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CASE STUDY 1

MANAGING THE INTRODUCTION OF A VOICE-ORIENTED CLINICAL DATA SYSTEM IN A PSYCHIATRIC FACILITY

The case study presented here depicts a technology that does not actually exist. That hypothetical technology, however, sets the stage for important dynamics among public sector decision makers. The issues and choices they face in this case study have occurred in the past; they continue to be relevant today and will surely reappear in the future. No organization can face the prospect of adopting (or adapting to) changing technology without dealing with these issues. Moreover, as the pace of technological change accelerates, the ability to handle its operational implications will become increasingly critical. The details of the case situation are pertinent to many real jurisdictions, but the situation, agencies, and characters are fictional.

The year is 2007 and the information industry is entering what many observers believe to be its most profound transformation since the late 1940s. Fundamental developments within the past decade, coupled with several new advances in nonlinear laser optics, promise to redefine the very nature of information processing machines (formerly known as computers). It is predicted that the traditional distinction between processing capacity (often measured in units such as MIPS) and core storage capacity (traditionally measured in units such as megabytes) will soon be obsolete. Shannon's definition of information embodied for decades in bit-oriented logics has given way to a new generation of machines that bears little resemblance to anything ever produced in the past. The classic categories of "hardware" and "software" no longer apply. Since the processing and storage of information are no longer separate in any way, these traditional distinctions no longer have meaning.

Several dramatic theoretical and engineering advances have combined over the past decade to bring about this new generation of machines. The first prototypes are now several years old, and a handful of small firms in the Silicon Valley and off Route 128 in Massachusetts are rushing to the market with new products (the industry is still marveling at their meteoric rise). Foremost among these is Voice Office Systems, Inc. (VOS). Thus far, traditional giants in the field such as IBM, AT&T, Digital, Unisys, and CROWN Data Systems have failed to introduce product lines using this revolutionary new technology.

BACKGROUND OF THE NEW VOODS TECHNOLOGY

The advent of Voice-oriented Optical Data Systems (VOODS) resulted from the convergence of five basic and applied engineering advances since 1997. The fundamental discovery that made this new technology possible came from a Danish mathematician, Erling Svensen. Svensen had demonstrated that, in theory, an infinite amount of information could be stored within the so-called attractor for a specialized set of non linear differential equations. His proof had broken a several-centuries-long stalemate among mathematicians concerning nonlinear equations and had opened numerous new fields of research. Svensen himself had received the Nobel Prize in 2000 for his proof.

Charles Farnworth, a physicist at Cal Tech working on the Defense Strategies Project, had demonstrated that Svensen's "attractors" could be nearly perfectly described using less than one megabyte of information (using the classic Shannon definition of information). Hence, in theory, an essentially infinite amount of information could be stored within a structure that itself could be described with a finite (and relatively small) amount of data. Brain researchers were quick to realize that human recall from a limited structure of neural networks must conform to the "attractor" structure defined by the Svensen-Farnworth hypothesis.

All of these developments would have been so much theoretical mathematics had it not been for the development of the first truly nonlinear laser devices at the Massachusetts Institute of Technology in 1999. For the first time, a physical device was capable of producing the theoretical attractors originally posited by Svensen. Using a small bit-oriented program to define the structure of the attractor, virtually endless amounts of information could be stored in unending combinations within the deep structure of the attractors themselves. In much the same way that a single set of nerves controlling the muscles of an arm or leg can produce an almost infinite variety of movements, so too the limited, but cleverly structured, information defining the attractor allowed for the development of virtually infinite new combinations of information.

The third breakthrough emerged from the Japanese initiative in "fifth-generation AI–oriented" machines first launched in the early 1980s. While this research program had not paid off for many years, deep understanding of the so-called knowledge frame and inference-generating technologies of Artificial Intelligence had emerged from that effort. While these advances had been operationalized in traditional list processing languages such as LISP, PROLOG, or IXLOC, the theoretical propositions developed by this research were directly applicable to the new VOODS technology.

The fourth breakthrough was in the systematic work on voice encoding and decoding that had been ongoing in many research centers since the late 1970s and early 1980s. Reliable protocols for coding voice commands had become available in traditional bit-oriented machines in the late 1990s. This technology was taken wholesale into the devices used to code the structure of the attractors.

Finally, dramatic advances in laser optics, beginning with the development of optically oriented logical devices in the late 1980s, provided the final advance necessary to bring about the new generation of VOODS technology. The creation of fully optical logic devices had clearly obviated the need for semiconductors or any form of electronically oriented circuits. This, of course, was necessary for the final development of nonlinear, attractor-oriented information processing machines.

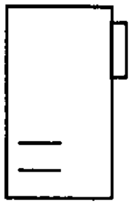
PRACTICAL APPLICATIONS OF THE NEW VOODS TECHNOLOGY

(See the accompanying schematic.)

While the theoretical and applied innovations that brought VOODS into existence form an interesting chapter in the history of science, the practical applications of the new technology are no less than astounding. Voice Office Systems, Inc. (VOS) brought about the first commercial applications of this new technology in the very early twenty-first century.

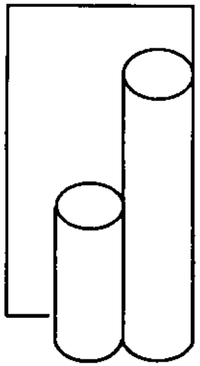
Its new system was capable of actually learning the voice, syntax, and style of an individual user. Each of these features of speech would be programmed into separate and ever-increasingly complex and unique attractors. Hence, the combination of these three attractors could literally learn to recognize and mimic the voice and speaking patterns of an individual.

Furthermore, using knowledge frames and inference-generating structures, additional modules of the system could literally learn routine office procedures. Using this powerful combination, such machines could actually carry out assignments given broadly worded instructions. For the first time,



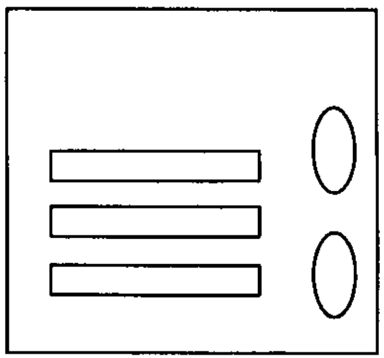
Hand-held Personal Attractor Device (HandPAD). Contains attractors related to an individual user.
Measures 6" x 4" x 1".

Unit cost $15,000.



Personal Attractor Generator (PAGE).
One unit located in each facility. Generates and stores attractor structures for each staff member and patient. Imports scientific, medical, procedural attractors from central AID. Up to 300 structures can be imbedded in each HandPAD. Handles inquiry traffic between HandPADs and AID.

Unit cost $14.4 million.



Attractor Integrator Device (AID). Maintains continuous scanning of all PAGEs. Responds to inquiries from all HandPADs and PAGEs. Performs integration across all attractors and users, generates locally available profiles, clinical reports, on demand and automatically as the result of integrative "learning."

Unit cost $154.6 million.

Figure VOODS.1 Major System Components

a machine could receive and "understand" abstractly worded verbal instructions such as "Draft a letter to Smith at Keystone Industries requesting an update on progress on the Generator contract." Attractor structures within the memory contained the necessary specific information on Mr. Smith, on Keystone Industries, and on the generator contract to create the necessary letter. In effect, the machine could play the role of a junior administrative

assistant of infinite patience and untiring energy, if only limited intelligence.

VOS quickly came to realize that this new technology could be invaluable in patient care within a medical situation. Various attractor modules could learn the pattern and style of an individual physician. Others could learn the knowledge frames associated with a broad range of well-defined (and some not so well-defined) clinical situations. Finally, each patient could be assigned a single attractor, so that in some sense one could imagine that the machine had come to learn about or "know" each patient. The machine could act as an intelligent physician's assistant, helping the physician to consistently monitor patient care. Other health-care professionals could query the system or update it when they interacted with the patient. The bottom line? The expert human judgment of physicians could be extended through this system, allowing fewer physicians to attend to the needs of more patients. The nonexpert aspects of patient care could be greatly streamlined by the unique "intelligence" of the VOS system. Moreover, clinical personnel would have far greater resources to draw upon in making diagnoses, prescribing treatment, and following a personalized plan of therapy. Since the system would have better, more complete information about a patient than the old paper or highly structured electronic records, and since it could continually stay abreast of changes in medical technology and the biological sciences, each patient would receive better-informed, more consistent, more specially suited treatment. In short, health services could be revolutionized.

GENERAL PROBLEMS WITH THE VOODS TECHNOLOGY

While the new VOODS technology offers immense advantages, it is not without its practical problems. Foremost among them is the uniqueness of individual attractor structures. The simple facts are that VOODS systems programmed to be used by one manager or physician cannot be used in any effective way by another. That is, these so-called junior assistants can be responsive to only one combination of voice, cognitive structures, and operating procedures at a time.

Second, these machines are not easily compatible with any of the old electronically-oriented machines. This is especially a problem, since most of the data systems developed in the 1980s and 1990s were in the form of fully relational databases in electronic form. While these relational databases are clearly obsolete in a technological sense, they are in use everywhere and represent immense capital and staff investments. More importantly, they contain essential information concerning, for example, patient demographics, which should be transported from these old systems into the new VOODS system. At the moment, only a "low-tech" solution is practical: optical scanning by the new system of individual data records in the old system, plus the creation of additional attractors that specify how the scanned data elements relate to each other.

Third, VOS has moved toward a new unit of information, the MERG (memory encoding and recall generator), for creating the attractor structures. MERGs bear no relationship to old memory units such as bits, bytes, or words.

In addition to these technical incompatibilities, the new VOODS technology creates a host of personnel and management issues. For example, data processing professionals have been trained for some time to work in an environment of fully integrated micro and mainframe systems with fully distributed processing through local area networks (LANs) and long distance data networks (LDDNs). This orientation will lose most of its functionality in the new world of VOODS technology. Existing data processing professionals were brought up on old concepts of fully integrated, relational databases and traditional hardware and software systems. The retraining costs will be immense.

THE SITUATION WITHIN DMHS

Dr. Sally Ehrlman, a young and aggressive director of the Adirondack Psychiatric Center, has been watching the development of the new VOODS technology since it first hit the press in the early 2000s. She had closely followed the first clinically based systems pioneered at the Harvard Medical School and decided early on that they were ideally suited to the management of patient care in state psychiatric facilities. She applied for and received a demonstration grant to introduce the new technology within her own facility in 2005. This grant had been provided by the VOS corporation itself, with VOS providing equipment and expert assistance in the project.

Her experiment had been an overwhelming success. Physicians were able to maintain individualized records on all clients and to use these data profiles for patient management. There was a demonstrated increase of 35 percent in the number of patients who could be served by the physicians on staff. Yet, even with this greatly increased patient load, they applauded the results and felt that patients were not being shortchanged in any way. In fact, just the opposite—they took great satisfaction in giving better care to more people with the same level of effort. It was an actual case of that elusive goal "doing more with less." The results in community-based facilities were not as certain, but if even half the success of in-patient care could be shown, this technology promised to become the first real hope for improvement in the community mental health world since the unexpected effects of deinstitutionalization took hold around the state in the 1970s and the need for these services exploded far beyond the services available. Physicians and clinicians were flocking to use this new technology, practically leapfrogging over the

facility managers and data processing personnel in their understanding and use of the new technology.

Features of the new system included

- Clinically oriented information storage and retrieval
- Profiles of individual patients tailored to the "clinical style" of the individual physician
- Powerful heuristics to aid in diagnosis and in prescription of treatment
- The ability to "learn" new clinical procedures or new information about individual clients as such knowledge becomes available, apply it to already stored facts and relationships, and identify patients who could benefit from revised treatment
- A high degree of decentralization allowing the attractors to be tailored to the needs of individual physicians and other users

The overall system has worked in what can almost be described as a miraculous fashion. Capabilities that could not have been imagined five to ten years ago are clearly operational. The Department of Mental Health Services (DMHS) commissioner has recommended that this system be implemented across the state over the next five years. The estimated cost of purchasing this new equipment is $435 million. However, the estimated payback period is expected to be less than four years.

PERCEIVED PROBLEMS WITH THE VOODS SYSTEM

While clinicians within DMHS have unanimously given the VOODS system for patient information the highest ratings, not everyone is totally pleased with the new technology, certainly not the technology as being marketed by VOS.

The popular press is filled with rumors that IBM is about to release its own version of the VOODS technology. Informed speculation is that IBM will not adopt the same MERG standard as has VOS. These rumors suggest that IBM has developed and is testing a more powerful new technology for shaping attractor structures that will not be compatible with the VOS system and may work better. It is likely, however, that VOS will institute a patent fight if IBM attempts to enter this market. A major lawsuit could push the availability of competitive systems off for years.

Laying this problem aside, there remains the technical problem of incompatibility between VOODS information systems and the more traditional bit-logic electronic machines. Information processing professionals in DMHS predict that the adoption of the VOODS technology will lead to the creation of two entirely separate client-oriented information systems within each facility. Furthermore, there appears to be little hope in the near future of reconciling the VOODS data structures to the more traditional structures necessary to maintain the existing bit-logic relational databases. Some specialized transfer protocol is needed, and although much R&D work is going on, nothing has yet been tested and on the market. Having just spent the past decade gaining integration of hardware and software capabilities within DMHS, information processing professionals are understandably reluctant to allow a fracturing of information systems again.

The unions have already expressed stiff opposition to the new technology. Quite frankly, their fears stem from the belief that the new VOODS technology will strip aides and other health-care workers of the last vestiges of professional responsibility. They believe the allied health-care professions will become devoid of clinical judgment and almost routine in nature.

Civil Service is concerned about the new technology for several reasons. First, it seems clear that their newly completed conversion of several job series to reflect an electronic age will become obsolete. For example, after what everyone agrees was much too long a struggle, Civil Service titles finally reflect the reality that stenographic positions no longer exist. They were only recently reclassified entirely into the word processing and information processing series. Since these new VOODS systems are truly voice oriented (they even have proper grammar and can spell), Civil Service is beginning to realize that the very nature of clerical work is about to be completely transformed again. Furthermore, a two-decade-long debate still rages over the role of technical information skills in professional job classifications. Do they belong in specialty titles or are they so fundamental that, like literacy, they belong in the description of every skilled occupation?

Program managers in the facilities have yet another set of concerns. Using a sophisticated network of the latest generation of so-called micro-mainframes, they have finally achieved a relatively uniform information environment. Most facilities have completed the transition to a paperless office, and internal and external communications, as well as client records and financial systems, are all being handled within it. The new VOODS technology now threatens to create self-standing information systems within every clinical unit—perhaps with every clinician having his or her personalized information environment. The administration of information resources is bound to be complete bedlam.

THE CASE ASSIGNMENT

The advent and practical application of this new technology raises a number of organizational, strategic, financial, and professional issues. The traditional lines dividing technicians and users become blurred, and coalitions form around various aspects of the problem. For example, many of the facility administrators and nonmedical program managers have joined with the data processing professionals in their desire to protect the stability of their existing information systems. The medical professionals and those charged with delivering mental health services around the state (the physicians, the Adirondack facility director—also a physician, and the DMHS commissioner) see in this technology a powerful tool to advance both professional and public service goals. The control agencies are struggling to both maintain a stable environment and make wise investments in the future.

The Senate is about to hold appropriations hearings on the $435 million funding request being put forward by DMHS. Senator Edgecomb, who will be leading the hearings, expects that a wide diversity of opinion will be offered by a number of constituencies. You are an administrative assistant to Senator Edgecomb. He has asked you to prepare a briefing that anticipates the types of testimony he is likely to encounter during the hearing. (*Hint:* Scan the three "points of view" depicted below as a starting place for your memo.)

THE CONTROL AGENCY POINT OF VIEW

Put yourself in the place of the agency's budget examiner in the State Budget Office. You are reviewing a request to invest $435 million over the next five years to acquire this system. How would you react to this request? What reservations might you have? What additional information might you request? Can you suggest strategies short of approving the entire five-year acquisition plan that you might adopt?

Look at the concerns of the state's other control agencies such as State Central Services, Civil Service, and Audit and Control concerning this acquisition. Are these reservations justified or are they just attempts to block progress on a good idea? Should a public agency be on the leading edge of technology or are the risks that attend radical change inappropriate to the purposes of government? Should this new technology be acquired in a way that would make it more available to other agencies or should the risks, if taken, be limited to one agency setting?

THE INFORMATION PROFESSIONALS POINT OF VIEW

A coalition of information processing professionals and facility managers have argued that acquisition and implementation of the equipment should proceed at a slower pace after being pilot-tested more thoroughly in several other sites. They urge that the complete acquisition of the technology be delayed until such time as a coherent updated information policy can be worked out for the agency as a whole.

What issues should legitimately be addressed in this information policy? Have past efforts to define information policy for the state and for the