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Managing By Wire, Revisited

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MANAGING BY WIRE, REVISITED

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Abstract

In 1993, Haeckel and Nolan published "Managing by Wire" in *Harvard Business Review*. This article provoked discussion jointly in the business strategy and information systems communities around strategic management, and the function of information systems in a rapidly changing business environment.

In 1998 through 2000, the researchers worked with Haeckel in discussions about how a managing by wire information infrastructure might be designed. Various proofs-of-concept were constructed to flesh out a greater understanding of managing by wire. These proofs-of-concept were then used as demonstrations for reviews with potential end users, to discuss alternative design details.

The researchers propose that the design of a managing by wire information infrastructure be viewed as a combination of three socio-informatic subsystems. Development of such an information infrastructure will require more detailed understanding of the implementation situation at hand, as well as prioritization and staging of functions based on user readiness.

Keywords: Human-machine systems, organizational strategies, organizational communication, organizational learning

1. Introduction

The concept of *managing by wire* was introduced in 1993 to the strategic management and information systems communities (Haeckel & Nolan 1993). The key idea was that "corporate IQ" could be improved by systematically enabling an institutional ability to deal with the complexity of change in the marketplace. Managing by wire was compared to flying by wire in modern aircraft, as software mediates the interaction between the pilot and the airplane itself. Through the increased adaptiveness introduced by this enabler, "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." (Haeckel & Nolan 1993, p. 131)

Between 1998 and 2000, the researchers of this article discussed with Haeckel how a managing by wire information infrastructure might be designed. The challenges were first to determine the key design points for the information system, and then to reframe the concepts into the current

mindset of business models and technologies. Various proofs-of-concept were constructed to explore alternative approaches, evolving into a design as three socio-informatic subsystems.

The proofs-of-concepts were demonstrated with various groups of end users. This article reports on the understanding about managing by wire gained by the researchers, the proposed design of subsystems, and the learning resulting from discussions around designs demonstrated.

2. "Managing by Wire" in 1993 presented some enduring concepts, with a challenge on informational representation

Through its publication in Harvard Business Review, the audience for "Managing by Wire" was leading-edge thinkers in management. As a prescription for managerial information systems, it provoked the question: how do enterprise information systems help the enterprise to adapt and respond to changing customer requests?

The concepts of managing by wire and the sense-and-respond organization are intertwined (Haeckel 1999). The sense-and-respond organization is a strategic management framework for strategy development, organizational structure and governance, designed for an environment of rapid, unpredictable change. Through the conversations with Haeckel, the researchers expanded their understanding of the sense-and-respond organization, while trying to maintain the focus on the supporting information systems.

2.1 The key concepts found in managing by wire are speed, change and variation, and informational representation

How do information systems for strategic management need to change?

With a deeper understanding of managing by wire, the researchers found that work is needed in three areas:

- They need to enable organizational speed at scale and/or scope.

- They need to support change (in customer values) and variation (in individual customer requests).

- The informational representation of the enterprise needs to reflect its state in near real-time.

This characterization supports the comparison to flying by wire. Without software mediation, the feasibility of supersonic aircraft would be limited by the individual pilot's personal ability to respond. Changes and variations of a flight plan may be executed before takeoff or mid-course. Finally, at supersonic speeds, any lag in correctly representing current status could lead to a misguided decision by the pilot.

2.11 The purpose of managing by wire is to attain organizational speed at large scale and broad scope
Why manage by wire?

> [The] goal is to "get that small-company soul and small-company speed inside our big-company body". (Haeckel & Nolan 1993, p. 122).

All enterprises adapt to lesser or greater degrees. However, large enterprises usually uncover creeping bureaucracy, so that they are not as nimble as when they were small. The challenge is not just speed, but speed at large scale and/or at broad scope. An enterprise can seek competitive advantage either through economies of scale, or economies of scope (Peppers & Rogers 1993; Teece 1980).

- Economies of scale are achieved by using an asset to produce more of a single output. Through the increase in volume of products or services of that single output, per-unit costs decline, and more customers will be attracted.

- Economies of scope are achieved by using an asset to produce different types of outputs. Through the increase in the number of outputs produced using the same asset, per-unit costs decline.

In small enterprises, coordination can occur through mutual adjustment, because everyone practically knows everyone else by first name. Large enterprises -- with the capability to produce a multitude of combinations of product / service / experience attributes for a multitude of customers with differing tastes -- face greater difficulty in coordinating all of the functions within the organization, let alone changes in those functions and how they're organized.

2.12 Systematic adaptation is needed, both in overall changes in customer value, and in variations for individual customers
What is different about managing by wire?

> Rather than following the make-and-sell strategy of industrial-age giants, today's successful companies focus on sensing and responding to rapidly changing customer needs. (Haeckel & Nolan 1993, p. 122).

Managing by wire is founded on the premise that customers find value in the enterprise adapting to their needs. These needs are at two levels: changes in the direction and scope of the customer value proposition that the enterprise seeks to satisfy as a whole; and variations within that proposition based on an individual customer request at a point in time. Following the changes in direction and scope at the enterprise level is a value migration concept (Slywotsky 1996). Responding to variations in individual customer requests is a one-to-one marketing concept (Peppers & Roger 1993).

The manage by wire strategy is therefore a strategy based in information, specifically about the customer and what he or she values. The strategy to make-and-sell products can be executed even in the absence of customer information. The enterprise that forecasts well and executes efficiently on plans, wins. The make-and-sell approach fails if the enterprise is unable to keep up with changes in the customer value proposition, and/or the number of variations in individual customer requests. Managing by wire therefore needs to provide the capability to know sooner what the customer wants, and respond more quickly with appropriate capabilities.

2.13 Changes and variations can be monitored through a real-time informational representation of the enterprise
How does an enterprise manage by wire?

> 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. [....] The role and accountabilities of the pilot become an essential part of the design. [....]

> Like a plane at mach speeds, a company must be able to respond to threats in real time. (Haeckel & Nolan 1993, p. 122).

Any manager who has ever created an organization chart has, in effect, managed an informational representation of the enterprise. However, what would happen if the organization needed to be restructured daily, or even uniquely in response to each distinct customer request?

> [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". (Haeckel & Nolan 1993, p. 123)

"How we do things around here" would appear to be mostly *descriptive*. "How we change how we do things around here" is a meta level, and would appear to be *prescriptive*. In managing by wire, therefore, the scope of design is not only to report on the current state of the enterprise, but also to guide how it can be changed.

2.2 Existing approaches to informational representations were considered insufficient to manage by wire

Managing by wire prescribes that senior managers, as designers of their organizations, should create and maintain the informational representation of their enterprises, much as software designers do. However, software development tools did not provide all of the function that was required for designing enterprises.

> [Enterprise modeling tools ...] 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. (Haeckel & Nolan 1993, p. 127).

Thus, the challenge was to extend ideas that were well-developed in the field of software design, to the design of enterprises.

3. The evolving context for enterprise design and informational representation into 2000 suggested additional considerations for managing by wire

When the researchers became engaged with managing by wire, the context in business, technology, and the work of managers had evolved from the early 1990s mindset. How did these changes in context impact the vision of managing by wire?

3.1 Business, technology, and managerial use of information have become more "open" propositions

Major shifts in the short span of seven years since "Managing by Wire" can be described from three perspectives: business relationships, information technology architectures, and a socio-informatic combination of these two, the managerial use of information. As systems, each has evolved from a closed design to become more open to the environment.

3.11 Business relationships have shifted from integrated organizations to digital mediation
Theorists have expected, in society at large, that hierarchy, as the single line of authority prevalent in the industrial era, would give way to heterarchy, as multiple lines of authority in the post-industrial era (Ogilvy 1989). The form for modern industrial business has predominantly been an integrated enterprise, with its primary functions mostly encapsulated within the legal boundaries of its incorporation (Sloan 1964). As an illustration of the shift by the mid-1990s, business alliances had become so commonplace that the term "co-opetition" was created (Brandenburger & Nalebuff 1996). By 2000, the intensity of inter-enterprise relationships has continued to evolve, leading to a discussion of electronic markets, and "e-business communities" (Ticoll, Lowy & Kalakota 1998).

To fit in this view of business relationships, managing by wire would no longer be limited to the legal boundaries of a corporation. The managing by wire concept would have to span multiple organizations. In this environment, enterprise leadership is less like a military organization or a single pilot in authority, and more like coordinating a group of volunteers.

3.12 Information technology architectures have shifted in form from centralized to network
In most large enterprises at the beginning of the 1990s, computing power was still largely centralized at mainframe hosts, with personal computers sometimes used as terminals. Information was often stored in different ways on different machines, and access was controlled by a few administrators. In the mid-1990s, the rise of departmental servers in local area networks demonstrated the shift to client / server architecture. Business people became more accustomed to sharing information, but bridging islands of productivity was sometimes a chore. By 2000, the Internet had become an everyday word, document formats such as HTML, PDF and XML had become widely adopted, and web browsers became a standard interface to the

computerized world. Access to and accessibility of information has become less of an issue, and digital communication across organizational boundaries has become more common. Indeed, corporate communications groups now seem to produce as much information for external consumption as they previously did for internal audiences.

For managing by wire, this shift has had a number of implications. Business people today are probably more comfortable working with computers, particularly through web browsers. At the same time, expectations on the sophistication of the user interface have risen, and users now expect highly-refined graphics, just as the "heads-up displays" from jet aircraft are now becoming available on luxury automobiles.

3.13 Computer support of managerial work has shifted from individuals to workgroups
In the late 1980s and early 1990s, improved access to product and customer databases drove an interest by managers in decision support systems, to support personal analysis and understanding (Ing 1994). By the mid-1990s, the interests of managers had shifted to business process (Davenport 1992). Into 2000, knowledge management and communities of practice had become the focus (Davenport & Prusak 1997; Wenger 1998).

For managing by wire, the user community has expanded from managers, to include knowledge workers in general. Rather than just extracting data, individuals have become more comfortable with ongoing dialogues, from extended e-mail exchanges to dialogues on discussion databases with comments and annotations. Although communications from individuals vertically up to executives are still relevant, communications to peers have become much more important.

3.2 The 1993 requirements plus changed context resulted in a larger set of design considerations

From the original vision in 1993, the three considerations for the managing by wire information infrastructure can be restated in the following way:

> 1. It should incorporate the notions of commitment and human accountability in business processes.

The informational representation must reflect human choice. Commitment and accountability are not difficult words, but they mean (a) that individuals understand commitments are negotiated, with consequences for failure, and (b) that communications are explicitly documented in writing.

> 2. It should deal with unstructured work and ad hoc processes.

The requirement to handle ad hoc processes means an emphasis on outcomes (or ends) rather than processes (or means). This perspective is considerably different from traditional workflow management software, that coordinates a sequence of activities (as means).

> 3. It should be capable of update in almost real-time, so the informational representation can be kept current.

Although a network of e-mail messages might satisfy the first two design criteria, this consideration would favor a central repository with some programming.

In addition to these three design considerations, the changed context suggested some others:

> 4. The informational representation should reflect the design both by the enterprise leadership, and empowered individuals.

Who creates the informational representation of the enterprise?

In a large enterprise, it is unlikely that a single mind will design the entire structure of individuals in roles. How is an accountable person in the organization supposed to keep a handle on what everyone else is doing, in the midst of continuous change? In a command-and-control organization, information primarily flows vertically in its silos. In an empowered organization, the leadership empowers individuals to "do the right thing" for customers. The empowered organization needs more lateral coordination. Since "the right thing" changes rapidly, the enterprise has, in effect, multiple "pilots" at any point in time.

> 5. An organization can participate in a number of enterprises.

If an organization is conceived as a system, then there's an implicit understanding that there are always larger containing systems of which it is a part, and there are smaller subsystems which are contained within it. Commitments across organizational boundaries require mechanisms to link with "foreign" partners.

> 6. It should need to be accessible throughout an extended enterprise.

This design consideration calls for either extremely thin client requirements on user's personal computers, or accessibility through web browsers. In either case, establishing different levels of visibility to ensure some level of privacy, requires establishment of security mechanisms.

> 7. In addition to the structured conversations required to operate the enterprise, communications on designing the enterprise should reflect organizational learning.

A managing by wire system not only needs to support adaptation, but also learning at the meta level, so that the adaptation itself can be adapted.

These considerations, plus others, led to the creation of a design for a managing by wire information infrastructure.

4. A managing by wire information infrastructure can be designed as three socio-informatic subsystems

How should the information infrastructure for managing by wire be structured? One approach would be to align with the information technology components, such as user interface, application logic, and database repository. The researchers chose instead to view the subsystems to be designed as socio-informatic, i.e., related to the communications in social relationships between individuals, mediated by information technology (Simmonds & Ing 2000). The emphasis on design, rather than implementation, meant an emphasis on understanding how people would work in a managing by wire environment, rather than how the information infrastructure would be constructed with specific technologies.

4.1 Three socio-informatic subsystems were designed, consistent with the type of computer mediation required

The computer-mediated medium for managing by wire is not necessarily the only way in which people within an enterprise can communicate with each other. The fly by wire mechanisms in an airplane do not exclude the pilot from having a conversation over a radio. However, the requirement of scalability in today's dynamic enterprises requires that individuals know "what's happening", even if they are geographically remote, or operating in a different time zone.

The three subsystems identified were:

1. empowered coordination support, where pairs of individuals can reach agreements on the design of "how we do things" in this situation, register their commitment, and link to other commitments;

2. collaborative decision support, where multiple people can have dialogues on alternative potential joint outcomes, feasible structures of action, and "who might do what"; and

3. role-specific adaptive loop support -- informally known as the "heads-up display" -- where individuals can monitor both changes in the external world, and their interactions with others, internally.

These proofs-of-concept were developed as research vehicles, to understand more fully the design of capabilities for a managing by wire information infrastructure. They have served as a foundation for some partial implementations of a support system for these aspects of sense-and-respond organizations. As the state of technology evolves, it is hoped that this design structure will be durable, even as the specific implementation changes.

4.2 Empowered coordination support explicitly documents commitments on business processes

When individuals are empowered to negotiate both the end (outcome) and means (procedures) of their work, how can the workgroup coordinate through apparent ad hoc changes?

The empowered coordination support subsystem has many features that support adaptiveness. In pairs, individuals negotiate accountabilities as either the customer or supplier of an outcome. An accountability can be either to provide a capability over a period of time, or to produce a deliverable by a due date. Either party may specify additional conditions of satisfaction, as greater detail on the outcome, or as specific constraints on the means by which the outcome is produced. The parties follow a structured protocol in definition, negotiation, performance and assessment of commitments (Haeckel 1999, Appendix C; Scherr 1993; Winograd & Flores 1986).

The primary supplier of an outcome can seek subordinate suppliers. In this way, chains of commitments emerge, as hierarchies of accountabilities. Linking of these commitments is important, as managing by wire encourages the renegotiation, when a significant unpredictability has been encountered. In order to ensure integrity of superordinate outcomes, commitments may have to be subsequently renegotiated either at higher levels or lower levels within these

hierarchies of accountabilities. These types of renegotiations happen naturally in business situations, but the empowered coordination subsystem requires explicit renegotiation to ensure that the integrity of the system of commitments is maintained. The value, to the enterprise as a whole, of the explicit articulation of these changes as records codified in digital form, must be made clear to everyone who makes commitments.

In the Sense-and-Respond Support System proof-of-concept, empowered coordination support was implemented in Lotus Notes. The history of negotiations and commitments were retained in a database, and automatic generation of e-mail kept parties to the negotiations and commitments apprised of changes.

In tests with early adopters, use of empowered coordination support demonstrated the need for development of social skills, particularly in the rigors of language use. Firstly, most individuals were not accustomed to negotiation for "win-win" situations, and negotiation training was suggested (Fisher, Ury & Patton 1981). Secondly, individuals had to become comfortable with communicating authentically: saying what you mean, meaning what you say, and knowing what you mean (Haeckel 1999, Chapter 8).

4.3 Collaborative decision support enables the creation of knowledge on which the design of structures of action is based

How should a group of empowered individuals ensure that the design of complex structure of action is feasible, and acceptable to involved parties?

If all designs of "how we do things around here" could be created through two-party agreements, then the empowered coordination approach described above would be sufficient. However, it is often necessary to coordinate the actions of a large number of people simultaneously. In order to do this, there must be agreement within the group on how to do so.

How does the group know that a design is "right"? The study of inquiring systems frames "right" in terms of "guarantors" to the inquiry (Churchman 1971; Mitroff & Linstone 1993). There are five categories of inquiring systems: (1) inductive-consensual (Lockean); (2) analytic-deductive (Leibnizian); (3) multiple realities (Kantian); (4) dialectic (Hegelian); and (5) multiple perspectives system approach (Singerian / Churchmanian). The first two categories support by objective knowledge being explicitly codified into records. In the latter three, knowledge is considered to be personal, so that meaning can never really be disembodied. At best, records of dialogues may be captured so that a "story" of how thinking evolved between individuals can be traced. The fifth way of knowing provides the foundation for the collaborative decision process used in the sense-and-respond organization (Kusnic & Owen 1999; Barabba 1995).

The Sense-and-Respond Support System proofs-of-concept were not designed as a complete knowledge support environment, because the subjective views of inquiring systems see knowledge as personal, and transmitted primarily through the interaction between people. They could, however, provide lightweight support for computer-mediated dialogues through document structures for discussion and debate. In addition to the final structure of action taken (which could be captured by empowered coordination support), these records of the dialogues, transcripts and commentary could be valuable as historical records of how decisions were reached.

In introducing the ideas of inquiring systems to structuring conversations, end users were both intrigued and apprehensive about purposeful structuring for debate. Many corporate cultures demonstrate a comfort for consensus, where "undiscussables" are politely omitted from agendas. The application of a collaborative decision-making approach requires a rather complete explanation for the procedure, followed by active facilitation to stay on track. For this subsystem, at least initially, management of the social dynamics of interaction required a greater emphasis than the technological support for dialogues.

4.4 Role-specific adaptive loop support keeps individuals up-to-date with changes

In an enterprise where adaptation is assumed as the norm, how can individuals know which changes will affect them, and how will they structure appropriate actions in response?

In the sense-and-respond organization, individuals can play many roles, each related to a different outcome. Appropriate support for adaptation through the sense - interpret - decide - act loop is designed for roles that individuals populate (Haeckel 1999). The specific configuration of the "heads up display" can be prescribed by the designer of the role type, or chosen by the individual in an instance of a role. These include the sources of the signals to be monitored; the rules, algorithms or routines that aid in filtering out "meaning from apparent noise; models or frameworks that calculate the values or benefits of alternatives; and methods to trigger other actions within the enterprise as transactions.

This managing by wire infrastructure augments, rather than automating, the functions of a manager. Judgement is still required at each phase of the sense - interpret - decide - act loop. In fact, the most important element of the adaptive loop is not included in the technology: the function of individuals to reflect upon and seek out what "they don't know that they don't know" (Davis 1987). This can be described as "thinking outside the system" (Haeckel 1999, Chapter 9).

The relevant practices for the design of a "heads-up display" can range from simple rules of thumb in graphical user interface design to the specification of critical success factors for an executive (Rockart 1979). In the proofs-of-concept, the emphasis was placed on different views of internal organizational: specifically, the empowered coordination support and collaborative decision support subsystems described above.

In practice, adaptive loop support first requires a strong understanding of the roles themselves. Since individuals are expected to play more than one role, a significant amount of effort may reasonably be expected to simplify the representations of the external world to them. Just as jet pilots have a few summary gauges that report status on flying by wire, managers will require similar reduction of the information glut.

4.5 Specific implementation of a managing by wire design depends on the enterprise environment

The primary purpose of the proofs-of-concept was to develop an understanding of design options. In addition, as demonstrations, they (1) provided a concrete example of how managing by wire concepts might be implemented; and (2) elicited some preliminary reactions by potential users on the concept of supporting adaptiveness with information technology. Discussions were framed as "what would be needed for a successful application", rather than "how do we take advantage of what has already been built". As an example, the acceptable level of visibility of

commitments was found not only to be organization-specific, but also related to level of authority within the organization: individuals lower in the chain of authority felt uncomfortable with the open visibility of their commitments to everyone, while individuals with more authority wanted access to every detail of the system of outcomes. Ideally, the visibility of commitments would itself be a subject of negotiation.

Development of production-ready information system drive implementation decisions on technology standards acceptable at that time.   Since the proofs-of-concept were created, capabilities that make real-time dialogue feasible, such as instant messaging or meetings over the Internet have become more generally available.   Implementations with web browser clients enable more standardized client access to the server, at the cost of limited support for pop-up frames, such as calendars.   The concept of a customizable "heads-up-display" is readily demonstrable with web portals such as My Yahoo or My Excite. To integrate all of these ideas into an environment where bits of conversation and data sources could be hyperlinked and shared with other people easily is still a research topic. (Simmonds & Ing 2000)

Although many challenges were technological, the greater challenges are expected to be social. One user suggested that the introduction of a managing-by-wire infrastructure was as foreign a concept as e-mail to the 1970s office environment.   Why would a person forego voice communication to spend hours looking at a computer monitor? At the same time, the shape of work is changing, as an organization may participate in many enterprises, and an enterprise can be composed of multiple organizations. The many roles and affiliations of individuals will have interesting issues in security, visibility, and commons, beyond the research conducted so far.

5. Full adoption of managing by wire will require motivation and commitment

Is managing by wire an idea that deserves the attention of executives today, or is it a concept for the future that will remain in the future? To respond to these question, the three key concepts found by the researchers should be reiterated.

- Is faster organizational speed at large scale and/or broad scope required?

- Is systematic adaptation to overall changes in customer value, and in variations for individual customers needed?

- Is a near real-time informational representation of the enterprise of value?

These issues drive the requirement for a managing by wire information infrastructure.

The next stage of learning on managing by wire will be in its introduction to pilot users. The proof-of-concept demonstrations help shape the design of the information infrastructure, but it is unclear which functions are most important, and which features should be introduced first. It is our belief that elements of all three socio-informatic subsystems should be present, but the depth at which they are to be applied is likely situational.

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