Conflicts in Production Planning and Control Systems

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Introduction

A wide variety of functions either comprise or interface with a Production Planning and Control (PPC) system. Some place demands on the system; some place constraints; some produce the the action; some monitor events and may initiate corrective demands; some monitor passively in order to compile records. Such a wide spectrum of interests normally results in conflicting demands being made on the PPC system, the satisfactory resolution of such conflicts and the design of an efficient system is at the same time difficult and vitally important.

This paper represents an attempt to clarify the scope of a normal PPC system, to structure its tasks and objectives, to outline the interfaces with other functions and activities, to to discuss some of the more obvious problems and to suggest the need for, and form of, some standards.

The Problem Area

Figure 1 shows an attempt to represent the main components of the problem area and the main information flows relating to PPC. At this stage no direct reference is made to automation or to the use of computers. It is assumed that the plant exists, that supplies such as raw material and fuel are available and that a general physical modus operandi has been developed.

Initial production plans may be laid on the basis of predicted customer demands for products and normally the longer term contracts for e.g. fuel, raw materials, must be based on estimates. It is customers' orders that initiate the real action and the Customer can be identified, therefore, as the first main pressure on a PPC system. Customers normally communicate with a PPC system via a Sales Office which constitutes a main interface with the PPC system both as the customers representative and in its own right. An order once received must be checked and, if there is a choice, allocated to the appropriate works unit.

The orders are usually in the form of an Order File when they are passed on to a works Production Planning and Scheduling Department. Each order is further checked and the details expanded to the point where clear and unambiguous instructions exist for all aspects of the orders journey through the works.

The Production Unit is next along the logical route for an order item. Each unit receives some material or part processed steel and following instructions received from production planning, they are expected to produce the required goods - to specification and to time. An associated task is to keep track of all material movements, test results, weights, etc. which go to make up the production records and management reports. Since this activity comprises a great deal of action it may be wise to split it down into sub tasks:

i) Receiving and disseminating instructions
ii) Producing
iii) Coping with deviations from the schedule
iv) Recording what actually happended e.g. weights, dimensions, tests, movements, etc.

At a variety of stages throughout the production path and in particular when some material is despatched to a customer, a whole series of activities is sparked off such as: production of advice notes, invoicing, completing sales ledger and customer records, reports for management, accounting, technical records, etc. etc. which all together throw a considerable demand for suitable data on the PPC system.

THE PPC SYSTEM FROM VARIOUS VIEWPOINTS

The Customer - Making Enquiries

Assuming that either a repeat order is being talked about or that discussions have already taken place about the nature of the steel the customer wants, the customer basically needs to know if his order quantity and timing can be accepted and at what price. A standard response time should be specified for the time taken to give a reasoned answer. Perhaps ½ to 2 hours is a suitable time bearing in mind that in the long run it is probably better practice to come up with a reliable quotation than an instant impossible offering.
The process of calculating a delivery time is the joint responsibility of the Sales and Production Planning Departments.

The Customer - Firm Orders and Acknowledgments

In general a customer will have had some previous discussion about a given order and there is unlikely to be quite the same pressure for a rapid response with the official order acceptance. This would not be true if no previous discussions about delivery times had taken place. Either way some standard time should be determined, perhaps something like 48 hours plus postage time would be appropriate.

Many of the worlds steel companies allow their sales staff to acknowledge an order and agree a delivery promise without any specific confirmation from the appropriate works production planning department. This point is discussed later under sales department activities.

The Customer - Order Status Enquiries

Prevention usually being better than cure, the number of order status enquiries could be low if customers became accustomed to being able to rely on original promises. However, production plans do go wrong and customers priorities do change and so an effective order status enquiry system is essential. A standard response time should also be determined, perhaps a maximum time of 2 or 3 hours can be sufficient although there will always be those who ask for an immediate response. It may be that if all queries that are received by noon are satisfied by 2 pm, all received by 3 pm satisfied by 5 pm and any later by first thing the next day, this represents a workable arrangement.

A possible second line of defence could be a regular listing (once a week?) of each sales offices' customers' orders that are known to be running late and by how much. Whether the customer ought to be advised of this situation is probably a matter of commerical judgment and may well depend on knowledge of the customer concerned.

Sales Departments - General Information Requirements

Apart from having a good general knowledge of the market situation, the loading status and the production situation relating to the products handled by a given Sales Department, the staff need to know enough detail to enable them to process customers enquiries, requests for quotations (price and delivery), firm orders and status reports.

To achieve the above they need to know:

a) By product and by production unit, the practical capacity (in tons and/or time and bearing in mind any major planned maintenance), the current loading, the status of production performance and alternative units or products.

b) Marginal and standard costs of production together with permissible selling prices. (Oxelösunds, Sweden, are known to have developed a production cost optimisation program which is fed- monthly, it is believed- a statement of the current plant loading. This is compared with the ideal and products are identified which "should be discouraged" and which "should be encouraged" whenever possible. A standard cost together with a minimum and maximum selling price are calculated for each product in the light of the loading situation and each salesman receives these details.)

c) If there is a real possibility of some orders being satisfied directly from finished or semi-finished stock, then either the sales department must have sufficient detail and be permitted to allocate, or there must be a satisfactory system for referring such cases to PPC for action. In many cases there will be no need for a rapid response but there will be cases when the sale depends on a fast response giving reliable news about a quick delivery and standards will be needed to define the speed and depth of a suitable system.

Sales Departments - Quotation of Delivery Dates

There are two main questions to be resolved and performance standards determined for: a) How much detail need be worked through in order to arrive at a suitably reasoned delivery promise? and b) How quickly should such an answer be available? Clearly both Sales and Production Planning are involved in the process but the decision as to what extent is very much wrapped up with the answers to a) and b) above.

Some of the options include (see Fig. 2):

1. All decisions made by sales on the basis of regular reports from production planning as to loadings, production achievements, etc., sales determine a feasible delivery date, allocate the

order to a specific production unit (in accordance with the guidelines laid down by the HO production control department) and actually make a commitment to the customer.

2. As for 1. above except that the commitment to the customer is made only after production planning ratification.

3. Sales department select the appropriate production unit but production planning calculates the delivery date and takes full responsibility for the commitment to deliver.

4. Production planning makes all the decisions.

5. Sales determine and agree the delivery date while production planning allocate the order to a production unit.

In each of the above cases "allocate to production" is to be taken to include allocation to finished or semi-finished free stock if such is feasible and desirable.

The majority of the world steel companies adopt option no. 1 with no. 5 as a variant on occasions. There is a common complaint made by production management to the effect that the company frequently gets committed to unreasonable delivery times by this method and that they -production- are left to dig the company out of the mess. Nevertheless, if sales are adequately and accurately informed, no.1 seems a reasonable option.

Undoubtedly some orders will be accepted that in the event put an uncomfortable strain on production and at the other extreme some customers will on occasions get less favourable agreements than could have been possible. So many factors do change as time goes by that even if all orders were to be fully broken down and loaded on to every individual process before any delivery promise was entered into, the reliability of such calculations would not represent a significant improvement and would be a waste of effort.

Production Planning and Scheduling

In some ways this function is the "go between" through which sales, representing the customer, and the production departments communicate. Information and demands for information are felt from both sides, the conflicts caused by the customers wish for everything to happen exactly to suit himself and productions reference for long steady production runs, must be resolved by production planning.

Several identifiable activities go to make up this function starting with the need to know and maintain records of:

a) Current realistic production capacity; production rates by process by product; the no. of shifts being worked; any planned maintenance periods.

b) Viable product routings; alternatives; costs; product mix limitations.

c) Current order book commitments in works order detail and consequential process loading.

d) Stock contents and the position of individual items; whether allocated or free stock.

From the sales side the main input is the Order file containing customers requirements which will again be checked for completeness and consistency before being expanded as required for all planning, loading and scheduling purposes.

The planning and scheduling functions themselves maintain a loading for each production process (balanced and/or optimised in order to minimise costs in an ideal system) over different timescales. The longest timescale is likely to be a quarter with the immediate quarter broken down into months. Similarly the immediate month would be broken down into weeks (4 weeks; 4 or 5 weeks; 3 x 10 day periods). The scheduling timescale will depend on the process cycle length but a typical period is 2 weeks. It is by reference to these loadings that a delivery quotation for a new order can be calculated or checked and so depending on the system in use, a digest of the loadings will be fed back to the sales department.

Detailed production schedules are the main end product of this function and are passed on to the production units for implementation. While it is clear that the detail must be specifically relevant to each process this is a fundamental interface and some thought must be given to standardisation. Both manual and computer process control must be catered for.

Post production feedback will be received from the production processes and such data are used to check actual production against planned, any discrepancy will necessitate some remedial action being initiated. The process control level will already be aware that some processing did not go according to plan, some suitable re-optimising attempt may have been possible at that level. One large area for thought and the determination of standards covers the policy for error detection, identification of which level should be responsible for remedial action and the response times of any system. One major point is whether on-line rescheduling should be attempted, or any misprocessed item taken there and then off the production line, or whether the piece should be subjected to some standard processing for stock. Having witnessed the BHP on-line reallocation system for plates in action, it reapplies 2/3 rds of all other than intended production to prime orders, the benefits of such system are most attractive.

Production Units

Many different activities and functions go to make up the production control stage and although interdependent these can be separated out to some extent:

a) The receipt of works order information in the form of a schedule co-ordinated with the schedules of adjacent processes. The form of data records and presentation may well be a fruitful subject for standardisation and the more integrated systems become the more urgent will be the need for a set of standards.

b) The dissemination of instructions to the right recipients at the right time in synchronisation with actual events as monitored by process sensors etc.

c) Control material indentification, selection, movement, processing, marking and testing. This may be via manual links or displays and sensors etc. It would be important to define the characteristics of each interface.

d) Generally and specifically to cope with problems arising out of any unplanned action or event. Anything can and will go wrong at some time and much thought and ingenuity has already gone into the design of recovery systems. The first problem is to define what is meant by a failure and the next step will be to define the nature, depth, accuracy and necessary speed of response of suitable standard recovery systems.

e) Sense, measure and record the following:-

i) Signals for immediate control and correction.

ii) Identity, weights, times, dimensions, movements, analyses, test results, etc. for:-

Production planning and control
Order status monitoring
Stock recording and control
Costing and accounting
Technical and metallurgical records
Payroll inputs
Personnel records
Management reports
Issue of depatch details, advice notes, invoices

Standards are needed for all the above with respect to timing, accuracy, speed of retrieval, security of records, speed of recovery from a breakdown, etc. It is easy to state that whenever and whereever some decision must be made all relevant available data should have been collected, checked, processed and presented in some suitable form to the decision maker (man or machine) on 99.99 % of all possible occasions, but to translate

such a statement into workable practical components will take some time and thought. In a real time situation like a production shop in which a complexity of operations is likely to occur simultaneously, one way to keep track of messages and records may be to record the time of the transaction, keeping it as an integral part of the message rather than rely on the sequence numbering when it comes to carrying out diagnoses.

Management Reports

The previous sections cover several individual forms of management reports, mostly as an integral part of a control system. There are however many types of management reports just as there are many types of management functions, three obvious types are:

a) "Action" reports which either confirm that actions have gone according to plan or identify deviations which call for some management action. It is easy to say that these should all be prepared and presented in a form and at a time which permits considered decisions to be taken in time to be effective, practical specified standard will not be so easy.

b) "Passive" reports which provide background information for decision makers in related fields but not in a position to influence events directly.

c) Pure records for a wide variety of purposes.

More senior management usually receive digested progress information and are not necessarily interested in all the underlying detail. This can be argued to be a separate study in itself and all a PPC system needs to do is to provide reliable, timely basic data. Since some more remote senior management do on occasions overrule the decisions and plans

of others in order to cope with some highly political pressure such as an urgent order from a valued customer, it may be educational to feed back the costs incured in rearranging production plans and schedules. At least future directives would arrive after more complete consideration of the ramifications.

Timing and Response Times

Time periods covered and the timing of given tasks, such as scheduling, are frequently thought of as being determined by factors like the calander, "natural" process cycles, and traditional ways of working. A study of such timings in different steel companies shows that there is sufficient variation in aparently similar plants for it to be clear that not everyone can be working to the "best" system. As time goes by therefore it is likely that changes will be made in methods of planning and control and systems that have been too rigidly, tailor made to an existing way of thought are liable to be more of a hinderance than a help. In today's situation a viable system must easily, even if not automatically, adapt to changing operating practices, market conditions, product ranges, cost structures, etc.

Figure 3 shows a very simple attempt to structure the planning/scheduling/control functions in a timing sense and indicates some of the more basic feedback routes. As always, if things go smoothly and to plan the simple step by step approach will be quite adequate and only when things begin to go wrong will the speed of response become inadequate. Since the point has already been made several times that things can be relied upon to go wrong, the "short cuts" and other devices designed to speed the systems calculated re-adjustment to the changing circumstances should be another high priority for the determination of standards for design and operation.

Computer Systems

So far little mention of computers has been made and the omission has been deliberate. All the functions and objectives that have been discussed must be carried out - with some degree of efficiency - whether manually or with some level of electronic/mechanical assistance.

The benefits of a computer system include:-

a) They handle data more accurately, reliably, faster, than people.

b) They allow more complex operations and calculations to be carried out.

c) They permit tighter control and facilitate wide scale implementation of overall policies.

These benefits must be weighed against the following:-

a) Objectives and required functions must be meticulously clarified and the system design must be carried out very competently. Poorly designed systems can be inflexible and have limited usefulness.

b) Only by accident will a computer system cope correctly with a situation unforseen at the design stage. A basically human system will do something even under unstructured conditions, though not necessarily the optimum.

c) If a computer system effectively takes the majority of decisions and human standby team are likely to lose their skills and not perform too well in an emergency.

d) Computer systems are costly and represent an easy way to waste vast sums of money.

These "disadvantages" are not included in order to discourage the use of computers but rather to emphasise the need for standards for systems in respect of:-

a) Design of data bases
b) Size and scope of program modules
c) All types of interfaces
d) Response times
e) Back-up facilities and systems to keep a plant going
f) Safety and security
g) Recovery: proceedures, speed and accuracy
h) Degree of input checking and methods to be used
i) Coding methods and practices

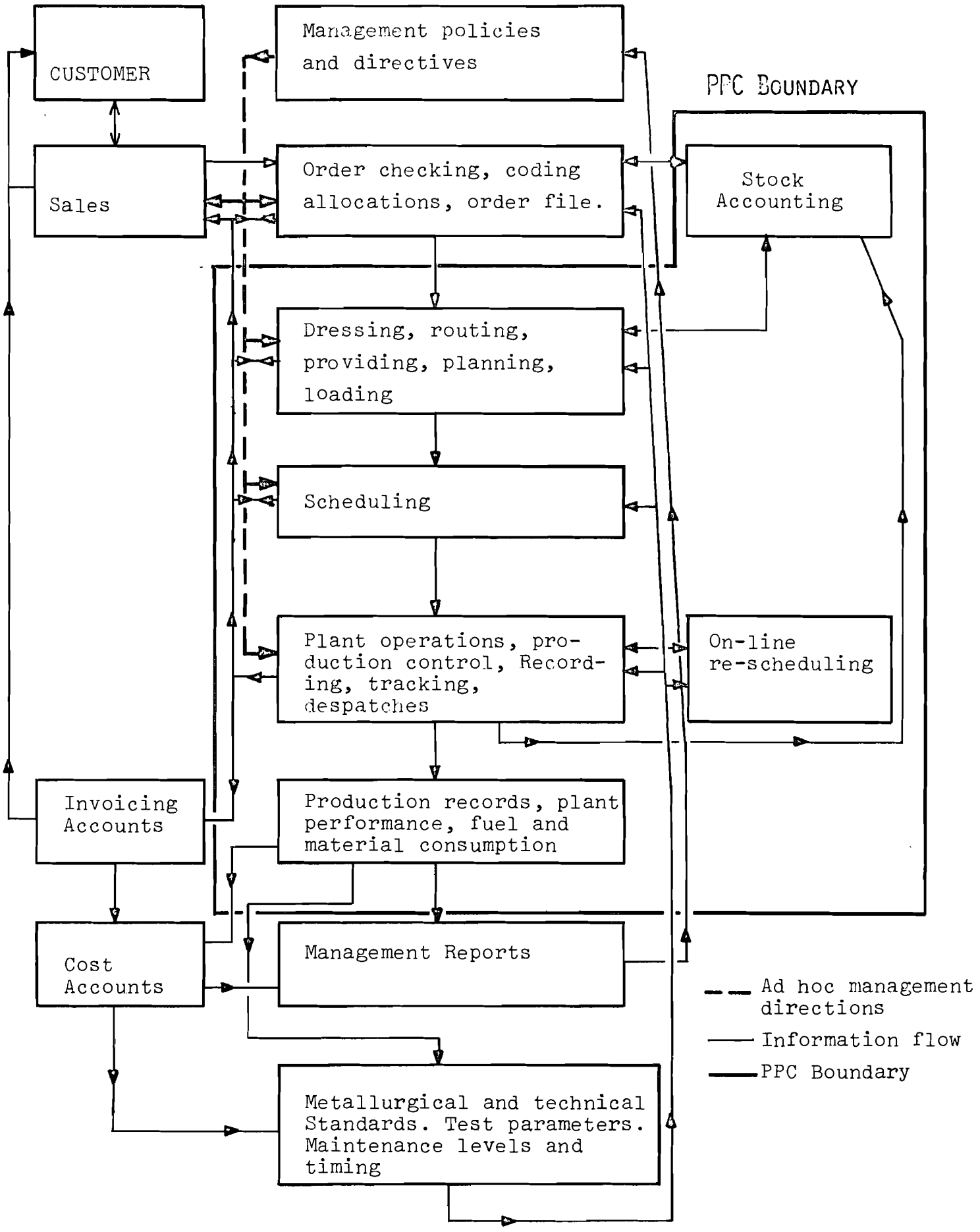

Fig. 1. PPC System - Main Components and Information Flows.

	1	2	3	4	5
Determine Delivery Date	S	S	P	P	S
Allocate Order to Production Unit	S	S	S	P	P
Make Delivery Commitment	S	P	P	P	S

S = Sales Department P = Production Planning

Fig. 2 - Delivery Calculation Responsibilities

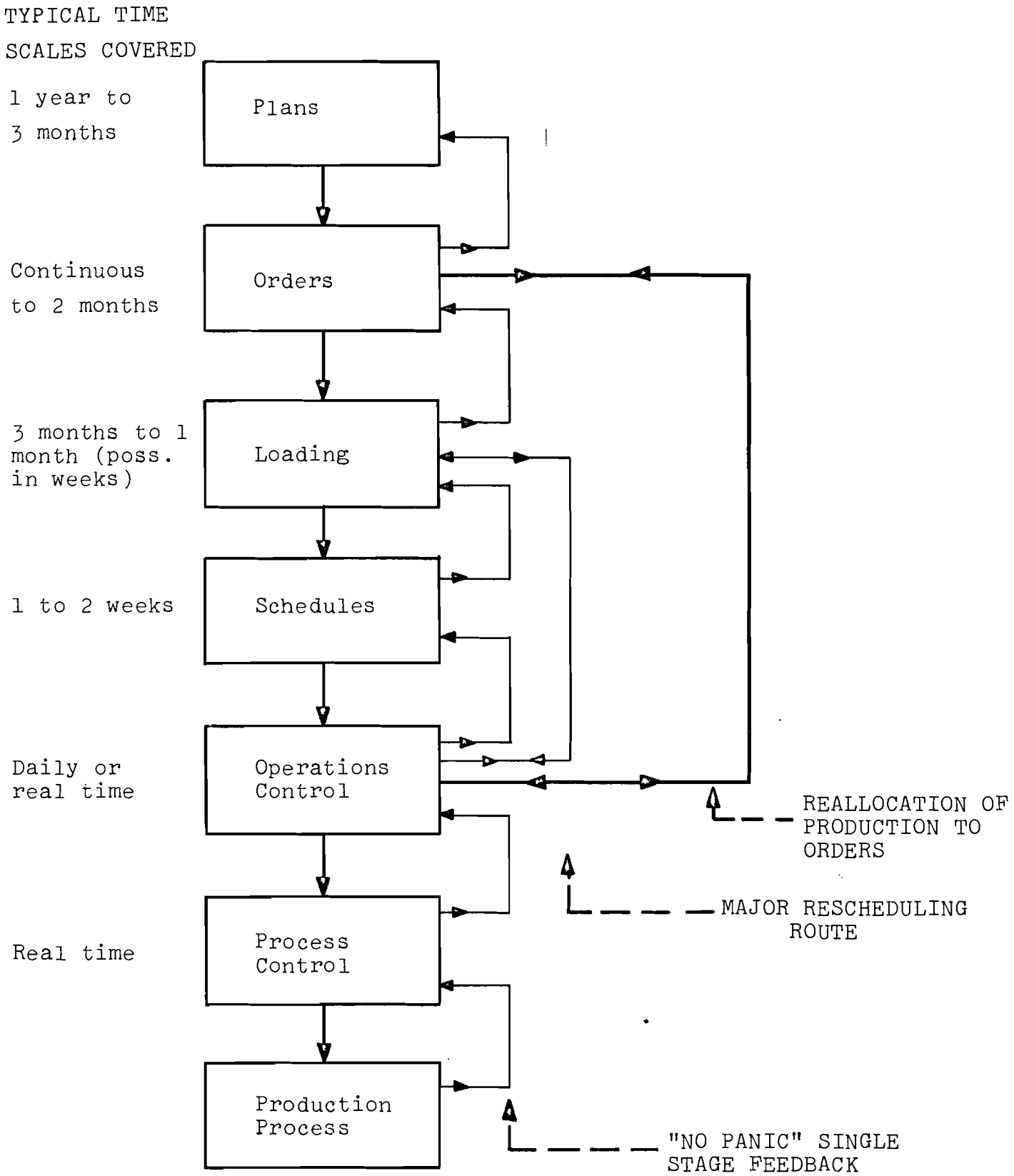
TYPICAL TIME SCALES COVERED
1 year to 3 months
Plans
Continuous to 2 months
Orders
3 months to 1 month (poss. in weeks)
Loading
1 to 2 weeks
Schedules
Daily or real time
Operations Control
Real time
Process Control
Production Process
REALLOCATION OF PRODUCTION TO ORDERS
MAJOR RESCHEDULING ROUTE
"NO PANIC" SINGLE STAGE FEEDBACK

Fig. 3 - TIMING