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AN INTRODUCTION TO AUTOMATED PRODUCTION CONTROL SYSTEM

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At a time when industry was small, with the owner as operator, no necessity existed for manufacturing control. The proprietor could keep many details in his head or in a memorandum book. Today's volume of record keeping is burgeoning. During the past half century, the number of clerical workers has risen at more than double the rate of industrial workers, with the cost of such labor constantly increasing. The entire field of planning is more difficult and intricate than in the past.

These factors have resulted in a trend toward mechanization of the manufacturing control system. Industry, however, has been slow to adopt completely mechanized methods, and totally automated production control systems are today the exception rather than the rule. Typical areas which have been automated include payroll, sales analysis, and accounting where the data can be collected in batches and processed. A control system tends to the integration of activities.

It is the purpose of this paper to present in abridged form a synthesized procedure for control of production using punched-card methods. The system may be considered a framework for application to any manufacturing enterprise engaged in the fabrication and assembly of parts, regardless of product. Machines are used to record and coordinate all paperwork involved in manufacturing from time of raw material receipt through transformation into finished product. A collateral objective of this presentation is to indicate that mechanization of the production control system is a logical role for the Industrial Engineer.

SYSTEM OBJECTIVES AND AUTOMATION

Those responsible for the development of a management control system must clearly understand the objectives of the total system, particularly where mechanized methods are employed. The following principles have been generally accepted as desirable attributes for a good production control system:

1. Furnish adequate, accurate, and timely information - this is possibly the raison d'etre for a mechanized production control system.
2. Be simple to operate - assuming the existence of a competent data processing organization, this, too, is a favorable aspect of the mechanized system.
3. Be economical to maintain - some companies have found that costs have increased rather than decreased after installing data processing equipment, common mistakes being mechanization of an installation with insufficient volume to justify cost of the machines, or partial mechanization resulting in non-optimum utilization of the data-processing system.
4. Be flexible to change - flexibility may be an advantage of a digital computer application but is possibly less characteristic of punched-card equipment.
5. Force advance planning - an automated system in many ways serves as a catalyst to forward planning.
6. Provide management by "exception" - much detail is eliminated in a properly designed data-processing system so that management judgment can be applied where needed with no waste of time.

DATA INPUTS AND PROCESSING

Once management has established objectives for its system, the Industrial Engineer may then determine data needs and flows throughout the organization and ascertain the reports and analysis required for achieving these goals. This is the systems study and should not be confused with detailed data programming which occurs much later. A graphic portrayal of some of the basic inputs to and outputs of the automated production control procedure, which will be described subsequently, is shown in Figure 1. This diagram also signifies the scope and complexity of the system.

The punched card has been considered the input document for the automated production control system depicted in this paper with electro-mechanical equipment used for data processing. The rationale for this is that the digital computer is not available in all enterprises today and that the procedures developed for a punched-card application are adaptable to a consequent computerized installation. Automatic converters can be used to transfer data from cards to magnetic tape. Memory of the punched-card system is contained in its card files.

SHOP ORDER PREPARATION AND CONTROL

The starting point for production control thinking should be the product to be manufactured, and this exists only after it has been designed. Complete drawings, specifications, and material lists are necessary from the engineering department for the production shops. Changes in specifications may occur between the time of the original scheduling of a product and its manufacture. An integral requirement for successful operation of the mechanized production control system is that the blueprint be thoroughly searched for possible improvements prior to its release to avoid excessive changes.

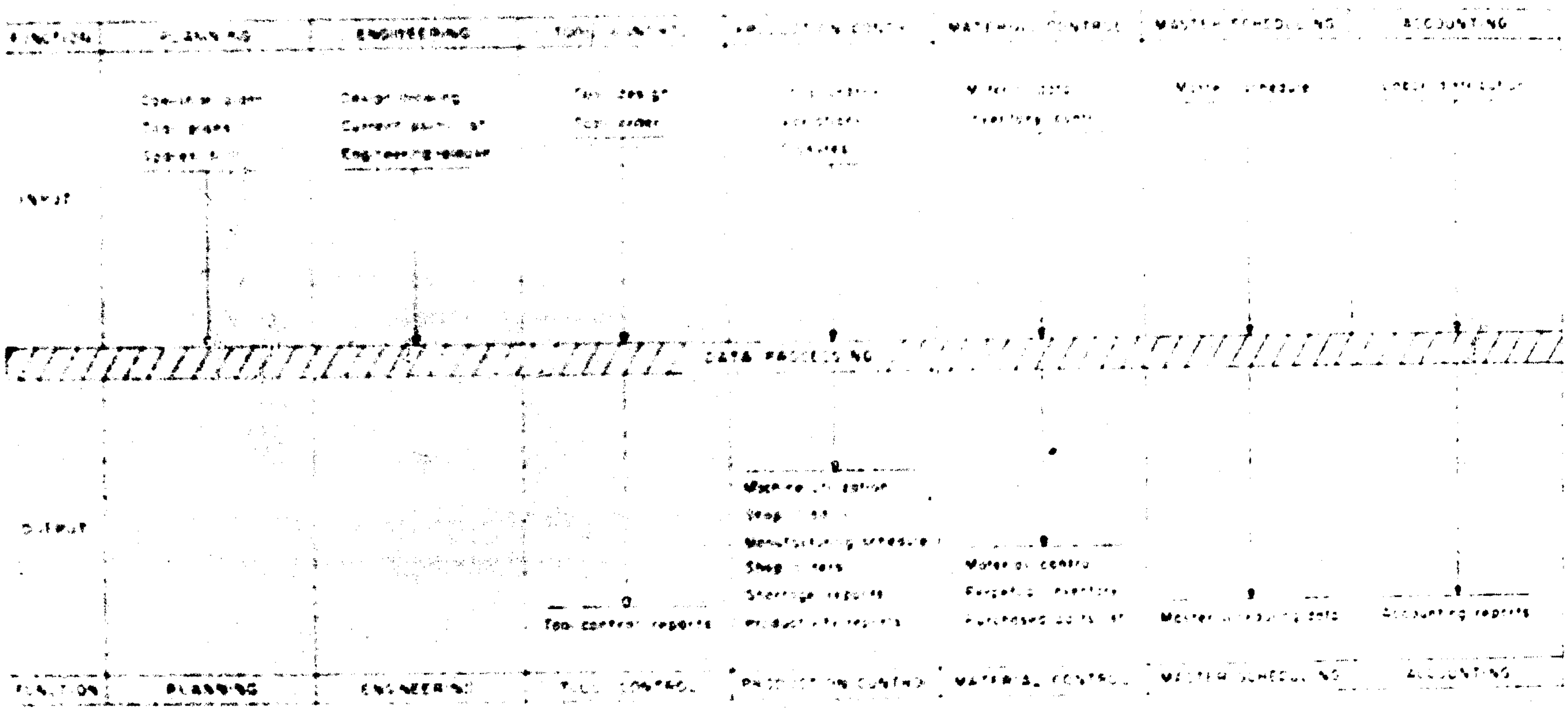

Figure 1

Inputs and outputs to production control system

After a product has reached the manufacturing stage, planning or process sheets are prepared. The planning sheet becomes authority for the production of a part and the basis for collection of costs. The genesis of the mechanized production control system may be considered the punching of data from the planning sheet into a master deck of cards. From this deck, a printed planning sheet is generated and distributed as required and the cards are used subsequently for printing shop orders.

A prime input of the design engineering function (see Figure 1) is the tabulated basic parts list by subassembly. This list is analyzed by the master schedule group to develop the master production schedule, which should be established simultaneously with the planning sheet. This schedule sets forth the rate and completion date of each product as well as allowed time for material procurement, machining, assembly, and test.

Shop orders may be thought of as secondary schedules, since they are products of the master schedules. The manufacturing release order establishes variables for a specific order: quantity, accounting charge, lot number, and schedule data. From the completed release order form, an order deck is punched. The order deck is used to extract appropriate cards from the aforementioned master deck and to print a shop order which duplicates the planning information plus variables.

The following is a partial listing of controlling and utility cards generated mechanically to accompany the "traveler copy" of the shop order to the production departments:

1. Material withdrawal card used to withdraw material from stock and provide debit transaction data to material control inventory.

2. Material identification card attached to material issued from stores and used to provide positive identification throughout the operational cycle.

3. Tool withdrawal card used as authority to withdraw tools and provide data for crib records.

4. Production operations card used to record completed operations and provide earned hours for productivity reports.

5. Inspection summary card used to record inspection data for quality control.

The following are some representative management control reports generated from information available in the tabulating facilities:

1. Shop load report used to show new jobs received during the schedule period, completed work, and status of backlog.

2. Behind schedule orders used to report department and/or areas behind schedule.

3. Shop efficiency reports available by machine group, operator, product line, and so on for any given period.

Special reports may also be requested by management to cover any special situation.

TOOL CONTROL SYSTEM

A copy of the printed planning sheet is transmitted to the tool design department. Following the determination of manufacturing methods, tooling must be planned early with the initiation of designs or toolmaking by outside suppliers. Methods and tooling studies can be undertaken at the same time as procurement and raw material storage studies but may be delayed by final release of engineering drawings.

For in-house manufactured tooling, a complete tool design is prepared based upon information in the planning sheet. Upon completion of the design, the tool engineer writes the tool order directly onto a multipart carbon interleaved form. A handwritten copy is satisfactory, since no subsequent reproduction is needed for reordering. All information from the tool order is punched into a master deck. This deck is used to generate controlling and utility cards, including labor distribution, material requisition, final disposition, and tool receipt.

Man-hours expended for tooling are collected from the prepunched job time cards and through use of tabulating equipment translated into dollars. Eventually the manpower cost is combined with tooling material expense and the data automatically posted into a master ledger.

From the data available in the punched cards, management control reports similar to those described for shop control are generated. As the tooling data are processed, both through the tool and material control subsystems, a complete history of the tool is posted automatically into the master ledger.

For tools to be purchased outside the company, a control sketch is prepared to provide detailed information to the vendor. Copies of the order serve as a requisition and are handled in the same manner as any purchased material.

MATERIAL CONTROL SYSTEM

Material control begins before the physical goods are purchased or received. It consists of both the physical control of materials and maintenance of records.

Requisition information is punched into tabulating cards which are used to provide a report of requisitions held in open file pending placement of the purchase order. This report provides a basis for follow-up of outstanding requisitions.

Each item of a purchase order is entered on a separate card to provide a means of entering "on order" records, for recording receiving information and for follow-up by material or tool number. These cards are also used to purge the open requisition file.

From the master deck of cards maintained by the tabulating function, the following typical utility cards are generated:

1. Dock receipt card, which provides a report of incoming material.
2. Purchase order receipt used to provide inventory data and purge open purchase order file.

Management control reports, such as open requisitions, purchase orders behind schedule, and orders due in a specific time, may be issued at established intervals. Stock transfers, requisitions, and other transactions are automatically debited and credited.

Miscellaneous operating reports are also generated from the punched cards, including, for example:

1. Excess material usage report indicating percentage of excess material by department or cost center.
2. Excess scrap report comparing weight of scrap to issued material.
3. Material commitment report showing monthly procurement activity priced at actual (or standard) value for use in estimating purposes.

CONCLUSIONS

The punched-card system for production control is particularly adapted to operations which are characterized by the use of thousands of parts, many of which are common to more than one assembly. Automatic tabulating equipment is faster than human performance and results can be obtained at lower unit cost where voluminous data must be processed and reported. The preparation of reports considered important but beyond the time and physical limits of manual operations is a prime advantage.

Punched-card methods provide a good medium for recording specifications. A permanent record source is provided from which all necessary computations, documents, and reports may be prepared. Similar advantages are realized in scheduling operations and material control.

Machines, however, should not be considered a panacea for solving all production control problems. An encouraging aspect is the introduction of many small digital computers in recent years, some for specialized applications.

EPILOGUE

The Industrial Engineering Symposia sponsored by the A.I.I.E. reported in part that the Industrial Engineer, in addition to his traditional roles, should in the future be concerned with:

1. Analyzing, developing, and implementing entirely new systems consistent with modern decision methods and computer technology.
2. Improving the design of existing controlling systems.

Within the time limits, an attempt has been made here to indicate or suggest that in many organizations the production control system may present such an opportunity and such a challenge.

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