Managing by Wire

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Flexibility and responsiveness now rule the marketplace. Rather than follow the make-and-sell strategy of industrial-age giants, today's successful companies focus on sensing and responding to rapidly changing customer needs. Information technology has driven much of this dramatic shift by vastly reducing the constraints imposed by time and space in acquiring, interpreting, and acting on information.

Responding to the competitive dynamic created by information technology, many large companies have drastically downsized, divested, and outsourced to reduce the costs and complexity of their operations. Yet simply reducing the size of a corporation is not the solution. As CEO Jack Welch has said, GE's goal is not to become smaller but to "get that small-company soul and small-company speed inside our big-company body." We believe that corporate size is worth saving. Market power, not bureaucratic clumsiness, can again become the dominant quality of a large corporation. But in order to survive in a sense-and-respond world, big companies must consider a strategy that we call *managing by wire*.

In aviation, *flying by wire* is a response to the changes introduced by jet-engine technology in the 1950s. It means using computer systems to augment a pilot's ability to assimilate and react to rapidly changing environmental information. Today heads-up displays (computer-generated pictures projected onto the pilot's helmet visor) present selected abstractions of a few crucial environmental factors, like oncoming aircraft and targets. Instrumentation and communication technologies aid in evaluating alternative responses. And when the pilot makes a decision, say to take evasive action by banking sharply to the left, it's the computer system that intercepts the pilot's command and translates it into the thousands of detailed orders that orchestrate the plane's behavior in real time.

When pilots fly by wire, they're flying informational representations of airplanes. In a similar way, managing by wire is the capacity to run a business by managing its informational representation. Manage-by-wire capability augments, instead of automating, a manager's function. Fly-by-wire technology – and by extension managing by wire – integrate pilot and plane into a single coherent system. The role and accountabilities of the pilot become an essential part of the design. Autopilot, or complete automation, is used only in calm, stable flying conditions. The system design allows for considerable flexibility in pilot behavior, including the ability to override the technology if, for instance, a sudden storm arises.

Like a plane at mach speeds, a company must be able to respond to threats in real time. In today's turbulent business environment, strategies have to be implemented in tactical timeframes. In response to this challenge, top-level managers need to view information technology in a new light. Rather than investing in isolated IT *systems* – such as e-mail, reservation systems, or inventory control systems – a company must invest in the IT *capabilities* that it will need to manage by wire.

The ideal manage-by-wire implementation uses an enterprise model to represent the operations of an entire business. Based on this model, expert systems, databases, software objects, and other technical components are integrated to do the equivalent of flying by wire. The executive crew then pilots the organization, using controls in the information

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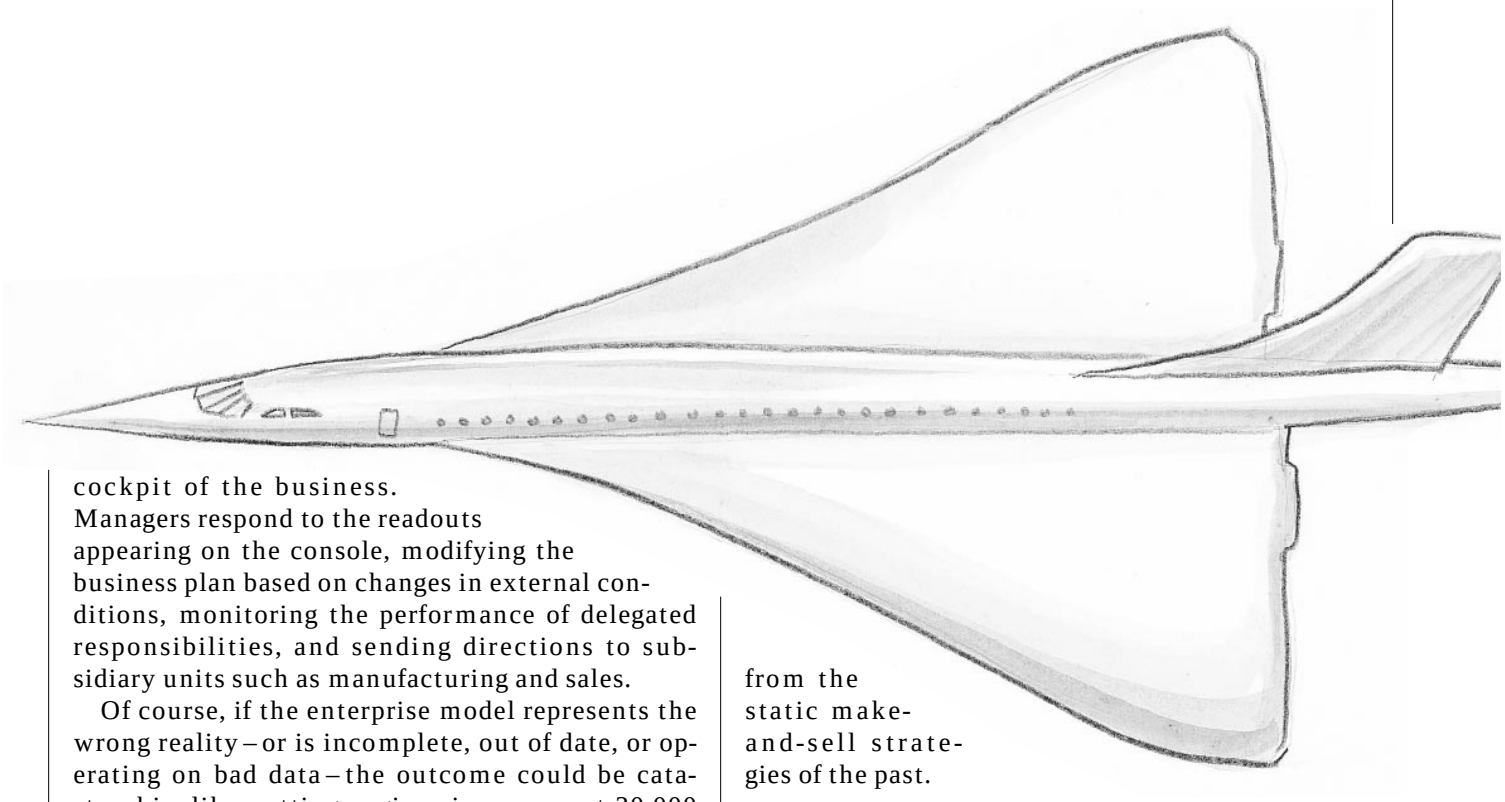
ogy to weather sudden changes in the business environment.



cockpit of the business. Managers respond to the readouts appearing on the console, modifying the business plan based on changes in external conditions, monitoring the performance of delegated responsibilities, and sending directions to subsidiary units such as manufacturing and sales.

Of course, if the enterprise model represents the wrong reality – or is incomplete, out of date, or operating on bad data – the outcome could be catastrophic, like putting engines in reverse at 30,000 feet. Creating a robust model of a large business organization is an extremely challenging undertaking. But companies like Mrs. Fields Cookies, Brooklyn Union Gas, and a financial services organization that we will call Global Insurance have already demonstrated the feasibility of representing large portions of businesses in software. These companies manage by wire to varying degrees, from "hardwiring" automated processes at Mrs. Fields Cookies to a complete enterprise model that codifies business strategy at Global Insurance.

Many companies have spent decades automating pieces of their businesses, scattering networks and incompatible computer platforms throughout their organizations. But the empowered, decentralized teams of the information economy need a unified view of what's happening within an organization. Coherent behavior requires more than blockbuster applications and network connections; it must be governed by an enterprise model that codifies the corporation's intent and "how we do things around here." More important, a coherent model should include "how we *change* how we do things around here." Adding the institutional ability to adapt in a dynamic environment has become a survival imperative for most companies. And this ability will ultimately differentiate a manage-by-wire strategy from the static make-and-sell strategies of the past.

Hardwiring a Business

Over the last three decades, companies have used information technologies in increasingly sophisticated ways to run parts of a business. From the mainframe complexes of the 1960s to the client-server platforms of today, computers already help executives manage by automating business processes, from payroll to cash-dispensing. In fact, a company like Mrs. Fields can build an extensive representation of its business by automating procedures, that is, by codifying them in software.

In small companies, the model of "how we do things around here" often resides in the minds of a few people. Under these conditions, if senior executives are willing to sacrifice some flexibility and delegate the technical design to IT professionals, it's possible to represent enough of the business in software to manage by wire. For example, Mrs. Fields Cookies has captured a significant amount of its well-defined business in software. Its hardwired processes resemble the autopilot capability of a fly-by-wire system.

In 1978, when Debbi Fields opened her second cookie store in San Francisco (45 miles away from her first store in Palo Alto), she confronted the logistical problems of maintaining hands-on manage-

DRAWINGS BY TOPAZ

ment at remote locations. She and her husband Randy, a skilled computer professional, had ambitious expansion plans that would prevent Debbi from personally overseeing each store. They needed a strategy that would let them know what was going on in hundreds of dispersed locations and at the same time ensure that local managers responded to daily challenges in the same way Debbi Fields would. In this case, Randy Fields had the technical expertise to implement in software the way Debbi Fields worked. He created the software at a reasonable cost and much more quickly than most traditional large-company IT groups could have.

Mrs. Fields uses software to issue advice to local managers, such as how many batches of cookies to bake.

Now with more than 800 stores, including franchises around the world, the central management of Mrs. Fields uses software to issue instructions and advice to store managers. Each morning, local managers project sales for the day and enter information into a personal computer: for example, day of the week, season, and local weather conditions. The software analyzes this data and responds with hourly instructions on what to do to meet the day's objectives: how many batches of different cookies to mix and bake; how to adjust the mixtures as the actual pattern of customer buying unfolds; when to offer free samples; how to schedule workers; and when to reorder chocolate chips.

There are a few fundamental principles that define Mrs. Fields's business concept: a thorough articulation of "how we do things around here;" a conviction that quality must be centrally controlled; and a dedication to knowledge sharing between central management and local store managers. As a matter of policy, the company integrates all of its information in one database and has one set of guidelines about how things are done the Mrs. Fields way. Because this vision is so clearly articulated, and because the company's business niche is relatively well-defined and stable, top management has, in effect, created an informational representation of Debbi Fields in each store.

Yet a manage-by-wire system that hardwires much of a business can turn out to be too rigid. For example, because its software was designed to describe the behavior of U.S. store managers, Mrs. Fields faced a number of challenges when it expanded into Europe and Asia, where different labor laws, languages, and supplier contracts had to be taken into account. In addition to the adjustments required to accommodate a wider range of local environments, falling profit margins forced the company to become more flexible in the way it applied information technology to running its daily business at remote locations.

Responding to these new conditions, Mrs. Fields Software (a separate business unit) developed a second generation of software, called the Retail Operations Intelligence system. ROI contained modules for inventory control, scheduling daily activities, interviewing and hiring, repair and maintenance, financial reporting, lease management, and e-mail. Senior management believes that ROI can be adapted to a variety of retail and service organizations. In fact, Mrs. Fields sold ROI to Burger King in 1992.

But at Mrs. Fields, top management relies on its IT division to translate business strategy into software. If senior executives want to change how the business runs, IT professionals must change the procedural software code. Because the cookie business doesn't change significantly from day to day – and employee turnover in a retail outlet like Mrs. Fields is high – it makes sense to run basic store operations as close to autopilot as possible. But most larger companies compete in more dynamic environments than Mrs. Fields, and, therefore, a corporate business model must do more than connect hardwired processes. It must also specify the roles and accountabilities of the people involved, incor-

porate the unplanned activity that can take up to 80% of a working day, and build in sufficient latitude for individual decision-making.

Institutionalizing Flexibility

Large organizations have become too complex for any individual, even the most brilliant executive, to keep complete models of the business in mind.

Whether individually or collectively, managers of companies with hundreds of millions in revenue and tens of thousands of employees can't track everything that happens, much less coordinate millions of elements into a timely, coherent response. In fact, they never could, which is why functional hierarchies were originally created.

The old chain of command was designed for a relatively stable – and now increasingly rare – make-and-sell business. But many fast-growing sense-and-respond companies never adopted functional hierarchies in the first place. Instead, in the process of expanding, they have used IT-enabled networks as the tendons that hold the skeleton and muscles of the company together. Large companies, attempting to compete with agile niche players, are heading in the opposite direction of hardwiring operations. Rather than explicitly specifying "do it this way," many executives are empowering employees to "do it the best way you know how." However, without coordination, accountability, and shared objectives, this approach can often lead to paralysis rather than coherent company-wide behavior.

The need for flexibility drove the $1 billion utility, Brooklyn Union Gas of New York, to a radically different IT strategy. By the early 1980s, Brooklyn Union's 1971 Customer-Related Information System (CRIS) had become obsolete. Among other things, the Public Service Commission had begun requiring utilities to treat certain customers – for example, the elderly and disabled – in different ways. Top-level executives were also convinced that micromarketing increasingly customized service offerings was essential to Brooklyn Union's competitive survival. But the practices and policies of 1971 had become petrified in software procedures that were finally rendered obsolete by the dynamic environment that the company faced in the 1980s.

A $2 million initial attempt to upgrade CRIS failed. Finally, after spending more than three years on feasibility studies, design, and prototype systems, senior management agreed to let the IT department completely redo CRIS. The project began in the spring of 1987 and was completed by January 1990 at a cost of $48 million. In this case, the manage-by-wire implementation resulted not from a new business design by management but from the system being redesigned by a talented group of IT professionals.

The IT department chose to implement the new system using object-oriented programming. Objects are reusable software building blocks: sets of instructions that programmers can reassemble for a variety of different operations. CRIS now contains 650 such objects that create, in various combinations, 10,000 appropriate actions in 800 distinct business situations. These actions cover everything from meter reading and cash processing to collection, billing, credit, and field service orders. Brooklyn Union has now codified a substantial part of its customer-related business behavior in these software combinations. And because of the IT department's flexible, building-block approach to software, the system is much easier to modify than a hardwired one.

In the competition with niche players, large companies are heading in the opposite direction of hardwiring operations.

But at Brooklyn Union, as at Mrs. Fields, the IT department functions as the intermediary between customer-related management policy and its execution. The IT shop translates into software an un-

derstanding of management's business changes. It does this by defining the conditions that dictate legitimate combinations of software objects. These conditions may relate to business policy, legal requirements, or common-sense logic: for example, "You can't cut off service to an elderly customer before *x* months," or "You can't bill a customer if you haven't installed a meter."

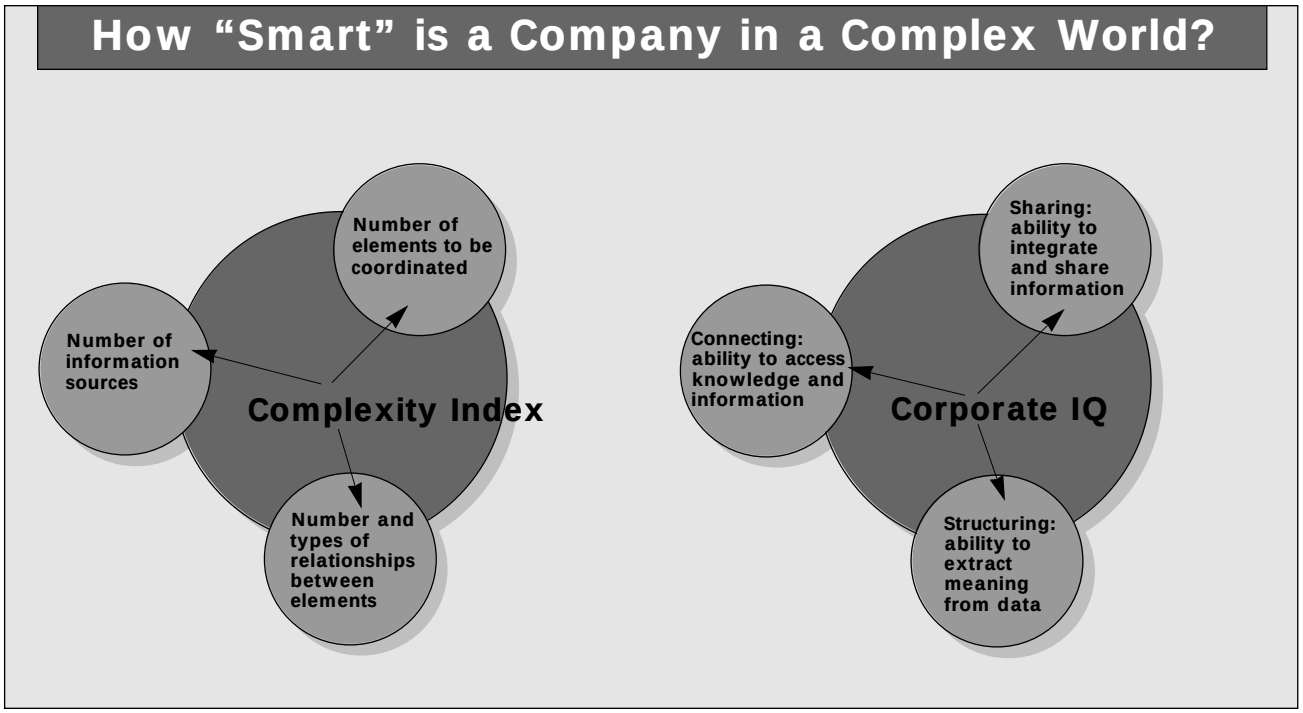
Brooklyn Union exemplifies how computers can be used to create and manage building blocks of business activity that can then be combined and recombined into a variety of responses. However, senior executives are still disconnected from direct influence over the software that determines how their company handles customers. In fact, it is middle managers, rather than senior executives, who are managing by wire. And in the sense that the IT department acts as intermediary, Brooklyn Union has not moved beyond the practices of many large companies.

Not that top management at Brooklyn Union feels shortchanged. Its IT experts had the vision and ability to build in exceptional flexibility by using object-oriented software. As a result, new capabilities can now be created by extensively reusing existing software objects and adding only those required for specific additional functions. A proposal for a new engineering system, for instance, estimated that up to 30% of the software objects that were required to implement the system already existed in CRIS. More important, CRIS has delivered on top management's mandate against obsolescence, allowing Brooklyn Union to respond to market change and new opportunities in a timely way and at a reasonable cost.

Creating an Enterprise Model of a Business

Mrs. Fields's and Brooklyn Union's IT strategies demonstrate that manage-by-wire implementations vary from business to business, depending on size and complexity. A company's complexity is a function of how many information sources it needs, how many business elements it must coordinate, and the number and type of relationships that exist among those elements. We think of a company's *corporate IQ* as its institutional ability to deal with complexity, that is, its ability to capture, share, and extract meaning from marketplace signals. Corporate IQ directly translates into three IT infrastructure imperatives for connecting, sharing, and structuring information (see the chart "How 'Smart' Is a Company in a Complex World?").

In most large companies, a low IQ results from change occurring so rapidly that keeping computer applications up to date is neither feasible nor affordable. Low IQs are particularly prevalent when processes have been automated over decades without any framework to integrate disparate applications and databases. At Mrs. Fields, where there are few information sources and clear and unchanging employee roles, ROI creates a high corporate IQ in an environment of comparatively low complexity.



Brooklyn Union's CRIS is less complete because it captures a smaller percentage of the total business. But this larger company operates in a much more complex industry. Brooklyn Union has a high capacity for sharing information and a comprehensive knowledge base in one important area: customers. Compared with many other large companies – with their disconnected information systems, competing computer platforms, and ill-defined business processes – Brooklyn Union Gas looks like a corporate genius.

But neither Mrs. Fields nor Brooklyn Union has a coherent model that fully maps key processes, how information is interpreted, and who is accountable for what. It is just such a model that can replace the IT department as the intermediary between management policy and execution. In fact, large companies need a coherent enterprise model to raise their corporate IQ.

An enterprise model is a high-level map of a business that guides the writing of computer code and the execution of nonautomated activities. Once procedures, data flows, and employee accountabilities are represented in computers by specific bit patterns and machine states, the map becomes the terrain; in other words, it becomes "real" in cyberspace, that computer-generated realm in which the informational representations of a cookie store or a utility's customer-related activities can be manipulated and modified. Companies can use an enterprise model to leverage a computer's memory and speed; to track and interrelate millions of events and relationships simultaneously; to allow selective sharing of information; and, finally, to initiate physical processes.

Of course, enterprise modeling tools have been available from software consultants and vendors for more than 25 years. Used primarily by information systems professionals to lay out procedures and data flows for certain business operations, the first generation of these tools were essentially high-level flow charts. Useful in highlighting procedural redundancies and omissions, they nonetheless have several major drawbacks that prevented their widespread adoption by management for designing business functions:

☐ They fail to incorporate the notions of commitment and human accountability in business processes, a particularly important omission because procedure without accountability often leads to bureaucracy.

☐ They don't deal with unstructured work and ad hoc processes.

☐ They take years to map into computer code, by which time the model is badly out of date.

Clearly, corporate managers, not IT professionals, should design a business. And business design extends beyond procedural design; it includes making strategic decisions about what market signals should be sensed, what data or analytical models should be used to interpret those signals, and how an appropriate response should be executed. To faithfully represent management's design, a robust enterprise model must consistently characterize any process at any scale, exhaustively account for the possible outcomes of every process, and unambiguously specify the roles and accountabilities of the employees involved in carrying them out.

Neither Mrs. Fields nor Brooklyn Union has a coherent model that fully maps key business processes.

A new generation of enterprise modeling tools that overcomes the drawbacks of traditional modeling tools is now emerging. Admittedly, creating a comprehensive information map is no simple task, but the benefits can be substantial, even for small business units. In a test at a large manufacturing company, one of these new enterprise modeling tools was used to map an engineering change process for electronic circuitry. Senior executives considered this process among the best in the organization. However, the new modeling tool not only revealed opportunities for procedural improvements, such as removing manufacturing bottlenecks, it also uncovered this startling fact: during the entire operation, not one person in the entire organization made a single commitment on volumes, cost, or delivery dates – only forecasts, estimates, and targets. If accountability isn't specified, business processes lack discipline and predictability, making them difficult to manage. A model that defines both procedures *and* accountability for outcomes can help managers of large companies do the job of managing.

The new enterprise modeling tools, for example, could make a substantial difference at Brooklyn Union Gas. CRIS uses data models to interpret signals from meter readings, field reports, and cash receipts. But the utility company has yet to develop an enterprise model that allows top managers to define and modify the policies that determine permissible combinations of its reusable software objects.

An enterprise model would raise Brooklyn Union's corporate IQ by enhancing the structure of its customer information system. In effect, top-level managers would move into the information cockpit and gain the ability to modify directly how CRIS drives customer-related activities.

Designing the Intelligent Corporation

To be useful in today's dynamic business environment, an enterprise model must do more than represent a static version of "how we do things around here;" it must also include the capacity to adapt systematically and rapidly. Like the process of piloting a jet fighter, a true manage-by-wire system relies both on an accurate information model and on the organization's ability to learn.

The United States Air Force assesses a pilot's ability to learn with the OODA Loop, a model for the mental processes of a fighter pilot. OODA stands for:

- *Observation:* sensing environmental signals;
- *Orientation:* interpreting those signals;
- *Decision:* selecting from a repertoire of available responses;
- *Action:* executing the response selected.

Fighter pilots with faster OODA Loops tend to win dogfights, while those with slower ones get more parachute practice. Note that the loop is iterative: a continuous cycle in which an action leads to the observation of the results of that action that in turn requires a new orientation, decision, and action. This iterative sequence constitutes a *learning loop.* It contains the four functions essential to any adaptive organism: sensing, interpreting, deciding, and acting. By analogy, an enterprise model for a business that incorporates learning is one that systematically creates and links learning loops (see the chart "Learning Loops").

> An intelligent company integrates "what's going on out there" with "how we do things around here."

Recent work on organizational learning focuses on the way that people in a company learn. But what about *institutional* learning? How much do companies know when the people go home at night? Many companies, with the aid of software, would know how to process payrolls. Some would know how to dispense cash and others how to replenish stocks. But one could hardly call that learning.

We define institutional learning as the process by which information models change, be they data models, forecasting models, or procedural models.

Learning Loops

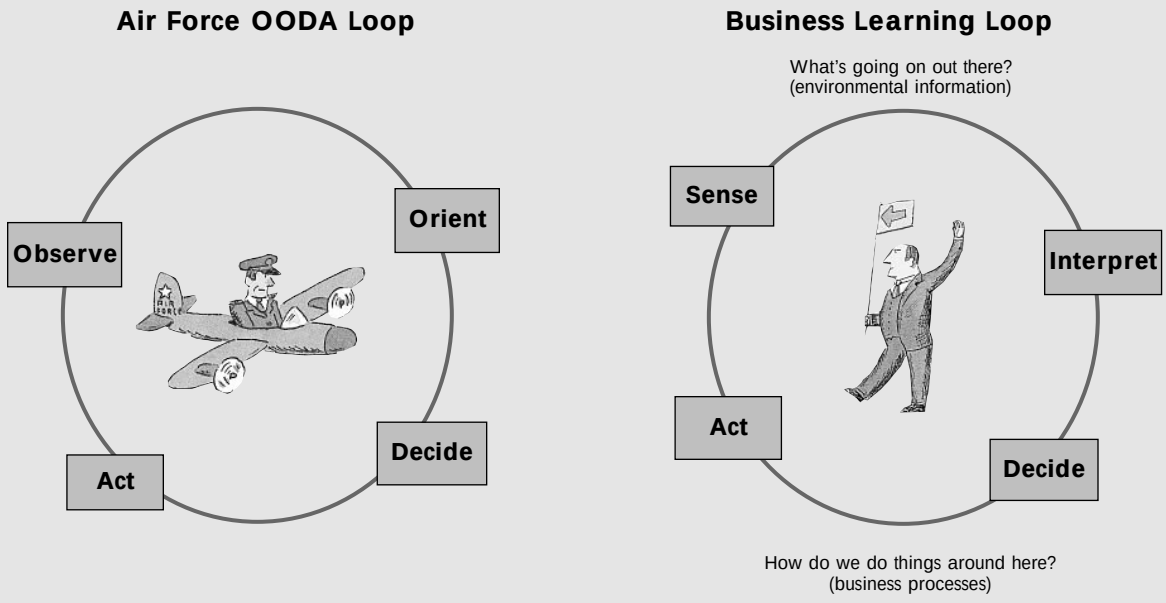


CHART DRAWINGS BY MARC ROSENTHAL FOR LAUGHING STOCK

Wal-Mart and Wrangler use an institutional learning loop to replenish stocks in Wal-Mart stores.

Therefore, a good enterprise model should include a design for systematically changing these kinds of models, based on signals received from the environment. That means an adaptive organization avoids running learning loops repeatedly over static information models.

An example of an institutional learning loop at work is the system that Wal-Mart and its apparel suppliers use to replenish stocks in Wal-Mart stores. For instance, every evening, Wal-Mart transmits five million characters of data about the day's sales to Wrangler, a supplier of blue jeans. The two companies share both the data and a model that interprets the meaning of the data. They also share software applications that act on that interpretation to send specific quantities of specific sizes and colors of jeans to specific stores from specific warehouses. The result is a learning loop that lowers logistics and inventory costs and leads to fewer stock outs. And every time the data model is changed to reflect a new fashion season or pricing pattern, both Wal-Mart and Wrangler learn and adapt.

Using technology to integrate how an organization interprets "what's going on out there" with a codification of "how we do things around here" creates an intelligent corporation. The company we call Global Insurance (the real company is disguised) is one of the best examples of managing by wire at this level of sophistication.

A large financial services organization, Global was driven to a fundamental reconceptualization of how it does business because of competition from niche players in the 1980s. The $78 billion company was facing extinction. New policies took two years from conception to consumer, and operational costs were 15% higher than those of smaller competitors, who were luring customers away with innovative offerings. Furthermore, the insurance industry was changing so rapidly that senior executives had little confidence that any specific strategy would keep the company afloat for more than a year or two.

Wal-Mart's learning loop lowers logistics and inventory costs and leads to fewer stock outs.

In the late 1980s, rather than investing in a specific business strategy, top-level managers decided to spend $110 million on an IT infrastructure that would allow them to implement *any* strategy quickly. Senior executives started the project with the development of an enterprise model for the company's two largest business lines: casualty and life insurance. The model linked product development, underwriting, sales, and other functions in a coherent informational representation of "how we

do things around here." Information specialists created the model based on senior managers' specifications of the information they wanted to track (observation); the data models needed to interpret the information (orientation); the analytic and decision support provided for underwriters, actuaries, and managers in the field (decision); and, finally, how these decisions should be executed via their on-line transaction systems (action).

Using combinations of more than 1,000 software objects, the company created the transactions, activities, and data that would, when properly linked, define any present or future offering in its life- or casualty-insurance business lines. "Enroll client," "send premium notice," and "establish risk limit" are examples of these software building blocks.

Elaborate data models are worth fortunes to banks, airlines, food manufacturers, and large retailers.

In addition, data models were developed to interpret the market research, transaction history, demographic, and economic information that Global collected from the field, external databases, and internal operations. Data models are explicit renderings of the way an application program, or a collection of these programs, views the world. When these models are used to create databases, they institutionalize specific ways of interpreting raw data. Elaborate data models are worth fortunes to banks, airlines, food manufacturers, and large retailers like Wal-Mart, because they help these companies reorient themselves continually.

At Global, a decision-support system used the patterns its data models revealed to trigger exception reports or approval requests that then appeared on managers' terminals. For instance, a manager whose product was losing ground to a new competitive offering would have the option of modifying the existing policy or creating an entirely new one. This process was codified by expert systems that contain legal, logical, and business constraints: for example, "we will not underwrite an aggregate risk for a single client that is more than *x* times the client's net worth."

Through this manage-by-wire capability, decision-to-action times have been reduced by 400% to 700%, enabling Global to meet the competition of small niche players. And certain types of decisions can now be carried out in real time. One example: agents, who have their own laptop computers with easy access to Global's electronic network, can customize a policy in a client's living room. They can tailor policies based on a client's specific situation, such as annual income, ages of dependents, or lifestyle preferences.

There was, of course, substantial technological risk associated with Global's project. Still riskier was counting on the ability of managers to specify adequately the hundreds of procedures and dozens of management policies necessary to ensure that Global's responses were consistent with its business goals. The CEO also worried that his information systems team, lacking sufficient business experience, might misinterpret these specifications when they translated business rules into the language of data models and expert systems. It was only through extensive prototyping that senior executives acquired the confidence to transfer processes gradually to the manage-by-wire system.

Along the way, Global has experienced setbacks. Vendor technology was late and slow. Some managers, who implicitly relied on bureaucratic procedures to buffer them from direct accountability for policy changes, resisted the extensive retraining that was designed to put them in the pilot's seat. In fact, many managers didn't make the shift successfully. Some key executives retired or left the company, taking with them crucial knowledge that the rest of the institution hadn't learned because it had never been codified.

But after more than a year's delay and a budgetary overrun, Global has implemented almost all it set out to do technologically. Because its enterprise model wasn't developed with the new generation of modeling tools, changes to the model must still be made by the IT shop. Still, the senior executives who run the life and casualty businesses are managing by wire a large portion of their operations. With a few additional changes, managers will be able to modify underwriting policy themselves through the IT system and have these changes reflected immediately in the policies written by agents.

Setting Guidelines for Managing by Wire

Given the right enterprise model and a technology-enabled capacity to learn, a large company's size can again become a decisive competitive advan-

tage. But to many managers, Global Insurance's successful manage-by-wire strategy will seem unattainable. For one thing, the technical expertise needed to implement such an integrated system may not exist within the company. The ability to change reality by modifying an informational representation of it is possible only with an underlying technological infrastructure that has a high corporate IQ. Indeed, managing by wire requires the long-term commitment of both senior executives *and* a world-class IT group.

Flying a modern jet airplane is a sophisticated operation. The current generation of fly-by-wire systems requires more than 20 million lines of computer code. Yet if an aviation information model can successfully capture this level of complexity, an enterprise model can do the same for the managers of rapidly changing business units. In fact, adopting a manage-by-wire strategy is nothing less than a change in the nature of strategy itself, from a *plan* to produce specific offerings for specific markets to a *structure* for sensing and responding to change faster than the competition.

Faced with an unpredictable business environment, top managers at Global Insurance were forced to fuse their business and IT strategies. It's imperative that today's senior executives make IT policy an integral part of corporate strategy and intent. Technological knowledge must join the financial and operational know-how of a policy-making manager; otherwise, crucial business decisions will implicitly be delegated to the IT department.

Managers can follow a few guidelines to help them implement a manage-by-wire system:

Top managers must assess a company's corporate IQ in terms of connecting, sharing, and structuring information. There are three critical attributes of a company's IT infrastructure that determine its corporate IQ. *Connecting* means the degree to which the IT platform links information sources, media, locations, and users. Since the 1970s, computer networks have sprung up in multiple places for multiple purposes. As a result, many companies today are crisscrossed by dozens of independent networks that are incompatible technically and thus actually inhibit, rather than promote, information sharing. Mere connectivity doesn't necessarily increase productivity *or* institutional learning. Management must not only determine what the signals should be but also ensure that these signals are understood and shared by the right people and teams.

Sharing makes possible coordinated effort and, therefore, the benefits associated with teamwork, integration, and extended scope. Getting everyone on the same page in a large business requires an institutional capability to share data, interpretations of that data, and specifications of core processes. The added value that this integration can yield underlines a subtle but important distinction: the actual implementation of a breakthrough application, such as an automated airline reservation system like American Airlines's SABRE, may ultimately be less important than *how* that application is implemented. A stand-alone application is less likely to deliver sustainable competitive advantage than one implemented on an integrated technology platform designed for extensive information sharing. Anyone who receives multiple premium notices on the same day from the same insurance company for different policies is on the receiving end of an unintegrated IT platform.

Structuring holds the most potential for the strategic exploitation of information in the 1990s and beyond. Structure is created by information about information, for instance, how data is classified, organized, related, and used. Tables of contents, indices, and "see also" references are familiar hard-copy examples. The data models of Global Insurance and Wal-Mart structure information by filtering the data that bombards these companies every day.

When information from previously unrelated sources is structured in a meaningful way, human beings become capable of thinking thoughts that were previously unthinkable. Computers that use their speed and memory to reveal patterns in raw data augment the extraordinary capacity of humans to recognize and assign meaning to patterns. For example, through spectral analysis and mathematical equations that model what scientists call the red shift, a computer can process light signals from a remote galaxy to calculate the distance and size of its parts. The results can be displayed in a three-dimensional picture and then rotated. Presentation in this manner allows scientists

Managers must shift from a *plan* to produce specific offerings for specific markets to a *structure* for responding to change.

to "see" a distant galaxy from the back or side and even to discover, as they did recently, a huge void passing through it.

An enterprise model should be expressed in business language, not IT terminology. Management should select and use one business design language and insist on its use throughout the organization. In many companies, a variety of first- and second-generation enterprise modeling tools have already been used to capture key processes in different functions or operating units. But in order to create a unified understanding of "how we do things around here" (and, if it makes strategic sense, to facilitate future integration of presently autonomous organizational units), a common business language is required.

Senior executives must determine the highest level at which coherent institutional behavior adds value. Managers must decide which business units, if well coordinated, could together create more value than the sum of their individual parts. In many respects, this is the strategic task facing managers in a sense-and-respond world. There's no one answer to this crucial issue. Many different approaches have been tried, even in an information-intensive industry like publishing. McGraw Hill's strategy, for example, is to treat their information systems and certain editorial content as assets to be shared among multiple units. Dun and Bradstreet, on the other hand, views its information and technology as assets to be separated into individual units. In other words, McGraw Hill shares assets at the enterprise level and Dun and Bradstreet at the business-line level.

Once a company embarks on a manage-by-wire strategy, senior executives must carefully plan the pace of its implementation. Just as information technology has fueled a new competitive dynamic for businesses, the advent of jet-engine technology in the 1950s profoundly affected aviation. By increasing the speed of fighter planes, the jet engine made it impossible for pilots to fly planes manually. But flying by wire didn't happen overnight. In the mid-1950s, no pilot would have felt safe with a sudden and comprehensive introduction of software between the cockpit controls and the physical airplane, even if the technology had existed at the time. In fact, only the latest generation of commercial aircraft truly fly by wire.

Similarly, few executives will feel confident enough to commit their company to managing by wire in one massive effort. How fast and how far they're willing to go will depend on how effectively the software currently mediates management decisions; how much confidence managers have in their IT staff; and how much money and time it will ultimately take to implement the process.

When a target level for coherent institutional behavior has been defined, common information and technology assets can be leveraged to create economies of scope. But realistically, most companies will model smaller business domains first, such as Brooklyn Union's customer information system. They will then link these domains to cover larger parts of the business, as Global did.

No corporation has implemented a fully integrated manage-by-wire system yet. But a growing number of companies like Brooklyn Union Gas and Global Insurance are showing that large and complicated business operations can be captured in an information technology structure and used to govern business behavior. These companies have already significantly improved their response times and substantially reduced the costs of developing new products and services.

The imminent arrival of a new generation of enterprise modeling tools makes a manage-by-wire strategy plausible. But it will be management's skill in codifying a competitive information model that will determine its success.

*Authors' note: The description of CRIS and its management implications has benefited from discussions with Joe Pinnola and Tom Morgan of Brooklyn Union Gas and Ben Konsynski of Emory University, who has written a Harvard Business School case study on Brooklyn Union, "Brooklyn Union Gas: OOPS on Big Iron." In addition, we have based our discussion of new enterprise modeling tools on Alan Scherr's work at IBM, which is described in his article "A New Approach to Business Processes" (*IBM Systems Journal, *February 1993).*

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