SYSTEM DESIGN METHODOLOGIES

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ABSTRACT

This purpose of this paper is to show how structured programming methodologies, used in the design and development of computer programs, can and should be used in the design and development of telemetry systems. One important concept presented in that of thinking of the telemetry system as a complete system from the very beginning such that a total system design can evolve "naturally". Many of the problems associated with telemetry systems today are due to the fact that the various "pieces" of the system were designed independently and without regard for each other. Also discussed are the various levels of documentation produced along with Engineering and Marketing responsibilities as they relate to systems design.

One of the main problems encountered today in data acquisition systems is that the various "pieces" of the system are designed independently of each other. Very little regard is given to the requirements that each part of the system has, as it relates to another part. By considering the telemetry system to encompass all those "pieces" and applying a structured approach to the definition and design requirements, a telemetry system can be developed which meets the needs of the telemetry industry.

There are various documents which must be produced to ensure the system being designed will meet all stated requirements and performance criteria. The documents and their contents to be discussed are:

- Marketing Requirements Document
- Product Specification
- System Specification
- System Interface Specification
- Subsystem Detail Design.

The Marketing Requirements Document is a document produced by the Marketing Department which states the capabilities of the system from a marketing stand point. The

compatability of the system with existing equipment as well as other products/systems this new system will support, are defined. Performance requirements for the system are stated. The market place the system will reach is defined and a marketing window determined. The cost of the system is evaluated and set. No engineering responsibility is incorporated into the document. This document is based on past experience, current knowledge, marketing surveys, competitor products and customer needs.

The Product Specification is a refinement of the Marketing Requirements Document by engineering, management and marketing. The purpose of this document is to clearly state the capabilities, performance and cost of the product to be designed. The refinement is based on current technology, feasibility, manpower and marketing window. This document generally goes through several iterations before all parties approve. The importance of this document cannot be stressed enough as it is the base document for subsequent product design. The Product Specification should not contain any "hows" or implementation criteria but only the "whats" or capabilities. A person reading this document would understand what the system is capable of doing.

The System Specification is the next level of documentation to be produced. It is based on the information contained in the product specification. The purpose of this document is to partition the system into its fundamental components or subsystems based on the capabilites stated in the Product Specification. The various elements of information contained in the System Specification are as follows:

Objectives

The objectives of the system should be concisely stated, clearly defined and quantified if possible. The objectives should summarize the performance requirements and goals of the system.

Functional Description

Based on the capabilities of the system, it is partitioned into functional subsystems. Current telemetry systems would be partitioned as shown in Figure 1. A discussion of the functions each subsystem performs shall be given and relationships to external hardware explained. A top level system control and data flow diagram is included to present an overall view of the interfaces between the various subsystems. Verbage discussing the control and data flow diagram in regard to peripheral equipment, external interfaces and functional interrelationships is also given.

Operational Scenario

A brief scenario of the concepts of operation shall be given, slanted from a user's viewpoint. The ordering of the various modes of operation should be stated and discussed.

Assumptions and Constraints

Basic assumptions key to the development of the system should be clearly stated. Limitations effecting capacity or constraints should be discussed. Any exception to the stated capabilities shall be noted. Additional requirements for flexability, expansion or upgrade shall also be presented. A qualitative summary of the benefits and limitations of the system should be included. A discussion shall be given that details the relationship of the system to meeting the desired goals and objectives.

The System Interface specification is a document which defines in detail the interface between each subsystem and also those external interfaces if any. The function of the interface is clearly stated. The medium for transfer and the characteristics of the data shall be detailed. The direction, content, volume, rate and format of the data are included. By defining the interface at the system level, the various problems normally associated with current telemetry systems today can be elevuated. The interface between the airborne equipment and the ground station can clearly be defined with both parties agreeing to a format which will ease the burden on both. It could be decided to support both PCM and computer word transmission and an interface could be designed to facilitate this. The interface specification will force a standardized and agreed upon interface between the various subsystems.

The subsystem Detail Design Document is a replica of the System Specification but in regards to that subsystem as opposed to all the subsystems. It is a detailed document which tells "how" the capabilities are to be implemented. It partitions that design which will be implemented in hardware verses that which will be in software. The information contained in the Detailed Design Specification is highly specific as to how the requirements are to be implemented. The subsystem is partitioned into its basic functions with a control and data flow diagram constructed. The interface between these various functions are defined and documented. This stepwise refinement continues until the functions are at the module level and all interfaces have been defined.

Conclusion

There are many more documents generated in the life cycle of a system. Those presented here were to emphasize that using design methodologies forces the communication between the various parts of a system. By considering the system from airborne to ground station, interfaces can be generated which makes adaptability and expendability easily obtained.
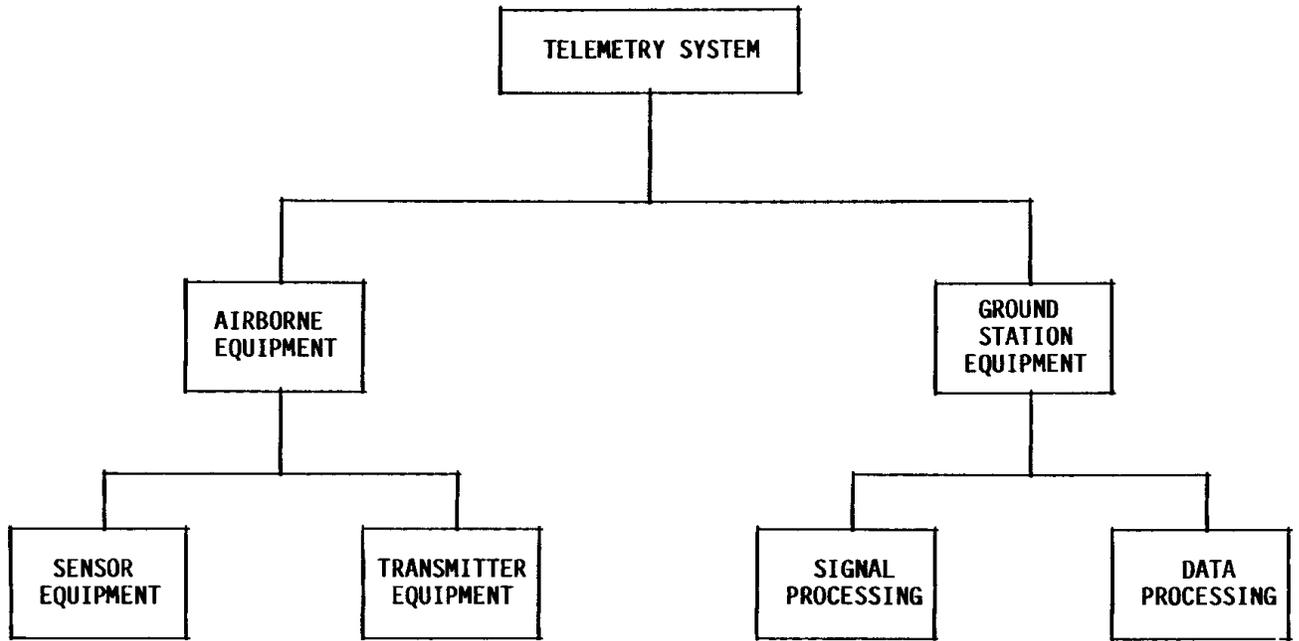
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                          │ TELEMETRY SYSTEM │
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           ┌───────────────────────┴───────────────────────┐
    ┌───────────────┐                              ┌───────────────┐
    │   AIRBORNE    │                              │    GROUND     │
    │   EQUIPMENT   │                              │    STATION    │
    └───────────────┘                              │   EQUIPMENT   │
           │                                       └───────────────┘
    ┌──────┴──────┐                                 ┌──────┴──────┐
┌───────────┐ ┌─────────────┐             ┌────────────┐ ┌────────────┐
│  SENSOR   │ │ TRANSMITTER │             │   SIGNAL   │ │    DATA    │
│ EQUIPMENT │ │  EQUIPMENT  │             │ PROCESSING │ │ PROCESSING │
└───────────┘ └─────────────┘             └────────────┘ └────────────┘
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FIGURE 1