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General Topic: **XML document processing**
Topic Title: Automating Construction of XML Document Processors

Description

XML is being proposed for a wide variety of information interchange problems. These proposals require software capable of analyzing specific XML formats. The formats are defined formally, and programs to carry out the syntactic portion of the analysis can be constructed automatically from those definitions. We have mature tools capable of automatically constructing programs carrying out complete (both syntactic and semantic) analysis of structured text. These tools have been applied to a wide variety of programming and specification languages. We seek a partner with an XML analysis problem, in order to explore the applicability of this technology to automation of software development for XML analyzers.

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General Topic: Software Testing
Topic Title: Evaluation of Test Criteria for Distributed Applications using OO Middleware

Description

We are interested in measuring the adequacy of test suites in the context of distributed applications using object-oriented middleware such as CORBA and Java RMI. We are evaluating test criteria based on the object interface descriptions. These criteria are related to method coverage, exception coverage, method sequence coverage and interface mutation. A tool that collects the coverage metrics will also be implemented.

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General Topic: Software Testing
Topic Title: Tool support for distributed software testing Description

Description

We are interested in providing a test infrastructure for distributed Java applications. The infrastructure will allow testers set up tests, monitor and control their execution, and observe changes in test coverage. An event and control-action specification mechanism will be developed and a prototype tool will be implemented.

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General Topic: **Supply Chain Management, Inventory Stocking Policies, Optimization, Simulation**
Topic Title: Supply Chain Management for a Repairable Service Parts Logistics System

Description

Supply Chain Management assists in meeting ever-urgent customer demands for finished products. The supply chain "consists of all stages involved, directly or indirectly, in fulfilling a customer request" (Chopra and Meindl, 2001). Managing the supply chain involves attention to, for example, developing a product, transporting finished products, and the timeliness with which these activities are conducted. Recent applications have addressed minimizing supply chain costs associated with getting the product to the customer, and sustaining the customer's use of that product.

Consider that many corporations purchase multi-million dollar computer systems to maintain data bases and websites, and carry out mundane duties such as word processing. The computer companies that sell these complex systems not only supply the customer with the product, about must also ensure that the computer systems remain constantly functional.

However, computer systems invariably fail, generating a demand for repair parts. This demand is extremely time-sensitive, as the computer systems, and the corporations who depend on these systems, become crippled without the timely response of a repair vendor with the appropriate hardware or software.

Policies regarding where and how many repair parts to store are far from obvious. For example, storing many and different types of repair parts close to the corporation will virtually guarantee an extremely rapid response to a failure. However, a computer company would hardly be able to economically justify such a policy due to the cost of maintaining many warehouses, and of holding a generous number of repairable parts in inventory. In the latter case, holding parts "in storage" causes the computer company to incur an opportunity cost, primarily a function of the company's inability to derive revenue—either directly from the sale of the repair part or indirectly through the part's inherent value—while the part sits in a warehouse unused (potentially becoming obsolete).

Because repair parts can be extremely valuable, even minor reductions in repair parts inventory can save a computer company millions of dollars. Therefore, our research investigates optimal inventory policies for the Repairable Service Parts Logistics System of a computer company. In addition to determining the stocking levels for each part at each warehouse, questions concerning the number and location of warehouses must also be answered. Different "types" of warehouses must be considered. Some only hold inventory, while others hold inventory and repair broken parts. A final level of complexity presents itself in determining the way in which warehouses interact, e.g., whether one warehouse ships parts to another stocked-out warehouse.

We propose to develop a model to determine strategic decisions such as warehouse type and location, and tactical decisions such as optimal inventory levels at each warehouse. Our software, which would contain the underlying model, could save the Repairable Service Parts Logistics System of a computer manufacturing company millions of dollars annually. The underlying model would interest researchers because of the required sophisticated operations research and management science techniques (e.g., optimization and simulation) needed to accurately capture the problem and enable it to be solved.

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General Topic: **Software Reliability**
Topic Title: Monte Carlo Method for Software Reliability Predication

Description

The objective of the proposed research is developing a quantitative estimation of the reliability of software system. The Monte Carlo method is a very useful tool when system complexity makes the formulation of exact models impossible. This characteristic of the Monte Carlo method makes it an ideal tool for estimating the reliability of software-based system. Unlike many other mathematical models that used for software reliability predication, the system complexity is irrelevant to the method. The method can predict the software reliability even in the lack of the precise information on the structure of system software components and the system dynamic. Instead, system components need only be tested for failure during operation, which ensure that components, which are used more often, contribute proportionally more to the overall reliability estimate. Combined with self-checking algorithms, which respond to randomly generated inputs, the method obviates the need for valid, nontrivial input data and external oracle.

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General Topic: Visualization
Topic Title: Visualizing DNA damage due to lead poisoning from Mines in Colorado

Description

Lead poisoning can cause many serious diseases in human beings who are exposed to mine areas. Diseases like lung cancer, asthma, allergies, have been reported from Mine areas in Colorado. The focus of this research is to create an Information base on Genomics from a specific mining area from State of Colorado. Visualization and cross comparison of this information will be helpful in understanding the relation between the degree of exposure and the extent of damage at genetic level. This would provide a better treatment for such diseases. We feel that this effort is important because there is no computer based system which analyzes the damage due to lead poisoning from a variety of mines in Colorado at this time.

Our research will primarily focus on:

1. Biochemical isolation and sequencing of genetic material (DNA and Protein) from the cells exposed to higher concentration of lead compounds
2. This sequence would be analyzed with the help of NCBI /BLAST software to see the degree of damage by comparing those with healthy cells.
3. Analysis of 2D/3D data on Genetic material and creation of Gene data bank for quick analysis and access to be developed at the University of Colorado, Colorado Springs using OpenGL and C, or Java3D.

We are working on gathering samples of related patients data or the sequence data from health science center and National Jewish Medical research center in Denver. The focus of our work would be on the efficient visualization and comparison of these data sets.

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General Topic: Digital Communication
Topic Title: Wavelet-Based Data Encoding/Decoding Algorithm for Efficient, Secure, and Noise-Robust Digital Communication

Description

It is proposed to develop an encoding/decoding algorithm using overcomplete wavelets. They will be used as building blocks for construction of communication signals, which represent binary data vectors. This approach should lead to a maximized throughput (number of users) as well as to the robust to noise recovery of user data. In addition, the algorithm is expected to ensure secure communication or low probability of the intercept of user data.

The aforementioned characteristics of the wavelet-based encoding/decoding algorithm were confirmed by a preliminary feasibility study. Once this algorithm is developed, its performance will be evaluated using proper quantitative tools, which are to be developed in the project.

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General Topic: Communications and Signal Processing
Topic Title: Signal Processing in Communications

Description

It is proposed to develop an encoding/decoding algorithm using overcomplete wavelets. They will be used as building blocks for construction of communication signals, which represent binary data vectors. This approach should lead to a maximized throughput (number of users) as well as to the robust to noise recovery of user data. In addition, the algorithm is expected to ensure secure communication or low probability of the intercept of user data.

Signal processing is a very important component of communication. Often there is a need to do some kind of signal estimation, system identification, spectral analysis, inverse channel identification, noise cancellation or prediction. Many of these problems would occur in communications signal processing or in the tracking of a vehicle or target. I am proposing to do research to solve a problem in one of the above areas using perhaps an FIR or IIR filtering or maybe an adaptive filtering algorithms such as LMS for stationary processes or Kalman filtering in the case of a non-stationary process such as the tracking of a target as it changes position, etc.

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General Topic: Contact Center Performance Improvement or Applications in
Simulation/Optimization
Topic Title: Contact Center Scheduling Using Simulation/Optimization

Description

One of the most important tasks that a contact center manager must accomplish is the scheduling of the center employees. The manager wishes to determine the optimal staffing levels throughout the day that provide the appropriate customer service at the least possible cost. The staffing solution may contain multiple skill levels that must be considered when determining the optimal schedule.

Traditional approaches to contact center scheduling have utilized Erlang and simple queuing models to approximate the real contact center system. Unsatisfactory service levels and high costs often result from the use of these traditional techniques. The reason that these approaches fail to produce efficient solutions is that the underlying models are poor representations of the true system.

Discrete event simulation is a powerful modeling tool that allows one to model contact center operations in an extremely realistic fashion. The model can be created to actually mirror the true system.

Given a contact center simulation model, a manager can try various schedules and accurately evaluate the resulting contact center performance. In theory, the manager could continue to try schedules until an optimal solution is found. The difficulty with this approach is that the scope of the problem makes human solution techniques ineffective.

Consider a contact center that schedules five skill levels every thirty minutes throughout the day. The manager is attempting to determine $5 \times 24 \times 2 = 240$ quantities. People can often mentally grasp optimization problems that contain a few variables but a problem with 240 variables is completely intractable for a human. The answer to this dilemma is to use an automated optimization system that can effectively address problems of this size.

We propose that a simulation optimization system be developed. Algorithmic development and scenario testing will be involved. Important features will be to integrate optimization with simulation in a manner that:

- (1) adequately deals with the inherent uncertainties and routing complexities reflected in contact center scheduling
- (2) provides a range of "near-optimal" solutions that can be evaluated by additional after-the-fact criteria
- (3) accounts for budgetary constraints on labor

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General Topic: Digital Optical Systems Design
Topic Title: Modeling, Simulation, and Analysis of Digital Optical Systems

Description

Digital optical systems such as optical communication networks and optical computers process digital information, which is optically encoded. These systems have the inherent advantages of speed, parallelism, and immunity to electromagnetic interference (EMI). These systems are characterized by device technology, architectural structure, and digital signal encoding method. Device technology can be optical or a hybrid-optical technology such as optoelectronics. The system architecture can be guided-wave (e.g. fiber optic) or free space. Digital signals can be optically encoded by intensity, polarization, and/or frequency.

With such a variety of system design options, coupled with high data transfer rates (speed) and a high degree of parallelism, it is difficult to analyze, quantify, and predict the effects a change in technology, architecture, or methodology will have on the function, the behavior, and the performance of a system. Digital optical systems have evolved in size and in complexity to the extent where current design tools lack the ability to effectively model, simulate, and analyze their behavior.

The major functional issues in digital optical systems are optical alignment, power budgeting, timing, synchronization, and control. Timing behavior is defined as the effect the location of a particular signal has on the functioning of a system. Optical signals propagate linearly at a constant speed. Signal degradation, the propagation path length, delays along the propagation path, and the duration of the asserted value can cause variations in the behavior of the system. Synchronization is defined as the precise timing relationship between signals. The control behavior of a system is the order of occurrence of synchronized groups of signals.

The research in progress models digital optical systems as a timed-colored Petri net (TCPN). A Petri net is a graphical and mathematical modeling method for describing and studying information systems characterized as being concurrent, asynchronous, distributed, parallel, nondeterministic, and/or stochastic. Petri nets are discrete event simulators. For research purposes, the generic Petri net is adapted to modeling digital optical devices and systems by adding timing capabilities and "color" constructs for modeling high-level system properties such as optical signals. The TCPN expresses the structural, functional, and behavioral features of a digital optical system.

The research goal is to develop system simulation and system analysis tools that will

1. Determine optical alignment in free-space systems.
2. Evaluate and determine the power requirements for a system.
3. Evaluate a system's timing, synchronization, control behavior in order to
 - a. Quantify the level of parallelism in the system.
 - b. Determining processing bottlenecks.
 - c. Derive/determine system performance measures.

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General Topic: Software Testing
Topic Title: Using UML Diagrams to Derive Test Adequacy Criteria

Description

The Unified Modeling Language (UML) is a language for specifying, visualizing, constructing, and documenting the artifacts of software systems. The UML uses several views and diagrams, such as design class diagrams and collaboration diagrams. We are interested in defining and assessing test adequacy criteria that are based on elements of these diagrams. The criteria will be used to evaluate the adequacy of quality assessment during both design and implementation phases. The proposed work will also develop a method for deriving test suites that satisfy the criteria.

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General Topic: Technology and Distance Education/Training
Topic Title: Critical Components for Computer Based Training

Description

Organizations are struggling to understand ways to effectively and efficiently train and educate employees. Employers want employees with both technical skills and skills that are "socially driven," such as project management, leadership, team participation, etc. As one thinks about this topic in a corporate context, the issues in corporate education and training parallel those found in distance education. What is the best way for technology to support learning and training? The purpose of this research study is to identify key components for organizations to use with their distance-based training and its derivatives (i.e. CBT) to their best advantage.

For the purpose of this discussion, distance education is defined as creating a learning environment that facilitates structured learning without the traditional practice of face-to-face interaction in an on-campus environment. This means that computer-based training CDs, video supported training, as well as, Internet-based distance classes meet the spirit of the definition. However, in today's world, distance education usually implies some sort of technological support through the Internet, email or videoconferencing. Ultimately, this leads one to consider how technology and people interact.

Overall, research is mixed on the effectiveness of distance learning. Some findings show no difference between groups in distance learning environments while other research show some dysfunctions. However, learning seems to have a significant social component and this aspect of learning has not been incorporated into much of the distance learning models. This project will look at the impact of adding more interaction to the distance environment. For example: Do structured debates on a listserv provide better learning and retention of topics? Do voice-supported materials help students learn? What computer interaction techniques seem to work best to support training and learning?

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General Topic: Telecom
Topic Title: Diff-Serve and Cellular IP

Description

Diff-Serve is very important as one tries to scale the Internet to provide quality-of-service (QoS) in the IP environment. Equally, Cellular IP is very important as one tries to make web-browsing and multimedia capabilities available in a wireless, cellular environment. In the case of the former I am proposing to do research at the edge router to facilitate the the achievement of QoS inside the core routers. Specifically, I am proposing traffic shaping, etc. using via conventional as well as with the use of intelligent algorithms such as fuzzy or neural network. In the latter area I am would examine ways to make the network more efficient in respect to mobility and use shorter paths than in Mobile IP when a mobile migrates a foreign agent.

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General Topic: Organizational Memory; Knowledge Management
Topic Title: Making Organization Memory Effective Description

Description

Companies are beginning to realize that simply storing data in warehouses and databases is not sufficient to ensure the usefulness of that data or information. Organizations must learn how to store and transfer knowledge over time and not rely on recreating it. Organizational Memories are the means by which organizations remember. They are both the software (database, knowledge base) and content (model, paradigm). With human memory as an analogy, organizational memories represent the long-term memory of organizations from which the organization wishes to extract accurately the information stored and use again, as with short-term memory, at a future date. We have preliminary research (1) that shows storing certain types of complementary information, comparative comments, influences the accuracy of the information retrieved.

The proposed research would expand the preliminary study to more formally identify what type of complementary information is best stored in an organizational memory in order to extract the original meaning or intent. A combination of lab experiments and on-site, field studies would test fundamental questions. For example: Does archived information on which a decision was based create the same decision when retrieved from the organizational memory? Do hypertext documents provide better information/knowledge transfer than plain text? What data/information do decision makers really use in making decisions? What information is best used to summarize decisions? Ultimately, the answers to these questions can help organizations understand what information is best stored to support ongoing information storage, decision making, and knowledge management in their organization.

- (1) Martz, Wm. Benjamin, Jr. and Morgan Shepherd, "Getting More Out of Organizational Memory: Comparative Comments and Output Medium," Journal of Computer Information Systems, Vol. 41, No.4, pp90-94, 2001.

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General Topic: Visual Perception
Topic Title: Near-field motion estimation for pose estimation

Description

In order to navigate to a desired location or to build a map, a robotic vehicle must know its position in its environment. GPS can be used for absolute position, but it is not always available and is not accurate enough for some navigation and mapping tasks. Inertial navigation systems, odometers, and compasses can accurately determine relative vehicle position over short times, but over longer times errors accumulate to significant levels. Navigation based on the near field motion of features of known or unknown location can complement these other position estimation methods to improve the overall reliability and accuracy of position estimates. Algorithms for estimating near field motion, for identifying known visual features, and for integrating the information from the multiple position information sources must be developed to realize a fully integrated robot navigation system.

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General Topic: Generic Workbench Architecture
Topic Title: Development of the Generic Workbench Architecture

Description

We present a plan for the development of a flexible, extensible framework for integrating engineering models under a common graphical user interface with a common relational database system. This tool, called the Generic Workbench, will allow engineering models developed under heterogeneous environments to be unified. The Generic Workbench is being written in Java to allow platform independence and is based on an industry-proven lightweight persistence framework object model. Distributed computing will be enabled using the XML/SOAP protocol. The initial demonstration of the viability of this tool will be made by porting it to the OpenChem Workbench. The general nature of the Generic Workbench will enable broad-based technology transfer to other fields.

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General Topic: Network Security
Topic Title: Network Survivability for Networks Under Attack Description

Description

A substantial amount of research effort has been devoted over the past decade on developing network intrusion detection (NID) systems, and today we have a number of sophisticated NID systems available commercially. Nonetheless, malicious attacks do occur and the results of these attacks are often serious. Current NID systems are able to detect these attacks most of the times. However, remedial actions are still taken by system administrators and involve shutting down the network temporarily. The delay in response is often enough for intruders to launch attacks on other networks from the compromised networks. This delay may not always be acceptable for critical networks. The current project addresses the problem of rapid response to intrusion alerts so as to isolate and contain intrusions.

We plan to develop a proof-of-concept for a computer network that is able to defend itself on its own against malicious attacks. This network is able to isolate any compromised subnet rapidly and automatically, thus protecting the remainder of the network from further damage. It is able to confine the attack to the compromised subnet only, thus preventing the use of the compromised subnet as a launching pad for further attacks. Our goal is to minimize human intervention needed to achieve all this.

The project has two major components:

(1) Intrusion Detection

- Enhance existing NID systems with the mobile, autonomous agent paradigm to develop the next generation NID system
- Empower this new NID system with data mining capabilities to allow real-time analysis of network monitoring data so that (a) both false positives as well as false negatives are minimized, and (b) identify potential intrusions for which no signature is as yet known.

(2) Intrusion Isolation and Confinement

- Develop mobile agent based techniques for real time damage assessment of intrusion
- Develop mobile agents based techniques to implement intelligent dynamically reconfigurable firewalls that can be deployed around compromised networks
- Develop techniques to ensure the survivability of mobile agents when these are targeted for attacks.

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General Topic: Communication, Telecom, Signal Processing
Topic Title: Performance Study of a Communication Channel

Description

Waveform modeling of signals through a communication channel is very important for determining system level performance. One may want to determine the effect that a nonlinear device have on system performance. The communication channel may be exhibit temporal and/or spatial correlations and one may wish to ascertain its effect on different coding schemes.

I am proposing to develop a model of a system and run monte carlo simulations to determine performance based on the applicable scenario.

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General Topic:
Topic Title: High Performance Computing for Embedded and/or Parallel Computers

Description

Many applications—in numerical simulation, physical modeling, multimedia, data mining, multimedia, and signal and image processing— spend a significant part of their time in loops. Often these parts of the program are not optimized to extract the best performance. We have developed considerable expertise on a number of program transformations that show considerable promise for optimizing the performance. For some loop kernels that occur in biological sequence comparison and gene sequencing, we have achieved up to 300% improvement.

We believe that our techniques can be used in many different contexts, for different (computation intensive) applications and for different target architectures, such as modern multiprocessors with a sophisticated memory hierarchy and deep pipelines and vector and parallel machines and supercomputers. They can also be useful for directly “compiling” the application to silicon (designing application specific circuits, in the context of high performance embedded and consumer electronic systems (games, cameras, image processors, printers, etc.) Furthermore, it is possible to optimize for different performance criteria (speed, power and/or energy consumption, memory, silicon area, etc.)

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General Topic:
Topic Title: Distributed Software Testing, Management and Run-time Visualization

Description

Testing software that runs on distributed, heterogeneous platforms presents even more difficult challenges than testing single programs. Our research is aimed at enabling software testers to apply rigorous testing methods for integration and system testing. We are developing techniques that will aid in the management (both monitoring and control) of test execution in the distributed setting. We are adapting existing fault injection techniques for assessing the fault tolerance capabilities of distributed applications. We are also developing and evaluating means for measuring the quality of testing performed. We are experimenting with test adequacy criteria and evaluating their effectiveness in measuring the quality of testing.

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General Topic:
Topic Title: Non-Intrusive System Debug Technique

Description

Embedded systems require the development and debug of software. The process to debug the embedded software is a complex and time-consuming issue. The real-time nature of the applications causes issues that continue to make the debug process more complex. This complexity occurs when the user does not have access to the internal operation of the microprocessor. External measurements are available. As cache is added to the microprocessor, the ability to obtain instruction and data information from the external bus is minimized. This proposal is for a non-intrusive method of embedded system debug using hardware and measurement information about the system. Hardware architecture information includes the hardware architecture of the microprocessor used and the software under test. Additionally, measurement data is added from external measurements. The premise for the non-intrusive method of debug combines the known information with measurements made from the system under test. Applications include multi-tasking and parallel processing.

This proposal is a continuation of a previous initial case study. The initial study utilized a Motorola 68020 performing a variety of functions including: simple subroutines, interrupts, and a form of multi-tasking. Several simplifications were made to accomplish the initial study. This included not using a high level language like C, but coding specific routines in assembly to accomplish the tasks required. The 68020 was selected since it had instruction cache and a pipelined architecture as well as being representative of a "high performance processor". The continuation would include more detailed software applications, as well as more structured coding methods and higher language development.

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General Topic:
Topic Title: AgentSheets Software - A tool for corporate training, education, and lifelong learning

Description

AgentSheets Inc. is engaged in the commercialization of AgentSheets software, an advanced simulation development environment developed at and licensed from the University of Colorado. We believe that AgentSheets simulations and models represent a new and unusually effective learning tool for corporate training, education, and lifelong learning. AgentSheets software has won numerous national and international awards and represents a decade-long research effort. Various government agencies and private firms have invested over \$3 million in the development of AgentSheets software and tools. AgentSheets commercialization has focused on the K-12 education market. We want to move into the corporate training market, and we are actively seeking corporate partners. We want to collaborate with private industry on using AgentSheets technology to solve their most challenging corporate training problems. We are interested in precisely defining the "AgentSheets advantage" in corporate training, and we need concrete and quantitative examples that show AgentSheets software addressing corporate needs. We will present the features of AgentSheets software, along with its advantages for corporate training, in the context of a collaborative corporate training project. Specifically, we will present a project in which we develop AgentSheets simulations, models, and tools that solve corporate training problems defined by our corporate partner. Our partner utilizes our training tools and quantitatively evaluates their performance. This will give us corporate training marketing materials and credibility. We hope that our CASI presentation will help us locate partners.

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General Topic:
Topic Title: Haptic Courtyard

Description

Haptic Courtyard is a virtual environment facilitating the study of cognitive maps, wayfinding and navigation for the blind. Our goal is to allow the visually impaired to navigate the real world with comfort and ease. This research is an outgrowth of our earlier experiments for shape learning in a virtual environment using sound cues.

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General Topic:
Topic Title: Project complexity and performance: Why failure is so natural

Description

Big projects experience cost overruns and schedule slips so routinely we accept such events with knowing cynicism. Truth is, honest attempts to accurately predict costs and completion dates are far more likely to fall short than we realize. This research explains some under-appreciated forces that drive projects and the resulting effects on project performance.