THE MINISTRY OF DEFENCE AS A CUSTOMER

BY

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Introduction

The Ministry of Defence has three salient features as a customer. First, the MOD spends very large sums of money with British Industry—something approaching £1,000m per annum. Secondly, the MOD is often a very demanding and knowledgeable customer having many special and very advanced requirements which are difficult to meet. Thirdly, the MOD is a very large Government Department, inevitably bureaucratic and ponderous in response. It is often difficult to get hold of the man who really knows and can give a quick and responsible answer.

Nevertheless, the MOD is rightly forced by the present economic and political climate to be a very cost-conscious customer so a discussion of its thinking, methods and attitudes will not come amiss.

Let us look first at some of the defence customer requirements since it is these requirements that condition the whole relationship between Industry and the Services.

SERVICE REQUIREMENTS

In the procurement of material and equipment for the Services due consideration must be given at least to all the following general characteristics:—

(*a*) Performance
(*b*) Reliability
(*c*) Robustness and durability
(*d*) Maintainability and repairability
(*e*) Ease of operation
(*f*) Compactness and lightness
(*g*) Safety
(*h*) Appearance

and there are usually additional special characteristics peculiar to each particular service or application.

Perhaps it is worth turning aside for a moment to look at these characteristics in a little more detail.

Performance

To be credible as a deterrent in peace, and militarily effective when deterrence fails, the Services require very advanced performance in their aircraft, ships and fighting vehicles and the weapons, machinery and equipment they carry. To meet requirements the whole spectrum of technology is tapped. A very substantial expenditure on Research and Development is inevitable from which Industry should at least get a useful fall-out. Performance can be accurately defined in terms of speed, range, height, capacity, power, etc; and it is relatively easy to check by trials on completion of production that the specified performance can be met. How long that performance will be maintained is an entirely different matter.

Reliability

Reliability can be quantified as the probability that, in a specified environment, a defined level of performance will be achieved for a specified time. In the past the standard of reliability, if specified at all, was rarely more than qualitative by using such adjectives as 'high'. Latterly requirements are being specified much more precisely and suppliers are being encouraged to study system reliability and demonstrate at the design stage that systems will give a stated level of reliability. Such studies are already bearing valuable fruit. A separate identifiable reliability programme should be part of any significant development project. Such programmes should follow established lines (e.g., those of MIL-STD-785) and must include adequate provision for the collection and analysis of reliability data from the earliest stage of rig-testing of components, as well as comprehensive failure-mode and failure-effect analyses. For aircraft, reliability requirements are usually quoted in terms of mean failure and defect rates. To meet the levels now being asked for presents a formidable challenge, but they should lead to significant savings in cost arising from increased availability.

Robustness and Durability

Service equipments need to be rugged and not only durable in service, but with a good shelf-life in store. Warships have to withstand not only the ordinary hazards of the sea—a corrosive environment, violent movement, vibration, wide changes in temperature and humidity, etc.—but additionally, the effects of enemy action. One of the most difficult to provide for is the effect of underwater shock. The Army's equipment must be fit to fight anywhere in the world; be able to operate from the arctic to the tropics, in desert and jungle; and stand up to rapid changes of temperature and humidity and heavy decelerations when airlifted. Aircraft may have to remain for long periods in severe weather in the open yet be at immediate readiness to fly. Aircraft skin temperatures on the ground in strong sun may reach 180 degrees F and after prolonged soaking in high humidity may be cooled to below freezing soon after take-off. Torrential rain can turn hard dry ground into a sticky morass of mud where minutes before dust had covered everything in a fine abrasive. It used to be stressed that service equipment had to be made proof above all against 'ham-fistedness' in use. But happily this is getting an out-of-date notion for the average soldier, sailor or airman is a well-trained user maintainer devoted to the care of the material on which his life depends.

Maintainability and Repairability

The ideal of course is that equipment should need no maintenance throughout its life, and never need repair. Of course, it always does. So it is very important that whole-life upkeep plans for each system should be carefully thought out at the design stage.

The maintenance and repair assessment on which such plans should be based, must start from analysis of predicted modes of failure, their effects and their frequency of occurence.

Upkeep plans should cover:—

(*a*) In-service routines, performance checking, and calibration

(*b*) Fault indication and diagnosis

(*c*) The modular depth to which repair by replacement is normally to be carried at the various echelons of maintenance

(*d*) In-service tools and documentation

(*e*) Replacement and reconditioning policy and the characteristics of special repair resources

(*f*) Spares support assessment.

Such plans must take into account the MOD's broad upkeep policy; and it may be that the Services haven't yet defined the pillars of their upkeep policy sufficiently clearly to Industry.

Proper upkeep planning is the best recipe for holding satisfied customers who come back again and again, and there are many who feel that we British are well behind some of our international rivals in this field.

Ease of Operation

All too often defects put down to maloperation are really attributable to insufficient attention to the need for simplicity and ease of operation. The importance of this characteristic is stressed by the need for military systems and equipment to be operated by tired, frightened, sometimes seasick men in the dark and the stress of action. In my time I've met a lot of machinery that would tax the skill of a conjuror to work it properly.

Compactness and Lightness

These are fairly self-explanatory, in these days of aerospace.

Safety

This characteristic is obviously important in all military equipment, particularly so in the aircraft, submarine, nuclear, and ammunition fields. But perhaps not so obvious is the requirement that systems must be so contrived as to limit the tendency for the effects of any failure or damage to spread.

Appearance

Though last on the list, the importance of this characteristic to morale, peace-keeping and foreign sales should not be overlooked.

Compromise

So much for the general and particular characteristics. Inevitably they are often conflicting; so the effectiveness in service of material and equipment that emerges from the procurement process usually depends on resolving the conflicts and reaching the best compromise. To get value for the vast sums we spend on defence, this optimizing process must take account of cost. We must aim at cost-effectiveness.

COST EFFECTIVENESS

In the past, the annual vote system for obtaining Parliamentary authorization for expenditure has tended to encourage a preoccupation with first or prime cost in the procurement of service equipment.

FIG. 1 is intended to illustrate (in qualitative rather than quantitative terms) the relationship between prime costs, in-service costs and whole-life cost. It is plotted on a base of reliability. A high level of reliability requires high R and D costs and generally increases production cost; but it reduces the cost of upkeep and spares, i.e., the cost of ownership. The converse is true of low

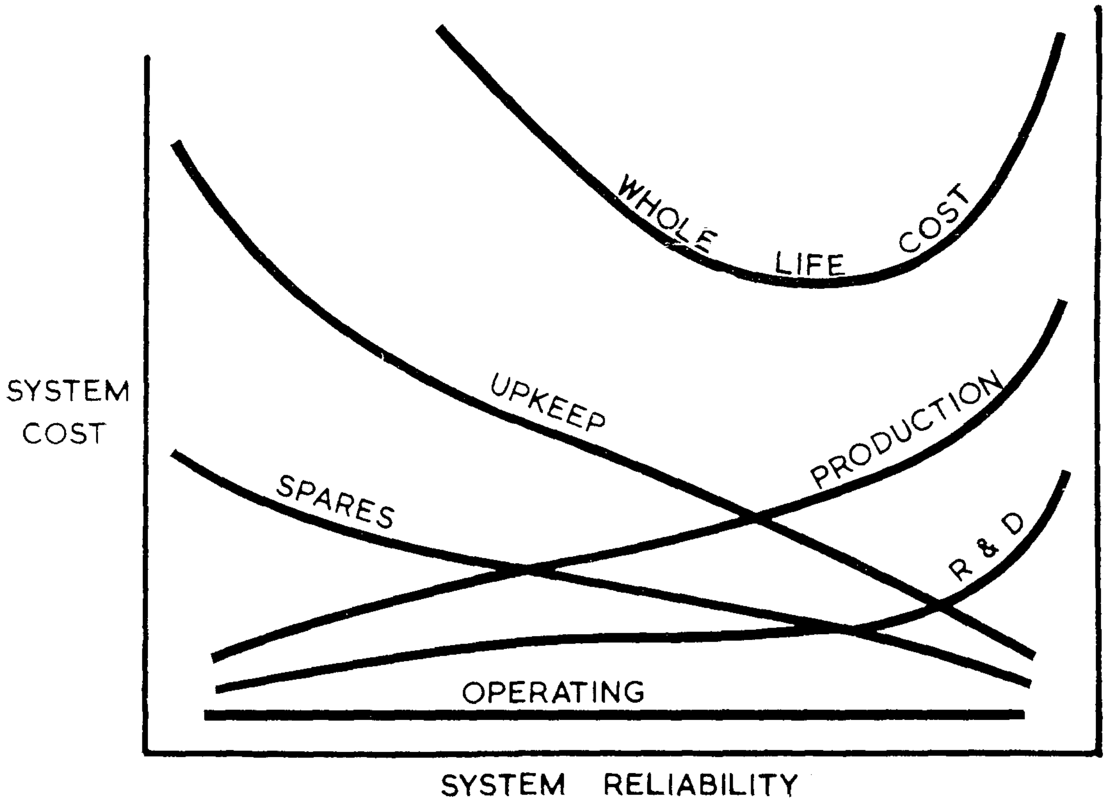

FIG. 1

reliability so that whole-life cost takes on the characteristic shown. A study of the Defence Estimates shows that enormous sums are spent by all three Services on upkeep. So when we talk of cost-effectiveness, the cost we must think of is through or life cost, not just first cost.

It is not enough for designers to concentrate upon meeting requirements for performance and effectiveness alone, however advanced these may be and however exciting the challenge of meeting them. Certainly at the prototype stage a designer's ingenuity and inventiveness must be given rein, but even at this stage producibility cannot be forgotten and may indeed be the major problem to be solved. By the time development is complete, the design is accepted as serviceable and production becomes a reality then all the required characteristics should have been taken into account, not least those contributing towards through-cost, particularly simplicity, ease of production, and ease of operation, maintenance and support.

DEFINITION OF SERVICE REQUIREMENTS

The Services have requirements spanning the whole vast field of materials and technologies, so that precise definition presents formidable problems.

There is the added difficulty of keeping up to date with the effects of changing defence policies, with reshaping of plans, and with technical advances.

Requirements are stated in a wide variety of documents covering both the general and the particular. Such documentation includes, for example, British Standard Specifications, NATO documents, Defence specifications and codes of practice, Navy, Army and RAF Dept. and MinTech publications, lists orders, and even letters, as well as particular statements of requirements in documents and drawings attached to or called up by the contract. No wonder it is difficult for Industry to understand and provide for the customer's requirements in such a situation.

A substantial effort is being put into rationalizing, codifying and indexing all the definitive paperwork; but industry is always likely to have to live with having the requirements of its customers stated in somewhat diffuse form. Indeed there will always be customers who don't quite know what they want but wait for something good to be offered.

As far as the MOD is concerned, Industry will need to put forward the effort necessary to digest the mass of information and requirements fed to it; and to convert this into specific quality control documentation for the use of its designers and producers. And no matter how much ink is spread upon paper or how many tapes are punched, there will always remain the need for personal contact and co-operation, and for first-hand acquaintance with service problems.

For their part, the Services are, to an increasing extent, trying to find out what Industry has 'on the shelf' and buy that which already meets requirements or will do so with slight modification.

SATISFACTION OF REQUIREMENTS

Clearly the satisfaction of customer requirements calls for a full appreciation by the supplier of the customer's problems and point of view. The reverse is also true of course although he who pays the piper customarily calls the tune!

There must therefore be an intimate relationship between supplier and customer, and the bigger the organizations concerned, the more difficult this becomes.

Let us consider this relationship from four aspects:

(*a*) Project management

(*b*) Quality management

(*c*) Contractual obligations

(*d*) Feedback from in-service experience.

Project Management

The more complex and advanced the systems or equipment becomes the deeper the understanding and the closer the co-operation between supplier and customer need to be. In such cases there needs to be proper project control.

The life cycle of a major military project may be expected to be something along the following lines:—

Initial concept

Scenarios and feasibility study

Sketch design proposals

Research and development

Prototype—design, manufacture, test and modify

Support policy formulation

Production design

Procurement and manufacture

Test, trials, tuning and setting to work

Phase into service

In-service—operate, maintain, repair and modernize

Phase out of service and scrap.

There are many variants on this 'cradle to grave' theme in form and language. For minor projects the process need not necessarily be so comprehensive. But the principle is clear enough.

All experience indicates that for a successful outcome this whole process must be treated as an integrated whole; the various stages must be properly planned and phased, leading smoothly from one to the next, and must be kept under proper control. It is particularly important to avoid a big project 'running away in auto' in the early stages pursuing the myth of perfection. It is all too easy for detailed control of the various phases or features to produce a smoke-screen of plans, promises and print-outs peddled by enthusiasts which obscure the main issues and allows decisions upon them to go by default. As a result overall control is lost, costs escalate and the programme becomes extended by delay upon delay. You don't have to look very far for examples of major projects which have been cancelled because this has happened. This was the genesis of the Downey Report, on the basis of which greatly improved procedures have been introduced.

What is needed on the part of both supplier and customer is proper project management. Dependent upon the size of the project and the particular circumstances, this can be achieved either by the appointment of Project Leaders or Co-ordinators within functional or subject-orientated organizations, or by reorganization on project lines. The important thing is to make sure that lines of communication are short and information flows smoothly both ways, and that 'across the board' decisions can be made with a minimum of delay. Proper project management requires a willing acceptance of a high level of discipline in the widest sense.

In complex projects embracing several discrete systems, it is important too to have systematic system management within the project boundaries. All too often we see machinery and equipment which, while doubtless admirable in its own way, gives unsatisfactory service because it is not really suitable for the system into which it has been fitted. Implicit in a systematic approach is the consideration of whole-life planning and whole-life costs.

The Polaris submarine programme has provided an excellent example of successful project management, by a completely project-orientated organization headed by a Chief Executive. Some interesting techniques were developed, some of them flavoured with American experience. One is the formulation of a hierarchy of Programme Management Plans (PMPs) linked to an organizational hierarchy responsible for their timely and effective execution. Another is the scheme of status reporting aimed at giving a regular audit of progress and enabling recovery programmes to be instituted before it is too late for them to be effective.

Quality Management

This is necessary to ensure that the required characteristics are developed, designed, and built into systems and equipment procured for the Services. Quality Management is not to be confused with Inspection. It is not just a 'with-it' word for Inspection. Inspection is a negative business for rejecting things which are found to be wrong, and contributes nothing directly to designing and making them correctly in the first instance. Inspection is merely one element of Quality Management and by no means the most important one.

Quality Management is compounded of two complementary parts: Quality Control, which is what a reputable supplier should exercise, and Quality Assurance which is what any prudent customer demands. This needs elaborating.

Quality Control

Quality Control is defined as 'that function of direction and management which must be performed in order to make sure that the end product meets the user's requirements'. The achievement of proper Quality Control calls for:—

(*a*) Determined direction and management
(*b*) The required characteristics and quality implicit in the design, drawings and specifications
(*c*) Production processes that are potentially capable of producing repeatedly articles which conform
(*d*) Process control to realize this potential
(*e*) Inspection and testing to ensure that requirements have been met.

The first and probably the most important step towards effective Quality Control is taken when direction and top management are convinced that it is necessary and economic. It is astonishing how hard they often are to convince in spite of all the evidence. They must recognize that quality is everyone's business and accept that Quality Control needs to be administered in much the same way as the control of money and men.

Quality Assurance

Quality Assurance, which any prudent customer demands, must be obtained without weakening the producers' control of quality, or in any way diminishing his responsibility or vigilance. This is not easy because the customer or his agent must often be intimately associated with the supplier right through the process of development, design, manufacture and testing in order to obtain the required degree of assurance. Only in the case of straightforward materials and relatively simple articles can such assurance be obtained by examination and test after delivery. Certainly the Ministry of Defence could not obtain assurance of the required characteristics and quality in complex systems and equipment by nothing more than inspection and trials, however searching, immediately prior to acceptance into service. By the same token, main contractors or system managers need assurance of quality from their suppliers, and they in turn from theirs. In the case of warships there is a document called GRAQs (General Requirements for Assurance of Quality) which attempts to specify in general terms what the MOD need to get quality assurance. GRAQs tries to avoid telling the contractor how to control quality.

Quality Surveillance

The soundest way to obtain quality assurance is to exercise quality surveillance so as to verify the effectiveness of the producer's own quality control measures. Quality surveillance is probably achieved most effectively by keeping the following criteria under continuous and critical review:—

(*a*) The effectiveness of the organization and the attitude of the people in it
(*b*) Competence in the design offices, their knowledge of specifications and codes of practice and interest in feed-back from service use
(*c*) Systematic, comprehensive and integrated planning, and control to plan
(*d*) Process suitability and the effectiveness of process control
(*e*) The development of proper quality control techniques and their disciplined implementation and documentation
(*f*) Effective communication down to all levels and laterally across departmental boundaries
(*g*) The extent of study in value engineering and the control of cost-effectiveness.

Obviously such surveillance demands a very high standard from the MOD agents in the field who require experience and understanding of professional and technical problems, user requirements, and people and their management.

The Cost of Quality

We need to be very conscious of the cost of quality and quality control. High quality is expensive to produce—perfection infinitely so! Unnecessarily high quality is wasteful in first cost. Inadvertently low quality carries the risk of costliness in service; in military equipment failure may be catastrophic. According to Benjamin Franklin:—

> 'A little neglect may breed much mischief . . . For want of a nail the shoe was lost. For want of a shoe the horse was lost. For want of a horse the rider was lost. For want of a rider, the battle was lost.'

Therefore it is obviously prudent to exercise adequate control over quality to ensure that a uniform economic mean of quality is expressed in the design and achieved in its execution. Uncontrolled random departures from the economic mean of quality encourage a designer to specify unnecessarily high and expensive quality. He attempts, for example, to limit the consequences of random departures by increasing the 'factor of ignorance'. Thus proper control of quality is a fully justified and economic overhead charge, and there is no area where the old law about the high cost of low overheads applies with greater force!

Contractual Obligations

The contractual relationship between supplier and customer must be based on a reconciliation of two different motivations. On the one hand, the supplier is striving, at least in the long run, for an adequate return for his efforts and sufficient profit and potential to attract brains, skill and capital to his support. On the other hand, the customer wants satisfactory equipment on time that meets his requirements economically in first cost and costs of ownership, with a reasonable prospect in continuation. The contract is the device which harnesses and controls the profit motive to achieving the results the customer desires in terms of price, delivery and fitness for purpose. In creating a relationship a contract must be explicit, legally enforceable and acceptable to both parties.

Traditional Approaches

There are two traditional extremes: one the open-ended contract placed with a selected supplier on a cost plus percentage or fixed-fee basis; the other a fixed price arrived at by competitive tender. Neither is accepted enthusiastically by both parties. I say traditional, but I am told that Pepys 300 years ago used a form of competitive tendering for ships with penalties for late and bonuses for early delivery.

Incentive Contracting

Lately the MOD have been negotiating various forms of incentive contract. Both cost incentive and multiple incentive with cost and delivery are used. FIG. 2 illustrates such a contract. It will be seen from FIG. 2 that target cost is 100, target profit 10 per cent for delivery on time with increase of profit with decrease in cost, and decrease of profit with increase of cost until a ceiling price is reached after which loss is borne by the contractor. For early or late delivery, the other lines apply. In constructing such a contract it is important to have due regard for the trade-off between cost and delivery. Such a contract can be approached by a programme of options so contrived that it is in the interests of both parties to reach agreement stage by stage.

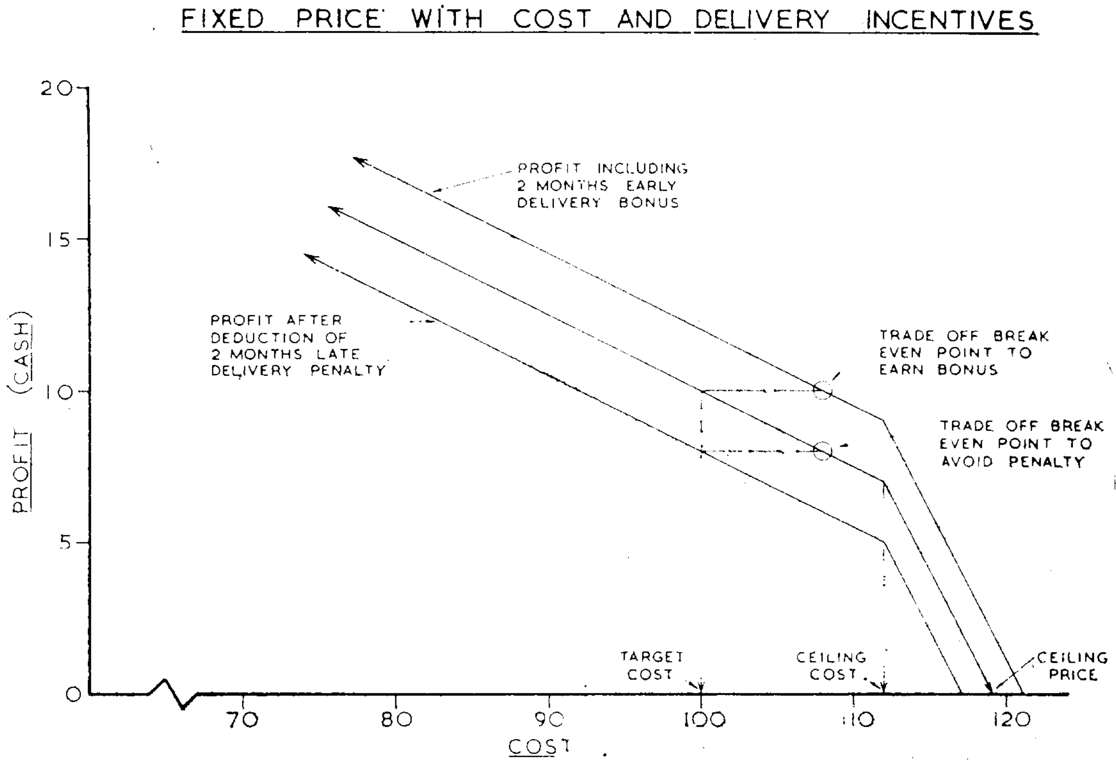

FIG. 2

Quite apart from any specific timely-delivery-incentive clauses in a contract, however, it often seems that the ill-effects of late delivery on profitability are not always fully recognized until it is too late to do anything about it. Customarily no financial recognition of the effects of wage escalation after contract completion date is allowed. The effect on a fixed price can be very substantial. Furthermore, in the manufacture of complex systems where the number off is small and the cost high, there is insufficient recognition of the extent to which investment in Work In Progress (WIP) can eat up profits. It has been suggested that often the extra manufacturing cost in speeding up work or having reserves of materials and components of cardinal importance, could be more than covered by reductions in servicing investment on WIP with consequential savings to the company in addition to any delivery bonus.

We still have a long way to go. All present contractual arrangements tend to highlight first cost and pay insufficient regard to the costs of ownership. The American Department of Defence have attempted to overcome this but so far have not really proved the value of their methods.

Feedback

Let us turn now to the question of feedback of information about service experience from customer to supplier. This is such a very obvious requirement, yet very difficult to meet satisfactorily, The user is a busy man so there is a tendency for too little information to flow. But attempts to correct this often produce a flood of information that is embarrassing because it is incomplete and undigested.

The efficient control of military cost-effectiveness requires the principal control loop to be closed by feeding back the digested results of experience in service to the conceptual stage. This is so vital to the military art that wars have been started or at least encouraged for the purpose. Nazi Germany's involvement in the Spanish Civil War is an example. Within the principal loop need to be many congeneric subsidiary loops. FIG. 3 is intended to illustrate this.

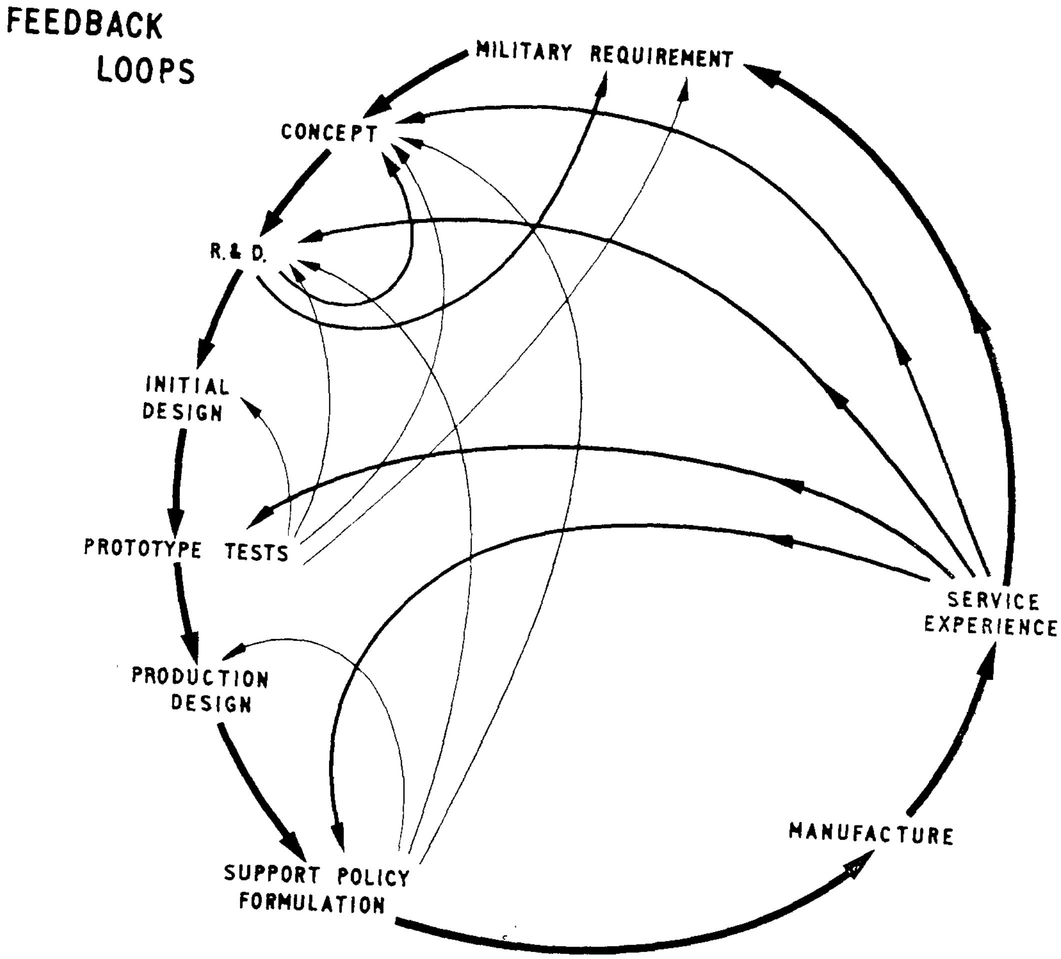

FIG. 3

It may be regarded as a complicated way of stating what is obvious but often overlooked, namely, that close co-operation and understanding between supplier and customer should continue throughout the whole service life.

Vigorous attempts are being made to improve feedback in respect both of the collection of data and of its digestion and assessment. For warships and their weapon delivery systems, the Ship Maintenance Authority (SMA) at Portsmouth have been at work for some years directing planned maintenance, analysing service experience, and feeding back both statistical data and detailed information about specific troubles. Plans are afoot to improve and extend this with the introduction of a computerised Ship Upkeep Information System (SUIS).

The Army

The outcome of the studies initiated in 1962 was a new system for the Feedback of Repair, Workshop and Reliability Data now known by its acronym FORWARD. Under this system the data is collected continuously over practically the whole range of Army equipment and sent to a data centre at Woolwich equipped with an ICT 1904 computer. There the data is processed to create a repair data bank from which output can be extracted in a variety of ways.

The Royal Air Force

The R.A.F. Central Serving Development Establishment, which has its H.Q. at Swanton Morley in Norfolk, provides project teams at contractor's works which give a practical slant to R and D and design. The Naval Air Technical Evaluation Centre works in a somewhat similar way To improve their present system, the CSDE are introducing a new maintenance data computer system for the R.A.F. which will satisfy Naval Air requirements too, and have data exchange facilities with the Army's data centre at Woolwich.

CONCLUSION

The Ministry of Defence is a very cost-concious customer; they are vitally interested not only in first-cost but in whole life-costs; and they are dedicated to getting value for money. If suppliers condemn the Ministry as being tightfisted, then taxpayers can but applaud.