



Effective SDI Leadership: The Antithesis of Good Management Practice?

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The *Pennsylvania Map* (PAMAP) is a partnership between the state, local, and federal governments and private industry. The goal of this effort is a complete, high-resolution, GIS basemap of the Commonwealth of Pennsylvania that will serve as a model for a national topographic map. PAMAP is expected to enhance Pennsylvania's technological infrastructure, economic competitiveness, and protection against natural and manmade disasters; it will be a crucial resource for public- and private-sector planning and decision-making.

Based on our experience developing PAMAP, we present lessons learned and pillars for success that we recommend be applied within the geospatial community working to develop spatial data infrastructures (SDIs) such as *The National Map*. SDIs are complex living systems created by people; therefore, the problems are rarely straightforward, and the solutions never clear-cut. (If they were, we would probably have a form of *The National Map* right now.)

An SDI is based on a different set of circumstances that are in contrast to those normally faced by managers of IT. SDIs emerge when potentially dissimilar local and regional geospatial data networks learn how to communicate and share information. Thus, success in the development of an SDI requires leaders and organizations more concerned with providing a technical capability than with following conventional management practices. SDIs are led, not managed. The paradox is that effective leadership of an SDI requires rejecting many of the long-established principles of management, including unity of command.

Management as Usual

Henri Fayol (1841-1925), who has been described as the father of modern operational management theory, was one of the most influential contributors to modern concepts of management. He proposed that there are five primary functions of management: planning, organizing, commanding, coordinating, and controlling. His principles have been considered as a classical organization theory that is universally applicable to every type of organization and activity. Fayol suggested that it is important to have unity of command: an accepted bureaucratic concept that there is only one person in charge. It assumes that a strict hierarchy is both normal and preferred.

SDI as an Open Partnership

Whether it's a team, an alliance, a partnership, a squad, or a platoon, organizations have learned that by working together, they gain more benefit from their budget dollars. Plus, if the organization's communications and geospatial information infrastructures are designed with collaboration in mind, it doesn't cost anything to gain the benefit. In successful collaborations, all participants find that the value received from the partnership exceeds the value available to them acting independently. It's a win-win-win — a win for you, a win for me, and a win for the collaborating community as a whole.

Every organization expends a great deal of effort collecting and agreeing on the information requirements and the roles and responsibilities that make the partnership successful. However, this effort is misdirected and wasted if the organization has not provided the right groundwork, the right framework, or more precisely, the right level of systems thinking to the effort. For success, it is imperative that the organization builds its SDI on a partnership framework using open and democratic processes that are appropriate to the complexity of the system ("Thinking at the Process Level").

The groundwork includes creation of policies that define the roles and responsibilities for data collection, storage, and dissemination, along with management roles and responsibilities required for the partnership. The framework of such policies provides the foundation and structure for the collaboration, so by analogy to physical construction projects, it has come to be known as the Reference Architecture (RA), essentially a strategic plan for coordinating PAMAP's users, data, and services ("Thinking at the Operations Level"). (The term "architecture" is unfortunate, since it conjures up images of software and hardware, but the planning followed the process in the ISO "Reference Model for Open Distributed Processing" [ISO 10746], which results in a document called an "architecture.")

Scientists' need to share information led to the invention of the Internet as a platform that enables inter-organizational sharing to take place. The leadership in the community had a vision that the technology would allow science to thrive in the face of government and business forces of change that were driving down the investment in science ("Thinking at the Leadership Level"). They envisioned Web hosts as the service components that enable data exchange and processing over the Internet; thus the technical architecture has come to be characterized as a Service-Oriented Architecture.

Open communication in science is fundamental to practicing good science. Open access to information and analysis take place throughout the discovery process, right through to the commercialization process. Scientists demand openness as a community practice ("Thinking at the Communications Level"). The experience of the Pennsylvania collaborative mapping partnership, PAMAP, in developing its RA provides useful guidance for others who seek to gain the benefits of well-planned collaboration.

Lessons Learned

Many incorrectly think of an SDI as just another database that stores data about the geographic attributes of a location. One who is casually familiar with an SDI might also think that it can be fully architected, developed, and administered like many information systems — by a centralized, administratively oriented, information systems organization. In

fact, SDIs are organizations that straddle and incorporate many pieces of other organizational entities, most of which are long-established bureaucracies. Here the thoughtless application of information technology (IT) rules and procedures stifles innovation, hampers adaptivity, and crushes creativity.

In our experience, leaders of SDIs (including PAMAP) operate in the realm of perplexing uncertainty and staggering organizational complexity. An effective leader in the SDI environment is an agent of change and performs the essential act of discerning when change is needed, such as when parts of an SDI — though operating as originally conceived within a bureaucracy — have come to be operating contrary to the organization's overall need.

So here's the rub: an SDI such as PAMAP does not follow the rules of a traditional state information infrastructure. The traditional way of thinking about the spatial data infrastructure does not yield effective processes and results. The complexity of the infrastructure, the scope and dynamics of the organizations that are involved, and the requirement that information must be open to all, are all factors. This realization leads to the first lesson learned.

Lesson 1: An SDI is a constantly changing, people-focused, self-generating network — an organism, if you will. The life of an SDI resides in its informal networks, or communities of practice.

The reach and impact of an SDI in the PAMAP example is from the citizen to the governor (including the legislature and judiciary) and everyone in between. But it doesn't stop there, since the need for information — and hence, the infrastructure — extends to the nation and beyond. An example of the enormous number of entities that must be included in the greater community for Pennsylvania demonstrates this point. In this one state, potential SDI stakeholders include a bewildering array of more than 5,000 governmental entities, including:

- 67 Counties
- 2565 Municipalities further classified into 56 Cities, 962 Boroughs, 91 First-Class Townships, and 1456 Second-Class Townships
- 16 Metropolitan Statistical Areas (MSAs)
- 21 Micropolitan Statistical Areas (MCSAs)
- 17 Local Development Districts (LDDs)
- 9 Regional Counter-Terrorism Task Forces (RCTTFs)
- 15 Transportation Metropolitan Planning Organizations (MPOs)
- 7 Transportation Regional Planning Organizations (RPOs)
- 1 Transportation Non-affiliated Planning Organization (NPOs)
- 19 Keystone Innovation Zones (KIZs)
- 501 Public School Districts
- 17 Community Colleges
- 23 Workforce Investment Boards
- 19 Congressional Districts
- 50 State Senatorial Districts
- 203 State House of Representative Districts
- 5 River Basins
- 13 National Parks including Historic, Military, Scenic and Recreation Areas

- 5 Large Urbanized Areas
- 12 Other Urbanized Areas
- 450 State Brownfields.

Add to this the number of research, academic, commercial, not-for-profit, health, safety, and welfare organizations interested in address-based information at a local level, on up to those interested in address-based information on a state and national level. Add to that some reasonable fraction of the 12,380,360 citizens (U.S. Census 2000) living in the commonwealth who are interested in address-based information, and you have a significantly large stakeholder system of diverse needs that the SDI must serve. A person could only hope to exercise control over a very small piece, and even then the total system will not support this behavior over time — as learned in our second lesson.

Lesson 2: An SDI is a network of continuously evolving infrastructures that is not owned and controlled by a singular organization, but is sponsored and supported by a community of stakeholders.

An SDI is an example of a complex living system of organizations and systems that evolve over time. As a result, traditional centralized information management methods are not able to keep up with the changes. Increasingly, in the case of managing a state SDI, one finds him/herself in a chaotic world where the infrastructure is constantly changing, organizational needs are constantly evolving, and the need for information is constantly changing. One must depend on the commitment and capability of the distributed organization for maintaining the integrity of the system.

Here, a successful SDI is thus the result of an open democratic process. Everybody is involved at their "relative local level," with the result that the SDI serves the personal, local, state, and national needs to better provide for health, safety and well-being. Open communication with the community is critical, since the ongoing knowledge-base that is built upon system assumptions and behaviors must be formed from an honest assessment of what is taking place, not from what people want to hear.

Simply put, no one is in charge, but everyone is responsible for managing the system and directing its development. People responsible for an SDI continue to sustain its growth by consciously observing its evolution, planning its development, and seizing opportunities that arise from the way in which the system naturally behaves, which leads to the next lesson.

Lesson 3: You cannot direct the development of an SDI; you can only influence it for limited periods of time in small and local ways. Participants in the SDI choose what to pay attention to and how to respond when the event is meaningful to them.

There is an old saying — "reforming the Navy Department is like kicking a 40-foot sponge" — that also applies to managing an SDI. The PAMAP experience has shown that because the SDI is a large and complex social system with interrelated parts, it has a tremendous amount of mass and resists movement. The frequently applied computer architecture analogy creates blind spots when used for social systems such as an SDI. Human systems are infinitely more complex, less obvious, and very dynamic.

Furthermore, it is counterproductive to view an SDI like a traditional architecture of

hardware and software. As with any complex system, when changes are made to one part, many others are affected, in a cascading and often unpredictable manner. Thus, organizational decisions pertaining to an SDI are fraught with second- and third-order effects that result in unintended consequences. Non-inclusive leadership, governance approaches that do not account for the broad SDI community, and actions that are cast in concrete can be harmful. Ironically, the level of management control is almost inversely proportional to success, since control is not possible.

There are so many interactions in complex SDIs that no individual can be expected to monitor and forecast the impact of even small actions that are amplified over time. Stating this another way, SDIs are living systems. Like the human body system, they have parts, and the parts affect the performance of the whole. All of the parts are interdependent. One internal organ interacts with and affects other internal organs. You can study the parts singly, but because of the interactions, it doesn't make much practical sense to stop there. The key to understanding is, therefore, a systems approach.

Lesson 4: A successful SDI contains both designed and unplanned structures. The challenge is to find the right balance between the creativity of the unplanned emergent elements and the stability of designed parts.

This is a key difference between an SDI like PAMAP and an enterprise database that a single agency might develop. SDIs are built by thousands of people, while most enterprise databases are designed and built by a comparatively small group. Emergent systems require large numbers of actors and interactions, whereas enterprise architecture designs are produced by just a few people.

There are two key concepts in this lesson. The first is design, which is essentially a rational, logical, sequential process. No real designer attempts to attain the perfect design. Indeed, there is no such thing as perfect design. Designers strive for constrained optimization, which is something completely different. This is contrasted with emergent systems. Emergence is the appearance of global structure as the result of local interactions. The Internet is emergent because it's the dynamic creation of countless people around the world interacting with each other via links as they create new content.

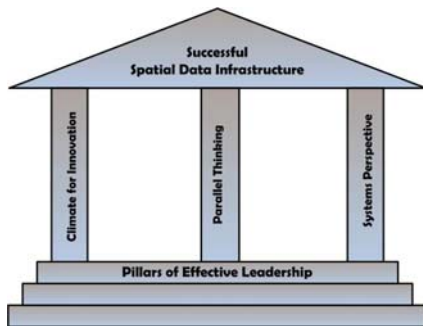
The PAMAP experience suggested an alternative approach to business as usual by considering the designed and emergent aspects in the development of its RAs. The RA defines PAMAP's long-term directions on allocating resources that impact the entire community. One element of the RA requires knowing who will use the data in relation to the services that act upon the data. It only makes sense, therefore, to view these elements as part of a larger enterprise, and to always remember the purpose of the enterprise.

Pillars of Effective Leadership

What has been learned that will help leaders create SDIs? First, systems thinking is no panacea for building an SDI. There is no checklist to work through that will guarantee a leader is thinking in a way that will capture the big picture or identify root causes of difficult problems. Experiences from PAMAP show that focus needs to be on the vision of what the SDI will accomplish, on the purpose for which an SDI is being created for the community, not on the processes and procedures of a bureaucratic entity. This is consistent with the

findings reported by Collins and Porras in *Built to Last: Successful Habits of Visionary Companies*. Companies that last are true to a vision and expend energy ensuring all employees share the vision; then they trust employees to make decisions consistent with the vision.

Patterns that develop over time, feedback loops, and relationships among entities are a better way to think about the dynamics of an SDI. Leaders need to think in terms of the behavior of the whole system, in preference to thinking about component parts. They must also think of the roles and functions of an SDI in terms of the overall purpose of the system. They need to think in terms of strategic objectives, and to measure success in terms of achieving strategic objectives. Activity is not a measure of success; busyness and excessive focus on the short term interfere with SDI development. Leaders must see what is actually happening, not just what they want to see happen. Think about an SDI as a living system that attunes the mind to the important aspects of organizational behavior and allows one to understand what keeps the system alive in terms of ongoing development and support.



A successful spatial data infrastructure is supported by effective leadership.

The work on PAMAP has led us to articulate the leadership in terms of three pillars grounded in reality, as follows.

Pillar 1: Parallel Thinking. Albert Einstein argued that "problems cannot be solved at the same level of awareness that created them." The coming of the Industrial Age, with complex processes and ever-larger organizations, led to the development of management as a profession. In the Information Age of the present day, organizations like an SDI are increasingly networked, and leadership has evolved the task-focused "matrix organization."

With SDIs, our challenge is to facilitate teaming techniques, and to evolve another level of leadership. The assignment of oversight to outside and high-level panels, boards, or ad hoc groups expands the insight and impact of the leader — it raises problems above the level in which they arise. Additionally, this high-level and "parallel thinking" provides unconstrained thought unbound by routine processes, and introduces different perspectives, ensures objective analysis, and enhances the credibility of results.

With parallel thinking, all parties are thinking in the same direction. There is cooperative and coordinated thinking. The direction itself can be changed in order to give a full scan of the situation. But at every moment, each thinker is thinking in parallel with all the other thinkers. There does not have to be agreement. Statements or thoughts which are contradictory are not argued out, but laid down in parallel. In the final stage, the way forward is "designed" from the parallel thoughts that have been laid out.

Pillar 2: Climate for Innovation. Leaders with a clear vision create a climate that encourages and recognizes viable innovation when it emerges, while allowing the freedom to make mistakes. Throughout the system's life cycle, an effective leader maintains focus on the behavior of the system as a whole, and on the roles it plays and functions it performs in terms of the overall purpose of the system.

Few would disagree, in principle, that the effective leader should see not only the parts, but also the big picture. But why is maintaining a consistent vision so difficult in SDI development? One reason is because many leaders are so immersed in the myriad day-to-day nuts-and-bolts technology management details that it is easy to lose sight of the bigger picture. We all know the saying: "Fighting off the alligators takes precedence over draining the swamp." The problem of "busyness" often compounds the problem of beating off the alligators, since it seems as though officials work excessive hours as a matter of pride. This crisis management, combined with a culture of busyness, has resulted in decision makers who favor short-term views over long-term solutions without taking time to think about the actual impact of the fix or the emergent patterns.

A vision has to be tempered with reality. In *Why Smart Executives Fail*, Sydney Finkelstein examined some of the world's most notorious business failures. His analysis indicated that in almost every case, the failures were not attributable to stupidity or lack of attention. To the contrary, the leaders were exceptionally bright, energetic, and deeply involved in the operation of their businesses. Up to the point of massive corporate failure, they were all extremely successful. In most instances, the executives failed to see or accept what was actually happening. In some cases, they were blinded by their own prior successes; in other cases, they inexplicably held tenaciously to a vision despite plenty of evidence that the chosen strategic direction was ill-advised.

Mistakes are a learning tool; they are inevitable in an era of change and advancement, and leadership needs to create a climate where the admission to a mistake is a sign of strength. The paradigm — that mistakes are bad, they ought to be avoided at all cost, and admitting a mistake is a sign of weakness — must be changed.

The leader's pragmatic focus on determining what is actually happening serves as a preventative to self-delusional thinking. Seeing and accepting what is really happening is the hardest part of the job. The continuous assessment process, brought about by broad-based SDI governance, is characteristic of systems thinking and is essential in a volatile, rapidly changing environment. It takes time and good habits of critical reflection to engage in this kind of learning, both for individuals and organizations. A systemic approach to learning from failure is more likely to result in effective long-term solutions.

While inspired leadership can make a difference under the worst of conditions, we might ask just how heroic we expect our leaders to be on a regular basis. When a system is so obviously stacked against our leaders, there is a moral imperative to change the system.

Pillar 3: A Systems Perspective. Effective leaders are systems thinkers and maintain a systems perspective. They see things in terms of loops and patterns, and are aided by constant assessment of what is actually happening and the changing relationships between elements, rather than flow charts and final output.

Peter Senge submits, in *The Fifth Discipline*, that systems thinking provides just the type of discipline and toolset needed to encourage the seeing of "interrelationships rather than things, for seeing patterns of change rather than static 'snapshots.'" Senge argues that this shift of mind is necessary to deal with the complexities of dynamic social systems. He suggests that we think in terms of feedback loops as a substitute for simple cause-and-effect relationships.

A common symptom of linear (in contrast to systems) thinking can be seen in the uncertainty of funding for PAMAP. Funding decisions are driven by simplifying assumptions made not by systems thinkers, but by decision-makers removed from the operations. An assumption like "the weather won't impact data collection" is absurd if you are considering orthophotography: the acquisition of quality aerial photographs is critically dependent upon the weather. In such cases, issues of significance can be misunderstood, and thus cannot be solved quickly. Speed and decisiveness in decision-making work to the detriment of good decisions at the strategic level. Absent some discipline, it is very hard to find time for thoughtful decision-making. In the past, we often had a few weeks to consider options before making a decision. Today, with e-mails and cell phones, we have come to believe that an immediate response is more important than a thoughtful one. In reality, learning happens only when time is taken for reflection.

Effective SDI Leadership Is Often the Antithesis of Good Management Practice

SDIs are led, not managed. There is an obvious need to change the way organizations approach SDI in the realm of management — a traditional IT bureaucratic management approach is no longer effective. Escalating demand for access, rapid changes in technology, a shift in customer demographics, and an increased emphasis on quality and flexibility of data and services all point to the need for change.

Sweeping changes are needed throughout most organizations to better meet the need and competing demands for resources. The past approach was to apply common IT and project management techniques. However, an SDI is based on a different set of circumstances that are in contrast to those normally faced by managers of IT. The paradox is that effective leadership of an SDI requires rejecting many of the long-established principles of management; the foremost is unity of command. Many IT professionals, most of whom have more training in management than in leadership, believe that delegating decision-making to "less qualified-individuals" and groups is not logical.

There is no checklist to work through that will guarantee successful SDI leadership. However, there is a basic concept that can be very helpful when considering an SDI development: focus on the purpose for which an SDI is being created for the community, not on the processes and procedures of a bureaucratic entity. A recent *Wall Street Journal* article by Terry Leap, "[Keys to Spotting a Flawed CEO — Before It's Too Late](#)" suggests avoiding leaders "with a fondness for rules and numbers that overshadows or ignores a broader vision." This is sage advice when building an SDI.