Pliant Proposal

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Two massive trends are affecting companies today. Both of them impose requirements that many organizations must meet to remain competitive, and even to survive in any form. However, these two trends are increasingly on a collision course.

The first trend is increasing dependence on information systems. Companies such as Federal Express, Wal-Mart, Dell Computer, and Amazon.com have gained key strategic advantages from structuring their business around their information systems. Essentially all financial institutions control most critical day to day activities through their software and databases. Companies doing business on the internet interact with their on-line customers largely through their information systems. This dependence on information systems will continue to increase dramatically, both in depth within each company and in the breadth of companies that experience it.

The second trend is the need for increasing agility. In today's rapidly changing and increasingly competitive world organizations need to adapt rapidly to their environment and to new operational challenges; they must be highly *responsive.* At the same time, they must maintain their coordination, focus and effectiveness; in other words, maintain *coherence.* Neither responsiveness nor coherence alone is enough, but an organization can often gain critical advantage if it can be **both** responsive and coherent— that is, *agile.*

To sustain and increase its agility, an organization must continually generate and reconcile multiple, often conflicting needs and perspectives. Internally, it must coordinate disparate groups with different priorities, skills, and outlooks, each responding to its own ongoing challenges; externally, it must constantly negotiate with outside groups, creating, adapting relationships as the needs and options of all parties change. There is an inherent tension between an organization improvising locally and creatively to solve problems and seize opportunities— which is required for responsiveness— and at the same time acting in a coordinated manner and remaining faithful to its top-level mission— as is required for coherence. Great organizations are distinguished by their management of this tension.

Unfortunately, increasing dependence on information systems, and increasing need for agility are in growing conflict. The type of information systems that we know how to build today are far too rigid and too homogeneous to support substantial agility. On the contrary, as organizations attempt to increase agility in their internal activities and their relationships with customers and suppliers,

their information systems typically impose an intransigent burden that must be worked around.

We believe that this conflict is deeply rooted in the assumptions underlying existing information technology. Today's systems achieve coherence through "pre-established harmony": they work to the extent that their builders anticipated all possible interactions, and crafted each of their parts to support these interactions. The result of this design approach is static coherence: as long as all the parts work perfectly, and the design successfully anticipated all possibilities, the system stays coherent. However, as soon as any of the original assumptions are violated, the system fails. This type of design is a natural legacy of the origin of computing in "computing machines."

Unfortunately, such design is increasingly unrealistic. The exponential trends toward more powerful, more networked computing result in larger, more complex systems. The related trend toward greater organizational dependence on information systems means that these systems can never be taken off-line for long, and can never be rebuilt from scratch. The most extreme case of these trends is the internet which is being "designed" by thousands or even millions of people and which will continue to grow exponentially in bandwidth, connectivity, and complexity. Pre-established harmony quickly becomes useless as a guide to managing change and solving problems as these trends continue.

Furthermore, the need to maintain pre-established harmony leads to inflexibility and fragility that imposes heavy penalties on organizations which depend on information technology. To provide adequate agility, organizations must allow local changes and multiple perspectives in their information systems. Furthermore, most local changes must be made in the process of solving business problems, without "going off line" to redesign parts of the system. These requirements for local changes make continued reliance on pre-established harmony impossible.

However, we also believe that the assumptions that underlie current computer systems are not inevitable: they can be changed to underwrite the creation of information technology that are increasingly *pliant*. Pliant information systems will allow open-ended local change and multiple perspectives, and will still help the organization maintain coordination and effectiveness as a whole.

Not surprisingly, among the notions that must be dispensed with is pre-established harmony. And happily, there is an alternative. Many, many real-world systems maintain adequate coherence even though they are subject to local change and are not under centralized control. This coherence is generated bottom-up through the convergence of multiple local interactions. As a result, this type of coherence can adapt to changing circumstances and can re-establish itself if it is disrupted. We call this phenomenon *dynamic* coherence.

Today, dynamic coherence works well on relatively small scales; small teams can often improvise brilliantly in demanding situations. However, as organizations scale up, they must increase their investment in maintaining coherence. And

correspondingly and consequently, they tend to lose their ability to respond locally. In particular, as the scale of an organization increases, it is more and more likely to be critically dependent on information systems to help it maintain coherence, and as we have just seen, existing information technology enforces static coherence, which is incompatible with local responsiveness.

We propose to develop technology that allows organizations to incrementally extend their information systems to take advantage of dynamic coherence. A convergence of research in game theory, statistical learning and inference, linguistics, population biology and several areas of computer science gives us the tools to get a theoretical and experimental grip on the generation and control of dynamic coherence.

Pliant systems will support both local changes and dynamic coherence. They will engage their users to help discover and solve problems, and grow the system to incorporate those solutions. Using dynamic coherence, pliant technology will drastically reduce software fragility and ease software component integration. As an organization makes its information systems pliant, these information systems will help the organization become more agile, rather than forcing it to be more rigid. The trends toward increased agility and increased dependence on information systems will be working in concert, rather than in opposition.

We propose to pursue three tracks in parallel to realize pliant computing:
1) develop a design framework for using dynamic coherence in information systems,
2) identify technologies that can be used to extend existing information systems into pliant systems, and
3) define prototypes that can demonstrate the feasibility of pliant systems in the near future.

Creating pliant systems is a radical but achievable goal. We believe that there is some potential for relatively short term benefits from adopting a pliant approach, but the largest benefits are in the medium and long term. While pliant computing is an aggressive goal, we believe that many critical problems with information technology can only be solved by such an effort. Organizations with early access to pliant technology will gain an enormous competitive advantage.