RATIONALISATION OF CONSTRUCTION METHODS AND MANAGEMENT

by

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The needs

Many contractors may crumble with the crashing construction market. From a capitalistic view point, this may be a 'necessary' process of natural selection. From another angle this may be a signal of the 'inevitable' collapse of free enterprise. But from a 'mere' client's position it could spell disaster: eg. a local client being compelled to choose between the supposedly fast foreign contractors and a bewildering array of mushroom one - man contracting or 'cowboy' outfits, who may be questionable on materials usage and conformation to standards. As concerned professionals, we too should therefore sit up and take notice.

Is there room for rationalisation in construction methods and management. We have been conditioned by the glamour of the unique nature of each construction project; each a fresh challenge to engineering ingenuity. The one - off characteristics that distinguish it from factory - line production processes, supposedly also stifle any scope for standardisation. Instead they throw up a few notable landmarks, and some outstanding personalities who build up a reputation for innovation in techniques of construction or management (rarely both, unfortunately). Reputations have been thus built on improvised methods and substituted materials; on 'benenolent dictatorial' management styles, as well as on effective delegation and decentralisation.

The time for trial and error is now over. We must take stock of what is available abroad, what we have here; and compare these with our actual needs.

There is a need for high calibre management at both pre-contract and construction phases: in designing, planning, estimating, pricing and execution. To extract the maximum from minimal resources, such capability should be of top quality and available across the board as required; whether in Client, Consultant, Management or Contractors' organisations. (depending on the type of contract). Herein lies the dilemma: The high overheads of such expert management are not loadable on to what should remain as competitive prices. So, if 'quality managers' themselves are spread thin on the ground, the alternative is to evolve appropriate 'quality management systems', which could be implemented by even the average manager.

So, even though engineering projects are less amenable to standardisation than others, there are common core elements of a project which can be isolated, and would respond to a structured approach eg: in selecting one of a predefined set of available methods for a particular activity, say, in choice of resources mix.

Lamentably there has been little local headway in developing, leave alone recording such approaches. Even within organisations, there may be one or two 'experts' whose experience and acquired knowledge is confined to them individually; and thereby lost to the organisation when they leave. Such experimental knowledge should not only be captured (in records) but also

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codified - organised for more efficient use, say in project manuals, check lists or even thumb-rules.

The alternative is to 're-invent the wheel' each time; as what may have trickled down to the 'budding experts' would be only the crumbs off approaches to current projects. A young engineer could thus spend many years (and sometimes the client's money) re-learning optimising techniques, on a different project-type, which could have very well been transmitted via an appropriate vehicle, earlier.

A comparative survey

Such needs have been recognised more readily abroad; and we may well profit by a pause to savour the flavour of some such approaches.

Optimising Resource Choice

In 1971 Beeston developed a computer programme called COCO (Cost of Contractors' Operations) based on decision criteria governing choice of construction methods and plant (1). This has been refined at the University of Strathclyde incorporating performance data for plant and labour, with procedures for harmonising their work rates, and for smoothing resources. It was found that planning methods of large contractors differed little from each other. It was also possible to simulate the few differences to produce a range of results. Such simulation required some project specific data such as bay size, number of storeys, weight of heavy indivisible items to be lifted, restrictions on positioning cranes, cart-away distances for spoil etc. Most resource mix decisions could thus be facilitated by a few key quantities, dimensions and a hierarchy of priorities.

Expert Systems

A particular development in this direction uses the so-called 'Expert Systems': glorified computer programmes, which (being spawned by developments in Artificial Intelligence) have become fashionable in the West to solve a variety of problems eg: (a) where a diagnostic approach is needed (having been first used in medical diagnosis); (b) where there is no established or definitive theory; (c) where human expertise is scarce; and (d) where data is 'noisy' (very variable). Such characteristics seem typical of our own field or domain, as we have just noted earlier.

An Expert System has been defined as a computer system that encapsulates specialist knowledge about a particular domain of expertise, and is capable of making intelligent decisions within that domain (2). It functions in two modes; (a) the 'knowledge acquisition' mode, where it interacts (or is made to interact via an Intermediary, the 'knowledge miner' or 'knowledge engineer') with human experts to build up it store of 'knowledge' and (b) the 'consultation mode' where it shares such knowledge with the human user (3).

An important distinction from standard computer programmes is that this knowledge need not be complete. Thus problems not amenable to algorithmic solutions can be attacked by a loose collection of rules that seem to work (heuristics or thumb -rules). The modularity of such systems offers easy updating facilities, so that, as the store of knowledge increases or improves, the solutions suggested become better.

An early example, MYCIN modelled the decision process by which an expert doctor (specialist) performed a diagnosis and selected a suitable treatment.

The four essential components of an Expert System, their relationships and functions, are noted in Figure 1. There are many commercially available 'Shells" of Expert Systems to which knowledge can be strung on or encoded, so that one does not have to build up such a system from scratch.

The knowledge that is encoded in Expert Systems has been said to consist of Facts, Beliefs and Heuristics (4). Problems would arise in our own, domain, as in most others: in knowledge 'acquisition and representation', rather than in 'manipulation'.

Knowledge acquisition is difficult because although an expert may solve a problem, he can rarely explain precisely how he solves it; or express the 'rules' he uses. This knowledge elicitation with an expert, a 'knowledge engineer' who will debrief him, and even a good sample of test cases is not always successful (5). Knowledge representation also poses bottlenecks in selecting suitable formats and handling uncertainty.

Even if one does not develop a foolproof 'Expert System' an useful 'spin-off' of this approach would be at least a codification of existing expressible knowledge, in our own domain of construction methods and management expertise.

Project Management Software Packages

Returning to more tried or popular practice (still abroad), one is confronted by a vast array of project management packages-computer software that originated on large mainframe systems, but now runs mainly on minis or micros. Microcomputer systems are usually adequate for individual projects, while minicomputer based packages are useful in consolidating and comparing data from a number of projects within an organisation, and simulating different resource allocations and resulting scenarios.

Complete systems usually offer four major modules or sub-systems (6) as illustrated in Figure 2. The capabilities and range of possible analyses warrant checklists and scientific evaluation in choosing appropriate project management software for one's needs. Time control and cost control, for instance, being broad areas of concern, may incorporate sub-facilities for sensitivity simulation (say in crashing critical activity times), and variance analysis.

Applicability of Computer Aids

Those wary of computer specialists who 'try to force the soft edges of the world into the rigid confines of hard edged computer storage' may prefer to await the refinement of Expert Systems which are far more flexible, user-friendly, and therefore applicable to the job at hand.

Still others may scoff at the costs (against benefits) of such sophisticated software; and perhaps highlight the pressure-cooker atmosphere of construction, where a job has usually to be done by 'yesterday', and there is thus no time for toying with computers.

However, with sufficient forethought and standardisation to suit an organisation's needs, one cannot be little the advantages of computers in construction; even of expert systems eg: (a) in solving combinatorial problems - where unintelligent (straightforward) methods of enumeration lead to an unmanageable (explosive) number of possibilities ie. in a very vast solution space, or (b) in interpreting large amounts of signal data.

In our general domain computers have been found useful to differing degrees, in Design Estimating, Planning, Programming, Accounting, Cash Flow, Valuation and Cost Control functions. The Key is to look for project - (or organisation) - compatible co-ordinated packages; either to access or own.

Other Advances

In any case, advanced or versatile computer software is not the panacea to all construction management ills. Man management is attracting increasing attention after the rude realisation that there may be a minimum of 25% of non-productive man hours on sites. Work Study methodology is now being adapted from its shop - floor orientation to more realistic approximate assessments needed for construction sites. New techniques are being developed to analyse and minimise the reasons for such time wastage (7). Perhaps ironically, but necessarily, these studies too use mini-computers or micros.

Resource scheduling has also drawn on Linear Programming, Simulations and other Operational Research techniques, towards a theoretical optimisation.

The Sri Lankan situation

Having strayed abroad for comparative studies, we may extract what is relevant, adapt what could be useful, and discard the rest. At least let us seek inspiration to organise ourselves, to focus on our own needs.

Differences and Similarities

Perhaps highly unionised and specialised labour imposes different management problems on the West. For instance, our own concern in the Third World may not be so much with the choice of plant, when as a small time contractor, we may have just one item (or none) to choose from! Then again the more politicised environment of the Eastern bloc countries may introduce other (macro) priorities, there: perhaps regional or national, that transcend those of an individual site or organisation; even in programming, allocating or optimising resources.

But resource allocation and control remains at the core of our own critical considerations in construction. Unfortunately one cannot discern a rationalisation of approaches to the problems, even though the roots are really generic, deep down. The requirements may be manifested differently in the diverse situations, thereby tempting one-off trouble shooting tactics that toy with the symptoms rather than attack the root causes.

The gaps

This was substantiated by a recent scan of a series of course reports submitted to the Centre for Housing, Planning and Building (under the auspices of the Construction Industry Training Project) spanning a cross-section of local Construction Projects. One is struck by the dearth of co-ordination in a project, say between estimating and planning at the outset; or between progressing and cost monitoring later.

Cost Control itself is a sadly neglected area although the need is known. Time and cost over-runs are therefore common and to be expected.

Contractors may crash flow crises; having allowed low margins, in hoping for high turn-over and not allowing for contingencies, cost over-runs, time stretching or high Bank interest, in the heat of competitive bidding for the few jobs around. This is a pity when one realises how a simple system of cost control could ring alarm bells in an early warning contingency plan to arrest runaway costs say in a particular trade or area by having suitable cost centres and cost codes (not too many or it becomes (unwieldy); and linking the initial estimates breakdown to progress and cost monitoring. If planned, the extra paper work (or computer output) is not much, as valuations could be produced by the same system, all based on sensible monitoring of progress and assigning pre-set values to work packages, or portions therein.

Although the tactical approach to each project would differ, the strategy could be pre-formulated according to organisation priorities, and the system designed accordingly. This would minimise the gaps, as well as the duplication (say, between Head Office and site) that plagues most projects. Resource scheduling and control may not be left to chance or snap spot decisions as often happens. Whilst we professionals deplore bureaucracy, we ourselves are sometimes guilty of 'adhocracy', which is worse, as it is not expected of us.

Some projects begin with good intentions, which fade out as construction gathers momentum. Detailed programmes, even networks may be prepared, critical paths identified, and then forgotten as contingencies arise. Labour histograms may go haywire as materials supplies get distorted. Zealously prepared Cost Plans may have to be jealously, hidden away, defended or up-dated, as they grow embarrassing due to poor cost control. True, the Client or the Architect may earn (but not acknowledge) most of the blame in such cases; but we could at least ring the alarm bells earlier.

Towards a Specific System

There are a variety of techniques in construction management, each with its own sub-set of different but converging approaches; from which one would choose according to the job at hand. Once the broad project specific strategy is identified, the level of emphasis, detail and necessary linkages between elements would guide the choice of such sub-techniques.

eg: (a) Line of balance programming would be more appropriate than network techniques in repetitive work, like housing schemes or multi-storey construction; (b) A hierarchy of sub-programmes would help schedule day to day or weekly work, once extracted from a macro-programme; (c) Control and Valuation systems could each be integrally linked, with appropriate detail, to progress monitoring procedures. (d) The repercussions of crashing critical activities, at particular points of time, could be assessed by checklists that highlight associated activities and their sensitivities. (e) Data banks of historical cost information and work norms could be assembled and updated with feedback from ongoing projects. (f) Quality Assurance procedures could be set up in advance, rather than rely on ad-hoc sample inspections or 'Quality Audits'.

Computers are not entirely dispensable, even with our low-tech concepts and (Asian) pride in our quick mathematical minds! For example at a basic level, 'word processing' contract documents would permit more managerial attention to the essentials of each project, rather than repeating the whole rigmarole due to lack of time or facilities. Intelligent intervention is of course needed, for instance in eliminating project-specific problems at interfaces (whether gaps or overlaps) and resulting claims for variations.

There is of course, also much scope for rationalisation of design methodology and matching cost control strategies at the conceptual and detailing stages of a project. But that is another story (5); and should not deflect the impact of rationalising construction methods and management.

Recommendation and Request

Towards a System Specification

What we should evolve are co-ordinated construction management strategies assembled from a range of options: in turn derived from built-up procedural manuals, checklists, ready reckoners or codified heuristics.

These strategies would transcend the one-off nature of each project by accounting for its peculiarities in assembling each package. It would also be weighted to suit Sri Lankan situations and styles of management with work study techniques, work norms and geared incentive schemes; specifying suitable spans of control (8) and appropriate degrees of decentralisation.

Quality, Cost and Time control systems would warrant particular attention and appropriate linkages and rationalisation: eg: in linking progress monitoring to valuations; and in co-ordinating valuations with variance analysis and cost control. Optimising Operational Research techniques would be incorporated in resource scheduling.

Each organisation would naturally favour such packages to suit their own policy priorities; and there will still remain essential individual decisions. But once the strategy is formulated for a project and conveyed in the form of a project manual, or guidelines; the day to day decisions would be that much easier and quicker; more consistent and co-ordinated. There will be less reliance on charismatic individualists; or on miracles.

Assembling such a System

The author has embarked on a research project (a) to investigate the scope, depth and adequacy of preliminary or feasibility studies preceding construction projects in Sri Lanka. (b) to study the formulation and planning of such projects: to see how a project is put together in differing circumstances eg: according to type of construction or source of finance. (c) to examine the management of such construction: including differing methods and approaches to control. (d) to assess the contribution of the above to project success, as against cost or time over-runs, or quality/performance shortfalls.

In seeking to focus on areas of potential impact and usefulness to the Sri Lankan Construction Industry in general, readers are cordially invited to communicate their views, contributions or pointers on any of the above: via the Institution, if convenient. Perhaps if sufficient interest is generated the Institution may be requested to set up a task force to assemble such a system, or at least to compile and manage a databank for the Industry. Credit to contributors would naturally follow; and our Construction Industry would be that much more prepared to meet new and existing challenges.

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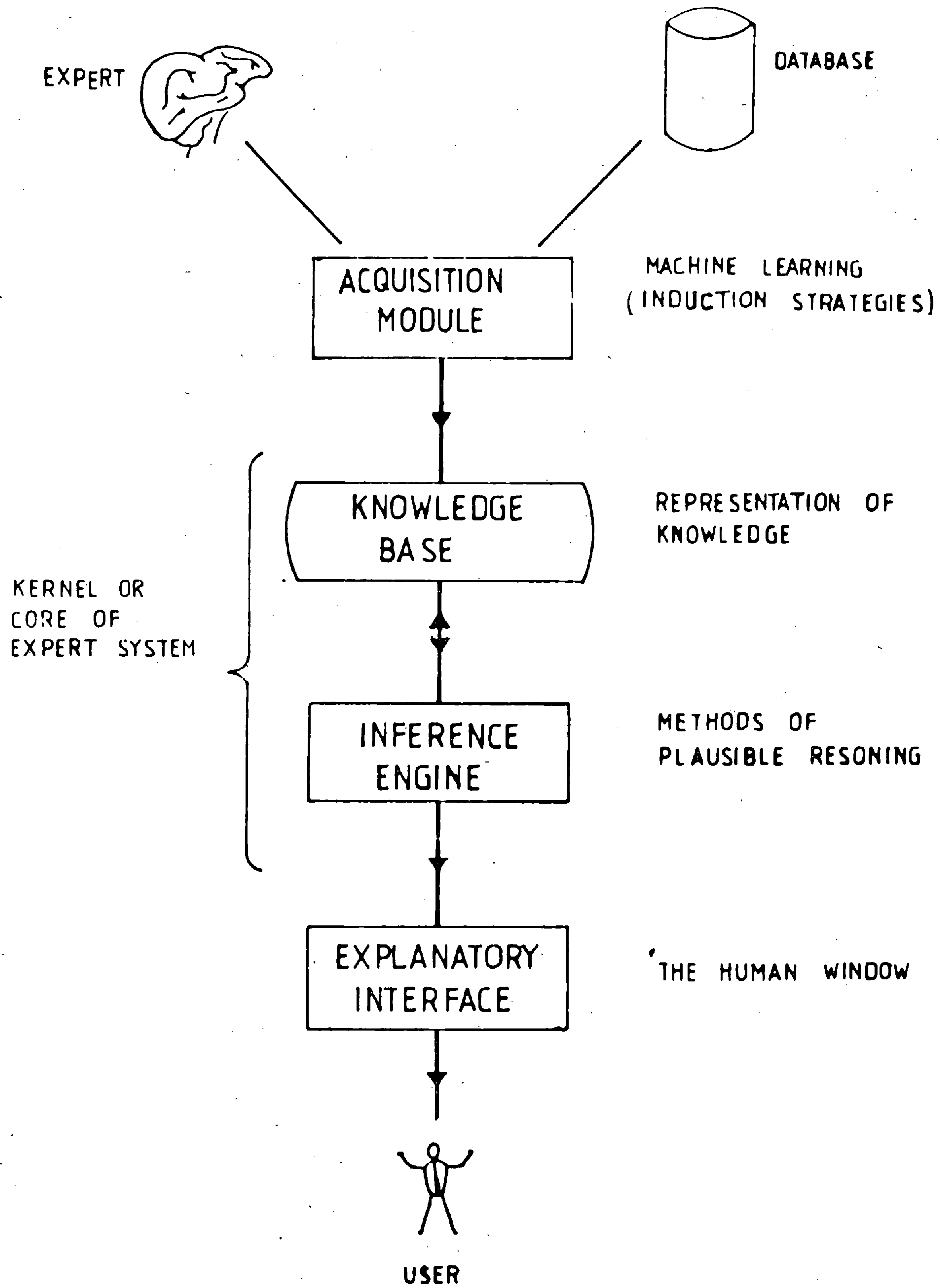
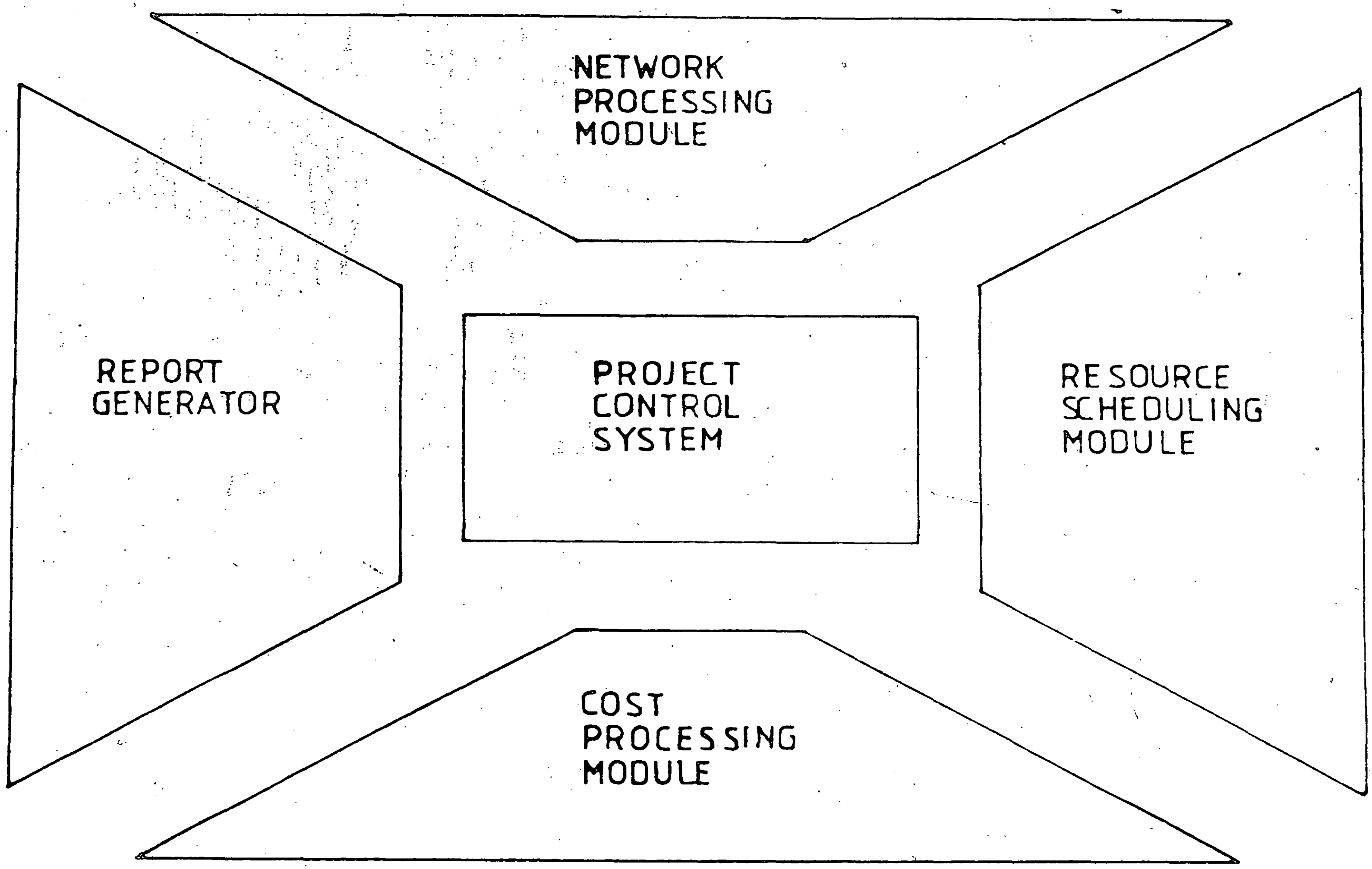


TYPICAL EXPERT SYSTEM (AFTER FORSYTH)

FIG. 1



THE FOUR MAJOR MODULES FOR A PROJECT CONTROL SYSTEM (AFTER PETERS)

Fig. 2