CONFIGURATION CONTROL

MR. E. C. LUTHY
General Electric Company

The decade of the 60's may be known in the future as the decade when the management leaders of Industry and Government turned their attention to the management of documentation and the means whereby this documentation is controlled. A specific area of documentation, that of engineering data, has been further highlighted under the requirements of Configuration Management which NASA and DOD have imposed on most of their contracts. This management of engineering documentation has been generally called Configuration Control.

In January 1961, General Curtis LeMay of the U. S. Air Force directed that a survey of Industry and Air Force be made to highlight the Contractor/USAF problems that were contributing to increasing high cost of new weapon systems. As a result of this survey, AFSCP 375-2 was released in June 1963, outlining in summary form the findings of this survey. A few of the problems identified pertaining to Configuration Control are:

1. Engineering decisions made unilaterally by design groups without considering effect on other functions.

2. Inability to determine exact hardware configuration at time of shipment.

3. Inability to determine changes incorporated at field sites.

4. Manuals not updated.

5. Spares not updated.

6. Difficulty in isolating design deficiencies because of partially incorporated or out-of-phase incorporation of changes.

7. High rate of system design incompatibilities between components of a system.

8. Excessive inventory or lack of spare parts due to inadequate reidentification or part numbering system.

These particular problems all relate to control of changes and the ability to provide real-time equipment identification visibility to the various dependent users of engineering design data.

Configuration Control has always been vital to the successful design, manufacture and field maintenance of equipment. The necessity of an adequate Configuration Control system was not invented as part of the Configuration Management concept, but should have been provided for in the business system of any organization engaged in the manufacture or use of hardware. Configuration Control is essentially the means by which engineering design data are maintained to the right baseline for utilization by all functions, and provides for the ready identification of any differences between the hardware "as-is" configuration and the current engineering design.

The following list identifies some of the many dependent functions which require engineering data to support the requirements of a major hardware program:

Engineering
Drafting
Reliability
Purchasing
Manufacturing
Quality Control
Logistics
Depot Repair
Handbooks/Manuals
Field Maintenance
Computer Programming

Increasingly short time cycles for design, fabrication, installation and maintenance of hardware, as well as more complex systems, cause the design data baseline to change more frequently with time. This makes it mandatory that all of the many functions using the design data are made aware of changes to the baseline and that a methodical system of "bookkeeping" is in place to account for these changes. Configuration Control is analogous to the financial bookkeeping system in that it is bookkeeping of engineering data with similar checks and balances for accuracy. Fidelity of engineering data is equally as important as fidelity of financial data.

The General Electric Apollo Systems Department has been engaged in designing, manufacturing and, in some cases, maintaining electronic ground support and checkout equipment for current space programs. As part of our compliance with Configuration Management requirements, we established a Configuration Control System and we have also utilized it as the prime information source of a business data system.

The purpose of this paper is to advocate the integration of Configuration Control activities with those elements of your business data system which are dependent on those same elements of data control and/or maintained by Configuration Management requirements.

This paper will describe four areas of Configuration Control as they relate to a business data system.

- Configuration Identification
- Change Control
- Change Accounting
- Post Delivery Configuration Identification

CONFIGURATION IDENTIFICATION

Configuration Identification is defined as the technical documentation defining the approved configuration of systems/equipment under development, test and production. Not only does the customer require that a contractor be able to identify in detail the items delivered, but during the contractor's activity, it is obvious that many related functions are also in need of the same data in order to supply support to the program.

The primary means of identifying equipment is via drawings; therefore, if a centralized means is established for keeping current the latest drawing and drawing status definition, substantial savings in redundant bookkeeping can be obtained. At ASD, we have established the Configuration Management Identification File as the source FILE to feed all of the other related data requirements which are required as parts of our business system. It is called the Engineering Master File (EMF).

Because of the large number of different end items which we produce and the high volume of drawings associated with each, we have established the drawing identification description in a computer data bank. The advantage is that the related functions have the capability of developing specific computer programs which will allow them to obtain their specific information knowing that there is an accurate and timely source of data. As an example, reference Figure 173, based on the fact that there existed an Engineering Master File, we have developed a Computerized Manufacturing Material Ordering Management System. This system is capable of automatically producing our Manufacturing ordering document to Purchasing for each procurement item (MR); providing the definition of the assembly to be built and stock withdrawal cards for Manufacturing; and producing various reports which define the procurement activity and inventory status of each unique part on a program basis and/or for all programs in-house.

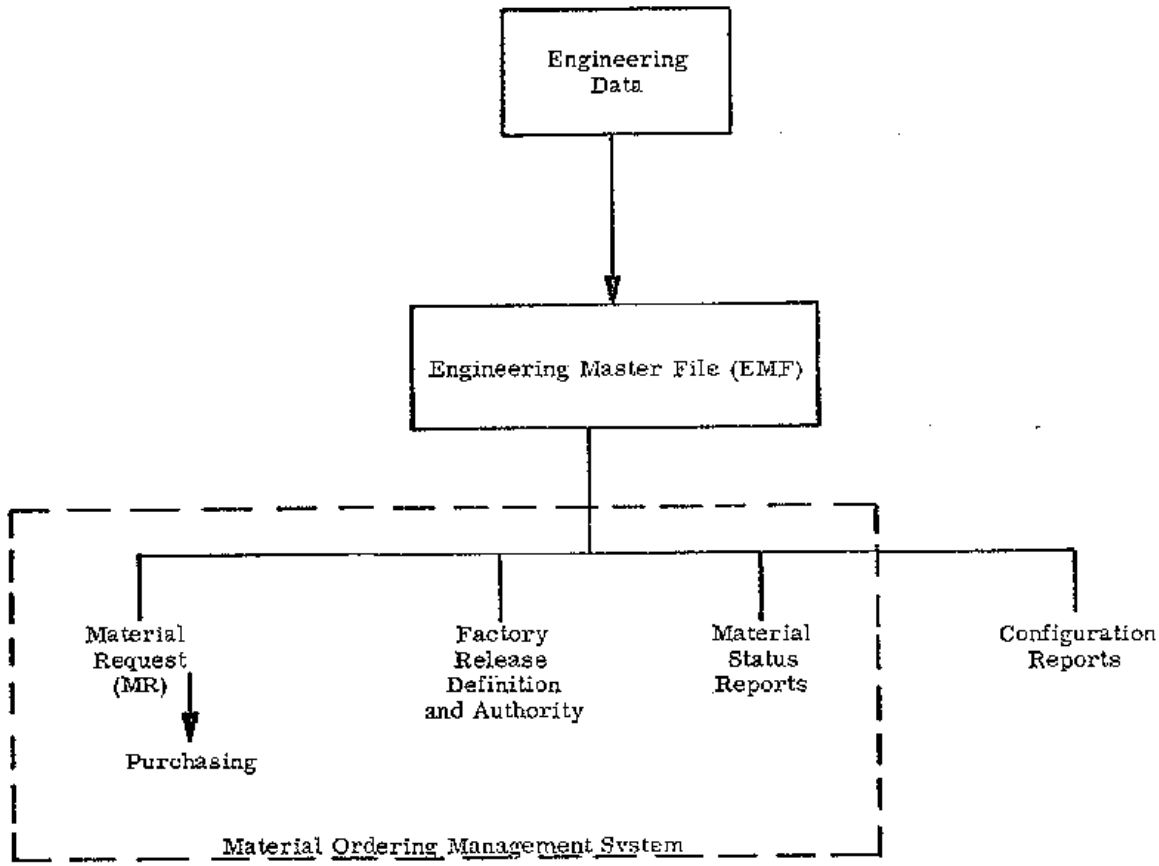

Figure 173. Configuration Identification

Besides supplying the initial data for the above system, the EMF file permits identification reports to be produced to fulfill the need of various groups. Some of these reports are: (1) drawing lists in indentured format, particularly useful in reliability analysis and for manufacturing planning; (2) lists which summarize total usages of each part/assembly, used for determining order quantities, determination of logistic requirements and for reliability assessment; (3) lists which define next higher usage of any part/assembly, which is particularly useful on large programs to ascertain all the usages of a part which may require modification.

CHANGE CONTROL

Intrinsic with the maintenance of a centralized Engineering Master File is the ability to control both the changes to the file and the ability to update the file real-time.

The recognized method of doing this is through the use of a Board comprised of representatives of the various functions of our business who have the opportunity to assess and make known the impact of a change prior to the change being authorized. This Board is commonly called the Change Control Board (CCB), whose Chairman is authorized by Management to make decisions for the Board. As Figure 174 illustrates, all changes, regardless of originator, are processed through the CCB. The CCB Chairman is responsible for preparation of the Engineering Change Proposal (ECP) for all customer requests and for assuring that all approved changes are completely implemented by determining that all engineering documentation is issued. A technique for assuring that all documentation for a change is issued, commonly referred to as "change packaging", is very important if the problem of incomplete change incorporation is to be prevented.

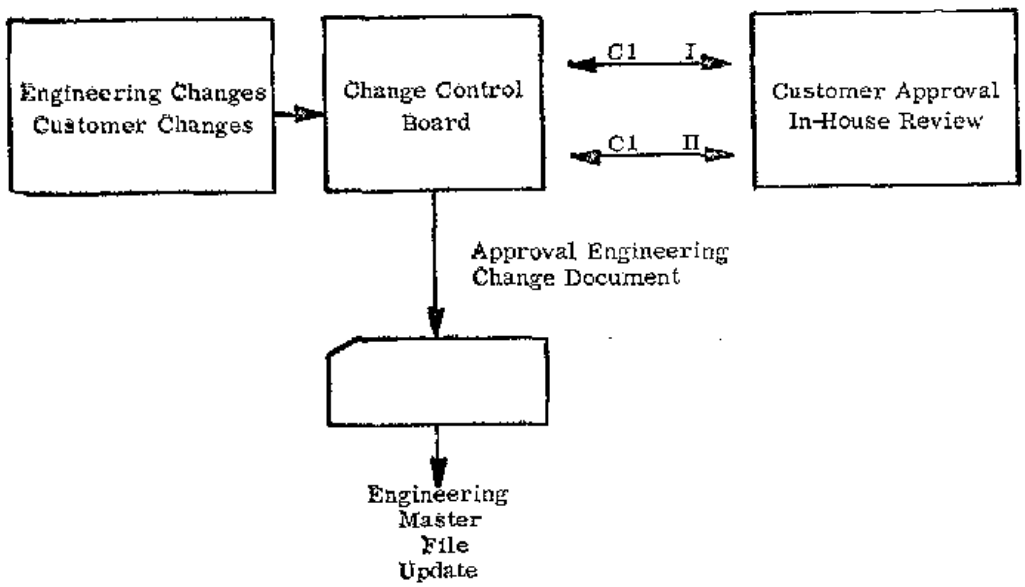

Figure 174. Change Control

To provide positive drawing identification control, only one change document form is used at ASD, and this document is not official until it carries CCB approval.

Immediately following CCB approval, the change is processed via a change update routine to the EMF file. At the same time the EMF is updated, similar EDP cards are generated for change accounting purposes which will be covered in the following section.

CHANGE ACCOUNTING

The dynamics of most hardware programs are such that drawings cannot be maintained and distributed fast enough to keep pace with the change rate, consequently, equipment is built to drawings plus change documents. The system depicted in Figure 175 is being used to assure that the equipment built to change documentation is built to the approved baseline. As mentioned earlier, when a change is approved, not only is the EMF updated, but at the same time, the change document is used as an entry of the Engineering Change Status Report (ECSR). This report identifies the change document and other related information pertaining to the change such as each usage of the part/assembly being changed, authorizing document (i.e., ECP), class of change, change packaging number, whether the change is to be retrofitted or factory incorporated and the date on which QC verified the incorporation of the change.

The establishment of the change accounting baseline is based on the drawing revision status defined to Manufacturing at initiation of Manufacturing Planning by Configuration Management. The means for doing this is a Configuration Status Sheet(s) (CSS) which is prepared for each element of the Contract End Item and lists the current drawing revision status of the equipment design. The Configuration Status Sheets are, thereafter, maintained

by Manufacturing through final factory acceptance to indicate all changes incorporated by Manufacturing. Quality Control indicates their verification of change incorporation by stamping the CSS's. The Engineering Change Status Report is utilized continuously by Quality Control to assure that Manufacturing has, in fact, received all required changes. The verification date from the CSS is inputted in the Engineering Change Status Report, thus closing out the record. During the active portion of a large program, this report carries only the unverified changes, thus directing specific attention to outstanding changes.

The Change Accounting Report serves these functions:

1. Manufacturing uses it to determine that all change documentation affecting equipment has been received.

2. QC uses the report to assure that all changes have been received and incorporated.

3. *Our Resident Customer, QC, uses it as a continuous audit tool.*

4. Test personnel use it to assure Test Procedures are up-to-date if the hardware changes affect them.

5. To identify the change effectivity (retrofit or factory).

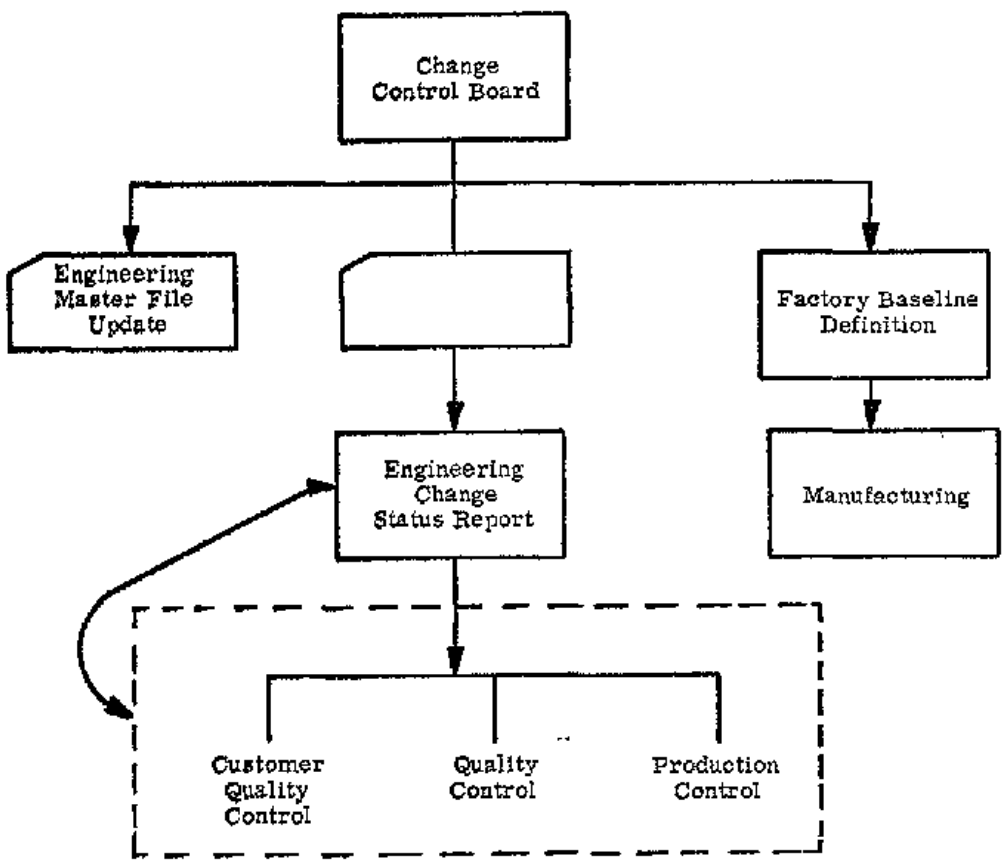

Figure 175. Change Accounting

POST DELIVERY CONFIGURATION IDENTIFICATION

Maintenance of post delivery identification requires the same essential techniques as required to maintain identification during manufacture.

The identification file, established initially, can continue to be maintained provided that proper drawing change documentation is issued, the change documentation is packaged, and a feed back-loop is established to indicate when the change is incorporated.

Discipline at the user location is essential to prevent unauthorized changes and to assure that changes are installed as authorized, similar to the Quality Control responsibility in a factory.

In today's complex organizations and complex equipment, as well as tight schedules and tight money, an effective Business Data System is essential. An effective Business Data System requires accurate and timely product identification visibility and the means to control changes to this definition in order to prevent unplanned cost and schedule complications. Coincidentally, the Government's requirements of Configuration Management require the same thing.

It is hoped that this presentation has stimulated some thinking on how to integrate your Business Data System and Configuration Management requirements into a single entity, and the advantages of doing so.

MODULAR PACKAGING TECHNIQUES AND DEVICES

MR. M. J. BERBERIAN
Sylvania Electronic Systems-East

I. DEVELOPMENT OF AN INTEGRATED CIRCUIT GENERAL PURPOSE LOGIC CIRCUIT PACKAGE (SYL/PAC)

Logic Package

Design Objective

A general purpose logic-package family was desired having the following three characteristics:

1. The interconnections on the package should be unaffected by system logic changes; i. e., all logic changes should be accommodated in the back wiring.

2. The line of logical building blocks should have applications in a wide variety of digital equipments and contain a wide variety of digital circuits.

3. An economical production package design should enhance the design and construction of prototype systems.

In short, a design was desired which would be flexible, economical, and equally appropriate to a single development system or to a large production run.