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A REVIEW OF ISEAS DESIGN

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1. Introduction.

The Space Station Freedom will offer facilities for experimentation and testing not available and not feasible or possible on earth. Due to a restricted space availability on board, the experimentation equipment and its organization will be frequently changing. This requires careful attention to electromagnetic compatibility between experimentation and other SSF equipment. To analyze the interactions between different equipment modules, a software system ISEAS [6] is under development.

Development of ISEAS was approached in two phases. In the 1st phase a PC version prototype of ISEAS was developed. In the 2nd phase, the PC prototype will be adapted to a VAX range of computers. The purpose of this paper is to review the design of the VAX version of ISEAS, and to recommend any suitable changes.

2. Architecture of ISEAS.

ISEAS consists of the following components: interactive interface, analysis module, output module, and data base containing data used by analysis routines. ISEAS user communicates via the interface his requests for analysis instances, types of analysis result displays, and supplies appropriate data. The interface will be implemented using ORACLE/SQL relational database environment running on a VAX platform. User's requests are passed to the control module which performs the analysis. The analysis routines will be implemented in C. The output module offering different ways of result's presentation will be implemented in Fortran. The data base will be created using the services of the ORACLE/SQL running on a VAX platform.

3. Design methodology

ISEAS is to be developed using a structured software approach [3, p.4]. Structured methodology offers a methodical approach to development, yielding good system design, correct and efficient data model, smooth implementation, and a basis for ease of maintenance. The methodology spans a whole software life cycle which consists of essentially sequential phases: Project initiation, Requirements elucidation, Feasibility study, System Analysis, System Design, Implementation, Testing, Installation, and finally System Review. Once fielded, the System Maintenance follows.

The review is limited to Analysis and Design Stages. The purpose of the Analysis stage is to consider what is to be done and what are the system's data requirements, while the purpose of the Design stage is to consider how it is to be done.

3.1 Deliverables

At each of the Software Life Cycle stages, structured software methodology predicates a number of deliverables. The System Analysis stage requires the following deliverables: 1) Context Diagram which presents a top level design of the system addressing its purpose and main functions, 2) Data Flow Diagrams which present processes within the system, functions that system will perform, and flow of data as these processes and functions are invoked, 3) Data models expressed via Entity Relationship Diagrams (ERD) which present the various data entities and relationships that are recognized by the system, 4) Decomposition Diagrams which present the logic of the system through hierarchical structure of the modules of the system. The System Design stage requires: 1) Transition Diagrams which present a reorganized Decomposition Diagrams after taking into account the module types in addition to their functionality, 2) Structure Charts which present the structure of system modules and their data interfaces, 3) Pseudocode or Action Diagrams which present the actions defining the modules.

3.2 Data Normalization

A Relational Database consists of data items, relations among them and operations that can be applied. Whereas "primitive" operations are defined by a chosen relational database -- in ISEAS case it is ORACLE -- definitions of relations are left to the system designers. To assure efficiency, to avoid data redundancy and inaccessibility, to protect against data loss, etc., the data must be normalized. It is a common practice to expect the relation tables to satisfy at least the first three (Codd) Normal Forms which present essentially steps for relationship transformation with the aim of assuring elimination of various anomalies (in particular data modification anomalies).

4. Review findings

The following summarizes review findings. A more detailed exposition can be found in [Bykat, 1993].

[3] presents ERD, Structured Charts, and Pseudocode. Omission of the other four items results in missing documentation of modules, inconsistencies, and possibilities for module design improvement. There are violations of the Structured Charts presentation semantics. Pseudo-code for a number of modules is missing.

Database table are presented but show violations of the first three normal forms.

Backup requirements as well as requirements concerning support of local and remote users [2, p.53] have not been addressed.

5 Conclusions.

ISEAS is a needed and timely project. The proposed version offers fundamental capabilities but requires further technical (EMC) development and evaluation of the offered capabilities and their functionality. In particular, current calculations view the equipment and their components as "point sources". The size of the equipment, the location of a component within the equipment are not taken into consideration.

EMC analysis recommendations are essentially diadic: pass or fail. This could be addressed by calculations for repositioning the equipment to find a location in which initially failing equipment would pass the EMC criteria. A further extension would be finding optimal configuration of a given equipment for EMC purposes.

6 Recommendations.

The recommendations fall into three categories. The first category relates to the strategy of ISEAS development, the second category relates to technical issues, while the third category presents a path for further development of ISEAS.

6.1 Strategy.

The main goal of the ISEAS project is to provide a tool for evaluation and analysis of EMC for the Space Station Freedom. This goal should be enlarged to "provide a tool for evaluation and analysis of EMC for the EMC community at large and for the Space Station Freedom in particular".

There are a variety of applications where ISEAS (or its descendant) delivered on a workstation platform would be of considerable benefit. Many of these applications are in commercial areas (aircraft manufacturers, land/water-based vehicle manufacturers, etc.), while other are in government agencies (Navy, Air Force, etc). In such applications EMC considerations are important, if not critical (eg. interference with navigational equipment, etc.).

NASA is now at crossroads, searching for ways serve broader national needs". This will lead the agency towards much greater involvement in private sector through attempts to "push technology through the federal door and into commercial marketplace"[1]. Such involvement has to be contemplated and planned a priori rather than as an afterthought. ISEAS offers an opportunity for such involvement.

I recommend therefore development of a VAX version in parallel with development of a workstation version of ISEAS operating in a multitasking Unix environment supporting X11 windowing environment, and with a suitable relational database.

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[1] speech by Rep. Alan Mollohan (D-W.V.) delivered at the 31st Goddard Memorial Symposium, 3/9/93 (Space News, 6/14/1993, p.19)

6.2 Technical.

R1. Develop Data Flow Diagrams and Decomposition Diagrams. Revise and complete Design Phase documentation. Gain: Lead to correct structure of the system.

R2. Complete the normalization of data. Gain: Avoid data modification anomalies.

R3. A user interacts with ISEAS in two distinct modes: define and select. ISEAS code should adopt the same philosophy in presentation of forms and screens for data/request entry. Gain: ISEAS code will be much shorter and much more efficient.

R4. Partial description of entities during data input should not be accepted by ISEAS. Gain: ISEAS code will be much shorter and much more efficient.

R5. Before the input of new data affected files should be preserved as prior versions. Gain: efficient restoration of prior version.

R6. Extend analysis selection capability to allow any combination of analyses to be performed. Gain: Batch mode execution of analyses.

6.3 Future development.

An intelligent object oriented interface for ISEAS should be developed to offer ease of use and functionalities which current version lacks. It should offer a graphical mouse-relocatable component and connectivity icons to aid graphical environment data input, visual validation, and reconfiguration of analyzed environments. It would allow improved presentation of results through a 2-dimensional "interference regions", easing subsequent graphical modification of equipment configurations.

Electro-magnetic compatibility analysis is a ripe candidate for further automation through knowledge based methodology [4, 5]. Development of EASE-MagIC, an Expert Analysis System of Electro-Magnetic Interference and Compatibility, would serve this purpose. Such a knowledge based system can offer evaluations controlled through heuristic rules, on demand instructive explanations of the analysis and its conclusions, and through such explanations -- coupled with the proposed graphical interface -- it would offer a sophisticated tool for EMC training.

7. References.

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