buy into new measurement regimes. There's also advertising competition. As a consumer you see that all the time. And there's also rivalry in the use of technology, and technology strategy.

Though this isn't directly from process analytic chemistry, look at these excerpts from a recent article from the Wall Street Journal, just last Tuesday, I think (McCartney, 2000).

"These should be turbulent times for airlines. Jet-fuel prices have doubled in 12 months, labor costs are up sharply, and passenger revenue has weakened as the big carriers have added planes to the skies faster than demand warrants..."

But technology can make all the difference. Indeed, here the president of Continental says:

"Technology has made all the difference in the world between airlines making money and airlines losing money....We used to go bankrupt when oil prices got this high and supply and demand got out of whack."

How? The article continues:

"The shift reflects widespread changes in almost every area: How tickets are sold, how passengers are seated and fed, and how planes and gate agents are allocated.

Carriers are now squeezing more dollars out of each airline seat while cutting costs elsewhere. And new projects promise even more substantial savings."

Elsewhere in the article the author said of airline management, when "they had to cut cost, they cut out the olive on your salad. Then they cut out your salad." And those of you who have flown recently know that now you get a bag lunch to carry on. You pick it up at the jetway. The impact of technological changes has gone further than simple cost cutting. Technological changes have diffused into other functional areas of the business, redefining business processes, roles, and relationships [Hammer and Champy, 1990]. That's similar to what you have experienced as a discipline [Henslee, 2000] and will continue to experience.

#### PRESSURE TO CONSOLIDATE

For the foreseeable future, you are going to see, in your own industry and the industries you sell to, continued consolidation. Changing cost profiles, new economies of scale and scope, and increasing worldwide financial liquidity are factors that fuel, in the case of the wise, and egg-on in the case of the incompetent, more consolidation. And so the cycle is that we acquire companies. We do it foolishly; we have to disinvest. Nevertheless, the maturation of the international financial markets makes capital available to your operations overseas as well as through more developed home country financial markets and the headquarters organization. Revenues may improve, as many have, as product markets also mature.

And, I'm sad to say, executive hubris also drives consolidation sometimes. It is just the simple pride, overweening at times, on the part of executives who want to be consolidating.

#### REDEFINING WHAT IT MEANS TO BE A TECHNICAL PROFESSIONAL

So, what does this mean for you? This means that you have to redraw what it means to be a successful, technical professional. You are going to have to rethink it. Dr. Henslee's presentation was absolutely clear on that. You are not only going to have to deal with the technical processes and master them — as I failed to do in my undergraduate organic chemistry classes on those sleepy afternoons after a quick lunch. As he pointed out, you'll have to go beyond that. I propose that you are going to have to be prepared.

- To bring new products to a wider variety of markets. Do I hear somebody from the back echoing Dr. Henslee's point about becoming a problem solver? This is the commercial problem, bringing new products to a wider, worldwide market.
- You are going to have to continue the job of shaving time, feedstock costs, catalyst expenses, processing, from your processes. But in the global millennium you've got to do it in a wider variety of locations, and now without the same backup support — in terms of electricity, utilities, clean water — that you've been use to in the past or that you've learned to take for granted.
- You have to begin looking to develop and transfer processes, as Dr. Henslee mentioned as his last point among the three areas. Developing not just major processes but micro-processes. Working on the major processes is straightforward; you're experienced at that. But in the future you'll have to look at the problems of scaling those processes down.

#### An Example

You all know that there is a real problem between moving an idea from the lab, at prototype scale, to a production scale. When you're making three meters of carpet per day on a machine, that's different from three meters of carpet per minute. The machines don't work the same. It's true for gasoline. It's true for intermediate chemicals of a variety of types. It's true everywhere. And now you've got to customize them too.

The marketing people will come to you and beg you, even in intermediate products, "give us something that gives us an edge over our competition," who have national actors like government officials in their backyards or back pockets, who have advantages of cost due to location, who have advantages due to scale. You're going to be called on to help differentiate the product in some very, very difficult ways. And you, as senior technical

people, are going to be asked to balance, on the razor's edge. You will be on the edge balancing pressures for centralization and decentralization inside your firm and inside your technical groups.

#### CENTRALIZATION VERSUS DECENTRALIZATION

Decentralization, with its demand for empowerment, is a chance for unit and activity managers and technicians to experiment, to adapt activities to their conditions, to their ways. It allows a scope of activities that supports people's interests and gives them a chance to serve other, you might say "other masters", than just cost reduction or new product differentiation. This intellectual "headroom" or area for experimentation and adaptation is an important part of moving technology into new countries. Not every firm has worked out the balance between central control and decentralized "headroom."

#### An Example

I ran into this at a large pharmaceutical company where the central technology officer [CTO] was absolutely positive that he could get all of these operating facilities or plants in a variety of countries to transfer production technology, both design and operations knowledge, internally and to follow his version of it absolutely because of the dominance of measurement and value of known relationships between chemical components and accepted measurement techniques. He did not for a second believe that technology was socially shaped. He did not believe that individuals in the subsidiaries could differ from him on how to measure, for example. He was convinced that there was a right way to do each thing, the data were unambiguous in revealing it, and that there was no countenancing any opposition. I didn't try to disabuse him of the notion.

Finding the balance between central control with its (assumed) better costs and quality and decentralization that allows local adaptation is certainly a problem. As you fight this fight to get the economies and the quality of centralization, you're going to be opposed by people who want a little bit of room, who want a few opportunities to experiment, who are under pressure from their customers, who want some room to differentiate their products. You're going to have to figure this one out. It's a difficult one.

#### AN INTERVENING VARIABLE

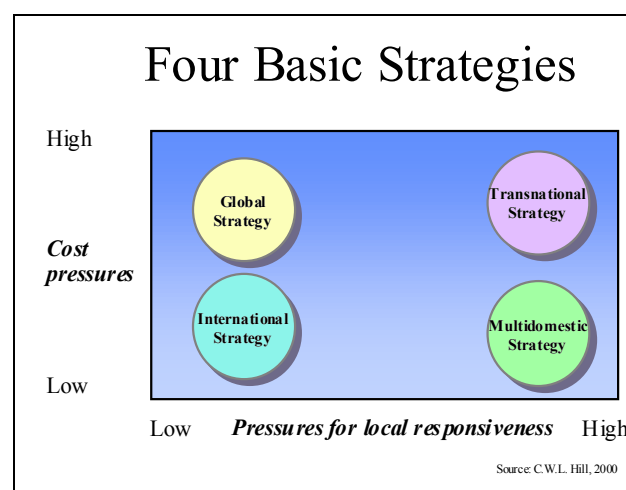
All this effort must be managed while working within the structure and constraints of what your corporate people are going to call an "international strategy." There are four types. They are often mislabeled, sometimes poorly used. The simplest one, an international strategy, is best when your firm is facing low pressure to reduce costs, perhaps protected by an enforced patent regime, and very low pressure to customize what you're doing or the product you're making.

Here's a simple model: a two-by-two matrix. The vertical axis is high and low pressure to pay attention to cost; the horizontal axis is high and low pressure to respond to local demand. So your international strategy, which is typically that of companies who have lots of protection from patent regimes, results in company approaches to worldwide markets by saying, "here's the product. Take it the way it is. Don't ask questions." We ship out of a couple convenient factories — perhaps they're overseas, perhaps they're local — but we ship to you, you take it as it is. That's the international strategy.

As pressure to go after cost savings rises, firms start to locate production facilities in more convenient, cost-wise, locations. These locations are attractive for reasons of low labor costs, better access to markets, or raw materials, or better access to final markets. That configuration and its management constitutes a global or global production strategy.

In a multi-domestic approach you have a situation in which your company or your customers have decided that France for example, is inherently different from the U.S. So there will be a French operation and it will create the product to French specifications, and we'll also have a U.S. operation. There will be some autonomy between the two units. They'll be different from each other. You may duplicate certain activities and have a French R&D lab in addition to the U.S. R&D lab. Technical and commercial managers' ability to balance forces to centralize or decentralize is going to be under pressure.

Finally, there is a much-ballyhooed transnational strategy. In which firms are locally responsive as well as highly cost competitive. We don't have any good archetypal example of this yet, but they are developing. We understand it in theory before it occurs in fact.



## DIFFERENCES IN NATIONAL CULTURES

Now, you've got several factors that are going to work together to create your future. They are already at work. You've seen industry consolidation; it's on the news. You can't miss it. There's certainly the impact of differences in national culture, and don't for a second be deluded that differences in national culture are disappearing — that we are converging on a world culture. That's great for the conspiracy theorists, it's absolutely false in practice. Even the dominance of an engineering or scientific culture does not erase persistent differences in values and beliefs between cultures.

## MANAGING KNOWLEDGE

And you also have the basic problem of managing technology itself — of managing knowledge. You have problems such as

- How do I acquire mass knowledge;
- How do I distribute or deploy it so that it is useful, so we can actually make products at the right price, at the right place, at the right quality, and in the right quantity? And at the right time, too;
- You have issues of interpretation:
  - What does it mean?
- You have issues of who knows what.
  - Who knows how to do this? And
  - Why can't that factory, that plant, operate like we do here?

This last question is going to continue to be a problem throughout this period of industry consolidation.

The issues from each of these areas are continually popping up as firms expand globally. For example:

- Developing and managing technical staff to function well, not just as problem solvers, but as trainers and transferors of technology;
- Developing reliable means of proving that you accomplished that transfer, not just cutting the other unit off once they have the documentation and you've done your two weeks visiting with them;
- There are issues also of managing the tacitness of technology.
- There is also an issue of how do you build, how do you develop, and how do you maintain an international management team, or an international technical team — the combination has to be there — so that they can continue to transfer and develop useful technology.

## MANAGEMENT OF GLOBAL TECHNOLOGY

Well, good question. How do you do that? Some of the answers are straightforward and old-fashioned. Others are visible now in the best firms. I'm going to cover just a couple of points of how they're doing this. Most effective companies that make good use of their technology are expending some effort to develop the notion of teams. Specifically in the context of technological teams I'm concerned with how do I change the team's duration? How do I change their scope, and with that scope, how do I link that to membership? How do I develop management structures? Not just conflict-resolution, but also incentive and reward structures when that team is an international team.

The most effective firms sending production technology to overseas units factor into their discussions over centralization and decentralization questions such as:

- To what extent should you, in making products, adapt to local culture — whether you're a producer of instrumentation or a maker of intermediate or final products that are used in the market?
- To what extent should I adapt my technology transfer methods to the local cultures I operate in?

Many companies are paying a lot more attention to employee cultural values and the culturally appropriate incentives that appeal to each set of employees, in addition to the professional incentives that have long been appealed to. More effective firms deploy their technology after:

- They've adapted technology packaging;
- Training; and
- Knowledge mastery or proving methods among others.

The better technology-managing firms are spending the time and effort to become learning organizations. In several, that means investing heavily on networking. Some of you probably already have video conferencing, E-mail, and other Internet or networking opportunities. These conferences are one method of that — a time-honored method, a personal one that has important value in many national cultures.

Questions include which team members should meet face-to-face? How often? Company managements are spending more mediating and underwriting those face-to-face, as well as electronic, contacts and developing more interesting, more culturally adapted codifications of technology.

Some are also recognizing that there are some very real costs to deploying knowledge. It's been known for many years that you could get the cheapest scientific brains in the business by going to Britain. This is a familiar form of outsourcing or configuring the firm's activities in the best locations. And many companies have outsourced scientific effort. Companies are trying to take a

look — some of them — at the cost of knowledge creation and knowledge transfer in designing programs and re-thinking approaches to help their employees in this.

The “physicians need to heal themselves” also. I am speaking now as a management scholar. Management needs to improve some of their views, too. Specifically, business management needs to get involved earlier. They need to fund technology creation and technology transfer team efforts much earlier in the process. They need to develop milestones by consensus, which tends to fall through the cracks. They need to change or take a look at the roles of the other network players, the other subsidiaries in the firm who are receiving technology.

Thank you.

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