HCI NASA Group
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Literature Review Summary

Conclusions and Relevant Information
from Research on Error Reporting and Mobile Devices

Monday, February 26, 2007

Executive Summary

The purpose of this literature review was to begin to understand the scope of the project our team will be undertaking over the coming semester and this summer. This task was narrowed to have three specific goals: first, to gain a baseline understanding of the current PRACA system and standing recommendations for change; second, to explore the extent to which and for what handheld systems are used in a variety of industries; and third, to analyze the process of problem reporting before beginning contextual inquiries (CIs). Guided by these areas of research, our team summarized and highlighted a number of articles. Notable among them are the MoRe project, analyses of the PRACA system done internally by NASA, the Wiisard system, and the CM3 problem management system.

The information about PRACA will be immediately useful for guiding CIs, and will also eventually help to shape the design of the final device. An understanding of the current system and where it needs improvement is an invaluable asset as we are performing interviews. This is especially true given our limited access to actual NASA facilities at present. The Wiisard and MoRé papers were also illuminating in terms of guiding further research in the mobile device domain, but also had the added benefit of giving us new perspectives on what a “handheld device” is and how it could be used. Finally, other papers on problem management gave us a general idea of problem reporting as it is applied outside of NASA.

Based on the information presented in this review, we plan to continue our contextual inquiries in the aforementioned domains. As we learn more from these interviews and the modelled data, another literature review with a narrowed focus may become appropriate. For the time being, however, the team’s primary goal is to gather as much data as possible, synthesize it into standard models, and extract areas to explore further.

Wiisard

From wiisard.doc - NASA Ames Research Team, NASA Ames Research Center

Summary

The Wireless Internet Information System for Medical Response to Disasters (WIISARD) project addresses the need for efficient information flow through a mobile support system for medical relief responders. The infrastructure supports management of patient status, tracking transport of patients and update of patient records, and coordination between offsite locations and with the medical team during field disaster situations resulting from terrorist attacks or natural disasters.

Wiisard Devices

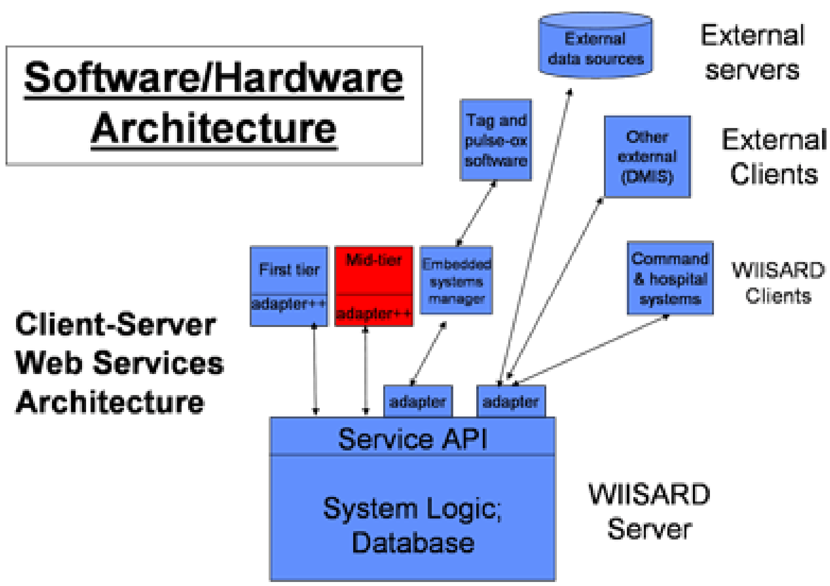
The wireless system infrastructure is set up to interconnect first0hand responder devices for handheld data entry and retrieval, electronic patient smart tags and monitoring devices, tracking and data relay units (TDRUs) that provide wireless access points with GPS to relay positional information, and integrated software systems to increase situational awareness. The current medical response process involves tangible artifacts that are not software-based: paper records of patient treatment and triage tags for rapid patient status information. Although updated information regarding medical resources and capacities are necessary, information is not reliable and consistently incorrect. The WIISARD system provides a real-time, integrated system that provides synchronous information readily available when needed through the use of handhelds as information retrieval tools. All entries are stored permanently, whereas previously medical records were difficult to manage.

The smart triage tags act as middleware for medical data storage, when connected to medical devices, execute accordingly. External LED indicators also specify patient priority levels for medical attention, hazards, and medical alerts. When considered from a human factors perspective, smart electronic tags are a more complex method of tracking the status, geo-location, and movement of patients (through accelerometers and magnetometers) in comparison with traditional triage tags, which are efficient, easy to learn, and intuitive. Paper triage tags may also be tagged with RFID identification. However, the functionality of the smart tags as an element of the entire system allows disaster relief teams to coordinate patient information and communication between the onsite team and offsite hospitals. Diagnoses are more comprehensive. Position information allows hospitals to prepare for patient arrival with expected resources. Thereby, although the switch to electronic tags may not be a significant improvement over triage tags, overall cognitive load in the course of action is reduced.

The technical architecture of the system is robust. Significant research and testing has provided criteria for processor power, memory, energy, battery life, availability of wireless access points locations and connectivity/ signal strength, cost, and maintenance of both software and devices. Network congestion is handled through monitoring software at a mobile command post, requiring unique IP address for each device.

Highlights

A few grounding points will be valuable to extend from this project: (1) a well-developed handheld device may be one component of a networked ubiquitous system to provide support for maintenance and consistency of problem reporting documentation, real-time information retrieval when needed, and a more efficient and accurate method of problem entry through tagging and/or identification sensors, (2) the overall impact and improvement of work is the primary goal although one aspect which may be an integral part of the system may cause more complexity from a human factors standpoint, (3) a centralized command system is an primary basis for the success of the system and may be necessary to mediate between individual systems, (4) work practices of problem reporting involve many other factors both cognitive and behavioral, the example in this case, situational awareness, by which investigation of may lead to further support of the problem reporting activity, (5) intelligent devices aware of location information may be a useful facet to consider.



An Analysis of the Fault Correction Process in a Large-Scale SDL Production Model

From analysis_of_the_fault_correction.doc - Dolores and Wayne Zage, SESSION: Experience reports: testing and fault correction table of contents, Ball State University,

Summary

This study analyzed fault detection, identification, distribution, and device removal techniques through software development processes. Faults were documented beginning early in the requirements phase, and faults from problem reporting records were tracked back to their origins as well. Problem reports required the entry of 35 fields, including the development phase when problem was identified and the development phase of origin, categorization by severity and fault types, detection methods, and fault resolution. Results were extracted from classifications of faults on several dual axes, including by development phase and severity. Results show that 75% of the faults originated in early phases of design in the development life cycle, and a minority percentage from coding phases. However, these results were compared to conventional processes and show that diverse development processes (SDL in this case) result in variations of fault origination. One third of faults were removed during early stages, another third during intermediate phases, and 15% during later stages. Half of design phase faults were not detected until testing phases, due to the increased inefficiency of fault removal during this phase. It was also determined costly to remove faults that aren't detected in their origin phase.

Highlights

Problems caught early in the development process can minimize the cause and cost of more problems later in the process. Classification of problems and problem reports may inform the distribution of problems and where problem reporting can best be supported. Statistical analyses of types of problems that are most common may also be useful for determining methods to support the majority of problem types.

MoRé

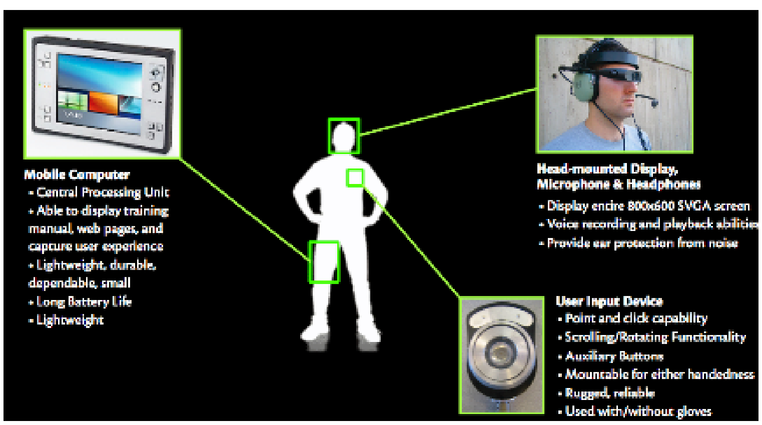
From more.doc - Brian Ellis, Anand Gopalkrishnan, Yong Woo Rhee, Aashni Shah, Wen Shu Tang, Dan Zinzow, Carnegie Mellon University Human Computer Interaction Institute

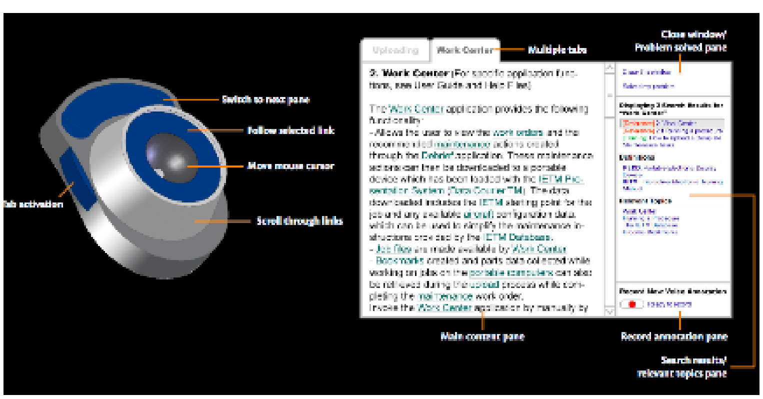
Summary

MoRé is a system the was developed as a generally tool for helping maintenance crews work on aircrafts, both in training and regular maintenance. The system will work with any set of training or reference manuals. The researchers identified a number of hardware constraints:

- No small parts could fall into the plane, get lost, or protrude more than 1/2 inch from the technician's
- Must be rugged enough for high temperatures and harsh environments
- Must be usable in various lighting conditions
- Most be usable with or without gloves
- Must have no large, flat screens or keyboards

From a software side they needed easy navigation an ability to make annotations. Interestingly, they decided to focus instead of just making a handheld device into making a wearable systems since the expectation is that this is something they would need all the time. Although it was disappointing that they didn't measure how people liked the system.





Highlights

The MoRé group did not use a mobile computing device as but instead used the laptop http://www.oqo.com/, which is a small portable pc and built a holster that made it mobile and wearable. They also used audio annotation to provide more information. Tagging and linking to other documents was also supported. Detect if certain manual pages are repeatedly viewed and prompted user to see if they wanted help.

FieldWise

From fieldwise.pdf, Henrik Fagrell, Kerstin Forsberg, Johan Sannelblag, Viktoria Institute

Summary

FieldWise is a system developed for evolving and interdependent tasks. Fieldwise can organize tasks using deadlines and time-critical information. The system relies on the creativity of autonomous but interrelated people through a culture of cooperation and sharing. The people that use Fieldwise are both mobile and distributed.

The system allows for collaboration by informing mobile users who to get in touch. This is often difficult, since they are geographically isolated. Also, annotations of others are be displayed based when relevant. The system also dynamically changes the display of information based on the speed of the connection to the server maintain speed system use even when their were low bandwidth connections.

Highlights

Fieldwise can shape future posts by providing past information. It links with manuals so that terminology is the same. There is a distinction between long-term and short-term information needs. It has a dynamically generated UI, based on bandwidth.

Text Entry for Mobile Computing

From text entry on mobile devices.pdf, Scott MacKenzie and R. William Soukoreff, York University

Summary

This article is about optimizing mobile text entry. It predicts that movement minimalization will become and important theme for text entry. Currently there are two main classes of text input: pen-based and keyed. Keyed input comes either from a pad or a full keyboard. Number pads generally implement the T9 phone system. A lot of full keyboard devices continue to use qwerty keyboards (blackberry is a popular one).

Highlights

Successes in text entry for mobile devices depend on limiting the space of possible words immediately and as such providing a short list rapidly. Also, it is important to acknowledge that we have not yet solved the problem of text entry: there is a great deal of room for performance increases. Novices are still very slow at text entry while experts are much faster.

A Review of Mobile HCI Research Methods

From mobile hci methods.pdf - Jasper Kjeldskov and Conner Graham, Deparment of Information Systems, University of Melbourne

Summary

This article explores different ways to explore mobile HCI methods. It lists and then describes in detail such methods. Case Studies, field studies, action research, lab experiments, survey research, applied research, basic research and normative writings are among the techniques described.

Highlights

This paper might be useful to return to when determining what methods to use next as it describes why and when you would use these methods and what it will help you discover with respect to mobile devices.

CM3 Problem Management

From CM3_Report.pdf, Kajko-Mattsson, Dept. of Computer and Systems Sciences, IT University

Summary

CM3 Problem Management is a European problem management process model, created within ABB, directed at corrective software maintenance. In order to evaluate CM3, the process models of a variety of organizations (19 in all, some as component parts of the larger ABB Group) were investigated and categorized by a number of measures, notably including the recording of problem reports, the description of software problems, and problem investigations.

The majority of organizations reviewed had formal processes for the reporting of problems. However, several had differing, more informal strategies, mainly oral or written communications directly between stakeholders. The effects of this informality included the non-recording of cosmetic problems, differing standards of reporting from engineer to engineer, and the erasure of all problem reports after the solution of the problem.

Templates used to structure the descriptions of problems always included general descriptions of the problem, but rarely distinguished symptoms and consequences. About 5 of 19 included a field for descriptions of the conditions required for the problem to occur, and about 10 of 19 included a field for describing the reproduction of the problem. However, the actual rate of use of these fields on the formal template was not described and presumably not researched in depth. Most organizations included the capacity to attach files to the report, but the use of this capacity was also described.

Highlights

12 of the 19 organizations require that engineers report problems encountered during the problem management process to address them, however, trivial, while 3 never recorded these problems, instead fixing them silently. 17 organizations constantly revised the problem reports as more data emerged over the course of problem management.

7 organizations admitted their engineers had problems understanding the software system they were trying to fix; although the rest claimed their engineers had no problems, they could not supply any proof to back up this assertion. Time required to completely understand a problem system may range from half a day to several months.

Abaris

From Abaris.pdf, Julie A. Kientz, Sebastian Boring, Gregory D. Abowd, and Gillian R. Hayes, College of Computing & GVU Center, Georgia Institute of Technology; University of Munich

Summary

Abaris is an automated experience capture and access system designed for increasing the ability of teams of therapists to conduct evidence-based intervention approaches with autistic children. After the success of a 4-month test deployment, Abaris was found to be a success, although possible redesigns were highlighted. As the system depends on immediate recording of observed problem behaviors emerging from a complex system (in this case the child) into a centralized database, there are some analogies.

Abaris' success derived from its use of Anoto's digital pen and paper technology, which allowed the system's interface to as closely match the existing practices of trained therapists as possible. The developers credit this close match with the success of the system. While Abaris also tested Nexidia's voice recognition interface, and also a hand-gesture-based interface, neither provided enough benefit to justify their presence within the system.

Therapists frequently pick up where others leave off, and different definitions and work practices between therapists is known to cause significant problems. "Local jargon" between therapists also foiled the voice recognition system.

Two metrics used to gauge the success of the system were the decreasing proportion of time spent doing paperwork to time spent with the child, and also the increasing likelihood that therapists would adhere to best practice by recording behavior before rewarding the child, rather than after.

Therapists said that Abaris helped structure their sessions more than without it, even though that was not the purpose of the tool.

Highlights

Automated video capture is promising for interpreting both the presence of an indicator, and its absence; the latter is easily missed.

Ability to see all data collected on a single screen helped the team of therapists review the data together, rather than one person with one screen, gaining more familiarity with the child.

Understanding Handheld Use and Adoption

From understanding_mobile_devices.pdf - Suprateek Sarker and John D. Wells, College of Business and Economics at Washington State University

Summary

The areas of mobile communication and mobile commerce are confusing, yet confusion is abundant. Much of the existing literature dwells on the description of technological leaps and the economic implications, largely ignoring the fact that without widespread acceptance of mobile devices the promise of mobility can't be realized. Mobile device adoption occurs for a variety of reasons, including

- if the functions of the device are useful
- to remain in contact with friends, ability to call people who otherwise would not be contactable
- to kill waiting time, such as on a bus, by checking emails or surfing the web
- to strengthen relationships by having conversation in waiting times
- in the US especially, there is an expectation of continuous availability and responsiveness
- mobile devices in some societies viewed as young, cool, rich
- sense of safety/security while travelling
- sense of detachment without devices (feeling "out of the loop"
- sense of self-worth professionally
- enable user to take care of business and social obligations throughout the day rather than taking care of everything at a workstation

Highlights

Technological self-effacy is the individual's degree of confidence using high-tech devices. This paper found that those who have previous experience with mobile devices and a high level of technological self-effacy had more difficulties switching to a different device. Reasons for this include "a different set of features, sequence of keystrokes to complete a task, and expectations of performance in comparison to other devices."

- In a study, users were shown to be forgiving of the physical limitations of a device due to technological constraints but were bothered by flaws in the logical interface of the device, such as functions being hidden under submenus or hard to figure out.

- Users' willingness to use a mobile device to communicate with superiors was shown to partially exist because of "power difference" within that person's culture. In high power distance cultures such as Korea, using a mobile device to send a message to a superior is a serious offence. In low power distance cultures such as Norway, it is not seen as offensive.

Medical Device Problem Reporting for the Betterment of Healthcare

From Medical Device Problem Reporting for the Betterment of Healthcare.pdf, Health Devices in Guidance Medical Journal

Summary

Common occurrence: nurse observes an infusion pump associated with under-delivery of medication to a patient sends the device for repair. The biomedical engineering dept examines the device, finds it to be working properly, and sends it back to service. Ideally, in this scenario, if the problem were appropriately reported then risk management, nursing, and pharmacy staff might review procedures for using the pump and identify that a lack of training led to the incident.,

Effective problem reporting helps prevent problems from recurring and helps meet the requirements of the government, insurers, or certifying bodies.

Some obvious trends in problem reporting are for multiple reports of broken (and unsterile) packaging in specific lots of a product or early failure of a brand of defibrillator batteries.

Highlights

An effective problem reporting system "accurately determines which problems should be reported and provides a mechanism to make, act on, track reports, and to track any corrective actions." Problem-reporting systems can be grouped into three areas:

1. in-house reporting systems
2. private, non governmental systems such as ECRI's Problem Reporting System and User Experience Network (UEN)
3. Systems maintained by government agencies, such as the FDA, Medical Device Reporting (MDR) system, and the UK's Medical Devices agency (MDA)

What kinds of problems should be reported by a hospital?

- heath-threatening problems
  - (wrong dosage, occurrence of airway fire during tonsillectomy, mislabeled packaging)
- difficulties and nuisances
  - (incomplete distribution of service bulletins, poor seals leading to device corrosion)

What should be included in a report?

- Identifying info
  - (patient's name, physician, device user's name)
- Description of the Incident
  - (what happened, how, why, when, where, what outcome was, any other pertinent info)
- Who receives report and actions they take

(someone to ensure that there is a system in place to evaluate the problem, act on it to prevent recurrence, report as required or requested by outside agency)

Steps that should be taken next:

- review & follow up on internal report
- document findings
- make recommendations for corrective actions to prevent future occurrences
- ensure corrective action taken
    - have risk manager/safety committee order preventative measures
    - follow up to ensure preventative recommendations implemented
    - complete required regulatory reports
    - provide report summarizing problem and resolution
    - retain appropriate documents & materials

A Paradigm Shift: Alternative Interaction Techniques for Use with Mobile & Wearable Devices

From paradigm_shift.pdf - Joanna Lumdsen and Stephen Brewster, Department of Computing Science, University of Glasgow

Summary

Paper conducted two experiments on hand gestures and audio cued interfaces. They found both demonstrated that novel interaction paradigms based on sound and gesture have the potential to address issues concerning the usability of, and standard interaction with, eyes-free mobile use of mobile devices.

The accuracy of "eyes-free" hand gestures has improved with introduction of dynamic audio feedback. The simpler the audio design, the better. Results suggest that there is potential for substantial recognition and recall of audio signatures for gestures. Participants overall considered this system comfortable, making it more likely to be acceptable to real users.

Non-visual interaction paradigms can be used effectively with wearable computers in mobile contexts. These avoid visual displays, which can be hard to use when mobile due to requirements of environments.

Highlights

- Desktop user interface design originates from the fact that users are stationary and can devote all of their visual resources to the application. In contrast, mobile users are typically in motion and cannot devote all or any of their visual resource to the device - their attention must remain with the primary task, often for safety reasons. Despite this, most mobile and wearable computers are based on those of desktop GUIs. These researchers believe that with the imminent dramatic increase in network bandwidth available to mobile devices and the rise in the number of services, new interaction techniques are needed to effectively and safely use mobile devices.

    - interaction must cater to user's needs to navigate through his/her environment while using mobile device, so this is likely to necessitate interaction techniques that are "eyes free" or even "hands free." These need to provide adequate feedback as to alert users of the progress of their interaction.

    - little has been made of physical hand and body gestures for input on the move because previous solutions involve chords to learn ("The Twiddler"), or stylus writing which is hard to use while moving

    - experimental studies show for music players show audio/gestural interfaces are significantly better than the standard, graphically based media players

    - one effective non-visual system - "Bullseye" by Friedlanderm, Schlueter, Mantei, "When Fitt's Law Doesn't Fit", uses concentric circles divided into quadrants - non-speech audio cues like beeps used to indicate when a user moves across menu item

- system this paper tested - user wears pair of lightweight headphones, InterSense InterTrax II tracker placed on headphones to detect head orientation. Xybernaut MA V running windows on user's belt and a PDA attached to belt via clip. User's head in the middle of a menu "pie" with sounds or speech for the menu presented in a plan around user head. Nod gestures bring up functions.

- other sound interface systems:

1. egocentric - sounds placed at 4 cardinal points around head (fastest ave. time)
2. exocentric, constant - four sounds arranged in line in front of user's head
3. exocentric, periodic - interface like 2. but sounds played one after another

- hand gestures systems used - for instance sweeping finger gestures across screen for "next track" or volume.

- the "attachment" of the wearable device shown to be the biggest obstacle to comfort

PRACA Enhancement Pilot Study Report

From PRACA Enhancement Pilot Study Report Unix File, David Korsmeyer and John Schreiner, NASA Ames Research Center

Summary

This paper documents the findings & recommendations of the Design for Safety Program's PRCA Enhancement Pilot Study of the Space Shuttle Program's (SSP's) PRACA system.

Highlights

Problems in the old PRACA system -

1. Vagueness in the definition of PRACA, its intended use, customers, and users that allows the inaccurate impression that PRACA meets the SSP's needs.

2. Current PRACA has technological basis, implementations are insufficient to fulfill program-level data mining and safety assessment.

UI & trending problems in current PRACA system:

- UI for all systems inconsistent or non-existent. Interfaces assume a specific user type that is different across all the element of PRACA systems which prevents simple navigation across all PRACA systems.

- trending & analysis often performed using non-PRACA systems or only accessing PRACA data as a portion of the data used. This has allowed PRACCA to evolve with insufficient data for statistical tending and insufficient supporting information for identifying data relationships in support of data mining.

- The SPP office and its project-level management currently meets the necessary condition of having enough problem reporting data and insight by relying on a set of domain experts possessing extensive knowledge of the shuttle subsystems and the PRACA data. These experts have access to additional non-PRACA data sources and produce consolidated reports and summaries for the SSP from which the SSP performs its tasks and formulates decisions. This is a time-consuming, labor-intensive, and workforce skill-level dependent process.

- For trending and risk analysis, additional data are required to produce results of statistical significance. These data are generated by grouping, or from augmenting databases. **Some data are "scrubbed" during reporting to present a correct result. Additional data are scrubbed by staff distant from data acquisition and intimate knowledge of the possible reason of questionable entry.**

Database & Data Management Problems

- Database schema & data fields collected are incomplete, inconsistent, not structured for data analysis

- The different disciplines' definitions of PRACA data field values yield different interpretations across the PRACA systems

- the United Space Alliance's ADAM data warehouse is a unified store for PRACA data and some associated information, but provides no mapping across various schemas or data field-naming conventions. This means that queries across the PRACA systems are via an undocumented interface that cannot be extended.

- PRACA is currently dependant on paper records, which leads to transcription errors

- There are multiple data sources on maintenance, repair, corrective actions, & engineering dispositions which are used to generate reports to the SSP but are not cross indexed with PRACA data.

System & Network Architecture

- Computer system hardware implementations supporting PRACA data management are all unique

- Network access to relevant data difficult due to location of PRACA systems throughout NASA

- Security incomplete & inconsistent, i.e. inconsistent authorization & authentication processes

- No SSP security policy for system implementation and data protection

3. A unified PRACA system as an organizational/programmatic entity does not exist

- creators & element level mangers of PRACA don't view their systems as program-wide

- WebPCASS and ADAM/IPAS projects are consolidating access to data in many of the PRACA and related systems, but that system isn't being designed for management of analysis of that data

-The element-only focus results in systems not useful for program-wide assessment and data analysis

- The user of PRACA data as a resource to access the program-wide safety and risk of the shuttle is a laborious and time-intensive effort

4. The motivation and requirements for the SSP PRACA system and its procedures and processes are unknown to the majority of data providers and collectors

- Collectors of PRACA data unaware of value and potential use of data gathered

- Collecting supporting PRACA data (eg data needed by the SSP for problem background and broad problem documentation to support data mining) not consistent with efficient workflow

- Element level training of use of PRACA incomplete

Recommendations:

- SSP should clearly define what PRACA is, where it should be used, design a PRACA system that can be used by all, establish plan for evolution of PRACA

2. Technical foundation of PRACA should be developed and enhanced so it is capable of supporting breadth and depth of SRQ & MA analysis. This includes enhancing the ADAM data warehouse with a consistent database schema and structure, standardizing COTS database applications, decreasing external data sources. User interface should be simplified and standardized to allow east of data access, cross-system navigation, and data analysis with managed knowledge sharing.

3. A clear set of SRQ&NA trending and analysis requirements should be developed.

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Assessment of the NASA Space Shuttle Program's problem reporting and corrective action system

From Assessment of the NASA Space Shuttle PRACA.pdf, Korsmeyer, D.J., Schreiner, J.A., NASA Ames Research Center

Summary

This is going to be a very useful paper. It is a reasonably thorough analysis of the PRACA system on four different levels: User Interface, Database and Data Management, Network and System Architecture, Problem Reporting Work Processes. One major problem that was highlighted was that the PRACA system is fragmented between departments and centers. In order to consolidate the database, a combination of paper systems, databases, and knowledge from expert individuals would all have to be tapped into. The theme of undocumented expert knowledge comes up repeatedly in the study as a barrier to both the scalability and longevity of the PRACA system. An interesting finding of the research is that much of the problem with the current PRACA system has to do with the fact that is perceived to be working quite well. As such, many questions about how to make it better have not been asked. It seems form the report that there are experts who are able to easily navigate the system and perform useful analyses, but that if they were to leave the group, it would no longer be possible. It is for this reason that the positive perception of the PRACA system may not accurately reflect its actual efficiency.

Additionally, there are informal databases that have been formed of data that is not originally from PRACA. These databases are only navigable by experts. It seems that the current system is not usable for the novice to intermediate user, but that it should be. This should be kept in mind as we are building our prototypes down the line. Some of the people who are doing trending and statistical analyses will be near-novice users. They presently make mistakes because the entered data is unclear and devoid of important context. NOTE: There is something called ADAM that was an attempt at consolidating PRACA. STOPPED AT RECOMMENDATIONS. The recommendations of the study are based around a series of questions about PRACA's current functioning (cited below). The final recommendations of the study include: add to the user base by making the interface easier to use, capture expert knowledge somehow to make turnover less of a problem, and integrate all PRACA systems into one database.

Highlights

"The Study determined that the extant SSP PRACA systems accomplished a project level support capability through the use of a large pool of domain experts and a variety of distributed formal and informal database systems. This operational model is vulnerable to staff turnover and loss of the vast corporate knowledge that is not currently being captured by the PRACA system."

The progress of this Study was greatly aided by the tremendously dedicated and hard working individuals supporting the Space Shuttle Program. Everyone we spoke to through the course of this Study was highly cooperative and willing to assist us in completing this assessment and to ensure a continued safe Space Shuttle System.

The current approach employed in the PRACA deployment does not scale or adapt easily to changes in workforce or technology. Further. the expert knowledge that is required to utilize the PRACA systems is not captured or documented. As a result, the current PRACA system is not capable of supporting risk-assessment functions performed at the Program-level.

a. Establish uniform standards to ensure safety, reliability, and quality of SSP.
b. Establish the requirements/procedures to assure problems are dispositioned prior to flight.
c. Ensure appropriate corrective action is taken in a timely and cost effective system.
d. Provide the problem data necessary to support engineering analyses and logistics management.

It is these two dissimilar requirements (workflow efficiency vs. extensive problem documentation) that are at odds in the current SSP PRACA systems.

It is important to note that reports of any sophistication (i.e., data mining, detailed cross PRACA correlations etc.) cannot be generated in real time using the on-line PRACA systems alone.

The expert knowledge that is required to utilize the PRACA systems is not captured or documented.

The data collection workforce is not currently trained in PRACA system Program data needs and usage.

Many of the visions expressed by NASA senior management for the ideal PRACA System include a prognostic capability with data search, navigation, and mining that extends across the Shuttle Program.

1. The Project/Element domain expert view:
PRACA should remain a collection of relatively simple databases that support the work process and record-keeping functions. These databases are designed primarily to support the domain experts who are responsible for reporting Project/Elcraent status and trending to the SSP. The domain experts would prefer that the SSP continue to rely upon the domain experts for data extraction, filtering, analysis, interpretation and reporting from the PRACA databases and other sources.

2. The Fund Source (SSP/NASA s Human Exploration Enterprise_ view:
PRACA is a multi-center clam system that is vital to the SSP mission. The domain experts role in the PRACA system is consistent with the team problem resolution approach and is not seen as a potential problem. Ongoing reviews and relatively stable workforce will sustain the system s viability into the future. Additional work on PILACA should be justified based upon new capability.

3, The NASA Information Management view;
PRACA should be a state-of-the-an data warehouse capable of data mining and advanced data analysis and trending using a simple and uniform point and click interface. The system should preclude data errors, incomplete problem tracking, and catch potential problems that might otherwise go undetected (e.g., escapes and diving catches). The system should reduce the sole dependence on domain experts and corporate knowledge, placing the power of top-level
knowledge and information in the bands of anyone with access to the system via a simple user interface. Additionally, advanced data mining capabilities would support the SR&QA analysts to improve the speed and

accuracy of their assessments. With the Shuttle expected to fly another 25 years, the system architecture must be dynamic and capable of overcoming changes in workforce, technology, and flight rate. The system should be enhanced to provide a foundation enabling the future implementation of a safety and risk prognostics capability. The system should serve as a model and pathfinder for the Agency.

The SSP-identified PRACA owner needs to make a global assessment of PRACA with both a short-term and long-term view.
It is important to answer vision-defining questions such as:

- Is PRACA sufficient for the SSP needs? if so, for how long?
- Is PRACA to be a cutting edge information management system? Is it to serve as an example for Agency emulation?
- Is PRACA to look beyond SSP focus to leverage other safety and reporting systems? (Aviation Safety Program,
Commercial aviation scheduling and planning systems, model-based reasoning systems, digitized Shuttle systems.
other NASA PRACA systems, etc.)
- What is the evolving role for PRACA looking into the next 25 years?
- What is the relationship of PRACA to the changing NASA workforce? And how does that impact PRACA functionality over time?
- Is PRACA to be the foundation of a Safety and Risk Prognostics System for the SSP?.

It is equally (if not more) important to answer design questions driving the requirements such as:

- Who are the customers for the system s data?
- Who are the users of the system?
- Who are the managers of the system?
- What skill level(s) is expected of the owner, customers, users, and managers of the system?
- What is the security level of the data in the system, and what is the desired visibility in the community?
- How large a dependence on expert knowledge and human interpretation is acceptable?
- Is it permissible/desirable to use data outside of PRACA (and PCASS) or should PRACA be the sole source of data
access?
- What are the roles of the Program office as an owner, user, and a customer of PRACA information?
- What is the role of PRACA at the data collection level? At the Program/Element level?

Recommendations:

- Clearly identify (list) the Program-level PRACA tasks from a Program-wide perspective
- Establish requirements for a PRACA System that performs SSP level PRACA tasks (dam retrieval, mining and
trending needs). This action should be performed without consideration of current PRACA capabilities.
- Design a PRACA System that satisfies these requirements.

* Either a) Implement this new system or b) Initiate a modernization activity to upgrade the current PRACA systems
and designs to satisfy the requirements.

- Replace or enhance the existing WebPCASS proposal based upon the above decisions.

Integrating Theory and Practice

From Integrating Theory and Practice.pdf, Stark, M. Integrating Theory and Practice. Goddard Space Flight Center

Summary

This paper is a discussion of analyzing product line engineering by way of a quality improvement paradigm. It begins with a series of steps to analyze the current process, culture of the organization, and other factors. Next, it incorporates that knowledge into a structured model for re-engineering the process. What we got out of this paper is how to analyze NASA's current culture, values, and problem reporting system with this model. This analysis is based off of four factors: assets, stakeholders, business model, and processes. Included is a study of how much processes rely on certain assets, quantification of improvements to the system, and the extent to which our process can extend across products/organizations. A helpful application of this theory would be to apply it to all of our CIEs and see its implications on a potential solution to their breakdowns. Once we are able to do NASA CIs, we would then have practice in performing this sort of analysis.

Highlights

Process evaluation:

- Project learning
- Post-analysis

Product development:

- Domain engineering
- Architecture
- Implementation
- Test