

DESIGN, DEVELOPMENT AND RESEARCH IN CHEMICAL PLANT CONTRACTING*

How to avoid sources of friction among the departments of a contracting organisation engaged in plant design

by M. DAVIDMANN, B.Sc.

ONE of the main problems facing the chemical plant contractor is that of obtaining effective team-work.¹ For an adequate solution of this problem three requirements have to be satisfied:

- (1) the organisation has to be divided into functional work units;
- (2) line relationships have to be defined; and
- (3) functional relationships have to be defined.

An organisation's work tasks change in size and scope. Fresh problems are continually arising. Here we are concerned with difficulties arising from misunderstood functional relationships and from a division of work which is not functional, between the design groups and other work units within the chemical plant contractor's organisation. A process of working-through these problems is applied with illustrative examples. The cause of the difficulty is established, not in order to attach blame, but to ensure that the cause is removed. The organisation is then altered or functional relationships are defined, by policy decision, thus resolving the difficulty.

The process of working-through is not easy to carry out, but the results obtained by doing so are of value. Each policy decision is recorded and published within the organisation, so that, whilst efficiency of organisation is increasing, there emerges an ever-clearer picture of the chemical plant contracting organisation and of the responsibilities of its constituent work units.

Requests for Immediate Action

The unexpected request for immediate action in connection with the occasional emergency is made. A system of work planning² assists in assessing whether this work can be done without serious delay to other work and also assists in deciding priorities. In addition, and in each case, the cause of the difficulty is sought through successively higher levels of management until it is clearly established. Executives have failed to work together, or there exists some other management problem.

Design

The following serves as an example. Suppose that a particular plant contains a by-pass line from a high-pressure to a low-pressure gas main. The by-pass, which contains an automatic control valve, safeguards a gasholder. During

commissioning the chemical engineer finds that the by-passing system has insufficient capacity for its purpose, so that it has to be redesigned and modified. This constitutes an "immediate action" request. Not only is the necessary work done, but the matter is investigated.

The procedure that was followed could have been that the chemical engineer specified fluid flowrates, pressures, temperature and permissible pressure drop across the control valve. The instrument engineer's specification for a suitable control valve could have been accepted. The mechanical engineer could have determined line sizes, both upstream and downstream of the control valve, and the layout. The chemical engineer, in turn, could have approved the drawing.

The capacity of the by-passing system is restricted not by the control valve, but by the pipelines upstream and downstream of the valve, the lines being too small. The chemical engineer, while examining the drawing, had compared the by-passing arrangement with his flowsheet and, as these line sizes had been determined within another group, he had not checked them.

It thus becomes apparent that two design groups are, in this instance, doing overlapping work. Both Chemical Plant Design Group and Mechanical Design Group are specifying pipe sizes, and it is not clear where one group's work stops and that of the other starts. In this case it can be decided that, as Chemical Plant Design Group are responsible for satisfactory performance, they also have to be responsible for specifying all pipeline sizes. And thus the cause of the "immediate action" request is established and removed. Difficulties of the type illustrated by this example require a policy decision at the level of the Technical Department's manager.

Planning

Another example can be the sudden requirement for the performance testing of a small plant, at a contractor's own works, within a week of receiving the request. Say that a delay of two months had occurred between receipt of order by Sales Department and issue of timing chart by Planning Department. Delivery of the plant may have been promised nine months from receipt of order and the initial delay had already caused dislocation of work. The policy of working-through and resolving each request for immediate action had not been instituted and the matter

* Article received for publication July 27, 1959.

had not been investigated. Furthermore, that Chemical Plant Design Group had been unaware that performance testing of this plant was imminent. It was decided to take up both instances.

The lesson learned is that this group's work takes place both at the beginning and at the end of a contract. To enable it to plan its work, early notification of receipt of order and of overall timing plan are required. Also, this group's overall timing plan has to be kept up to date by Planning Department, so that the group can adjust its work plan in accordance with progress made by other work units.

A difficulty of the type just illustrated requires a policy decision at a level higher than that of the Technical Department's manager.

A further example of a request for immediate action is the requirement to start work immediately on a contract the moment the group is notified that the order has been received. This is usually caused by delay between receipt of the order and notification to the group; and/or by an insufficient time allowance for the planning of the work in the estimate of delivery period. However, such a request for immediate action may also be the result of a policy decision to quote the shortest possible delivery time to obtain the order. Assuming the group to be fully loaded, then the initial policy decision results in further policy decisions being required when the order is received, to decide relative priorities and permissible delay to other work.

Development

Difficulties can arise between a Chemical Plant Design Group and a Development Department. The following are typical examples:

- (1) The design engineer, in Chemical Plant Design Group, is responsible for work on a particular type of unit process plant. He may be approached by a development engineer with the request for information on how he designs his plants. Detailed information is requested to enable the development engineer to design a plant of this type which will form part of a plant at present being designed by Development Department. The design engineer refuses to give this information, reporting his action to his executive superior.

The design engineer considers that to give comprehensive information on his own methods and experience will involve a considerable effort on his part. Indeed, he will not be able to pass on his accumulated experience and he is, indirectly, being asked to supply a few factors and coefficients for the development engineer to use. As design engineer he is being given insufficient data to carry out the design and the development engineer for his part will have insufficient practical experience to use critically any information given to him. Should Development Department's plant fail to achieve specified performance which in his opinion is a distinct possibility, then he, the design engineer, may be held responsible.

The development engineer considers that as this unit process plant is part of a complete new process plant in course of development, it has to be designed by Development Department, as they are responsible for the success or otherwise of the plant as a whole.

- (2) For an inquiry two specifications can be received by a Commercial Department for the same unit process plant, one originating from Chemical Plant Design Group, the other from Development Department. The Chief Chemical Engineer considers this to be a straightforward inquiry; the Chief Development Engineer considers that as no plant of this large

size has been built before it clearly constitutes development work.

- (3) A design engineer, on contacting the supplier of a certain type of specialised equipment, finds that a quotation is being prepared by this supplier for Development Department. But Chemical Plant Design Group, acting for the organisation as a whole, have some considerable time ago negotiated a favourable agreement with this supplier, which results in considerably reduced costs with consequent improvement in the competitive position. Development Department are unaware of the existence of this agreement and have phrased their inquiry in such a way that no benefit is obtained from the agreement.

The head of the Chemical Plant Design Group is the Chief Chemical Engineer, and he is responsible for chemical engineering design, for commissioning and proving. The Development Department's manager, the Chief Development Engineer, is responsible for the development of new processes, of new design methods and of new plants. In addition, there is the Research Department, engaged on pure research. Each of these three work units carries out chemical engineering design for inquiries and contracts. Which unit does the work depends on the degree of novelty.

Considering the Chemical Plant Design Group and the Development Department, it may not be clear where the work of one group ends and where that of the other starts. Sometimes the engineers in the two groups may be attempting to do the same work and consequently a large amount of work is duplicated. There may exist a decided lack of communication between the two groups, with the result that one group derives little benefit from the work of the other. However, plants designed by Development Department generally contain some parts designed by Chemical Plant Design Group, so that the two groups appear to work together in harmony. In fact, they may be competing against each other for work, a struggle for ascendancy taking place between them. Such conflict is detrimental to the organisation as a whole.

It appears that the work to be done by each group has not been stated clearly, so that responsibility for work cannot be assigned to one or other of the groups. Functional relationships also have not been clearly defined; this being another reason why responsibility cannot be assigned clearly.

The organisation's task, as far as this analysis is concerned, is to provide chemical plants for customers. To carry out this task, the work is divided. Development Department is charged with developing new processes and design groups are charged with designing plants. As organisation, to be effective, has to be functional, all design work has to be done by the design groups and all development work by Development Department.

A design group may require development work to be carried out in connection with a design method or in connection with basic data required for design. This should be done by Development Department, at design group's request, for the design group. Development Department may require design work to be carried out in connection with a development project. This should then be done by the design group for Development Department, at the request of Development Department.

However, this procedure still leaves room for doubt about the division of work between the two groups. It is not clear at what stage any particular process ceases to be a development matter, to be dealt with from then on by Chemical Plant Design Group. Neither is it clear just who is responsible for the performance of a pilot or prototype plant. However, as Development Department is charged with developing new processes—this being a direct contribution to the organisation's task—they have to be responsible for such work. It follows that as long as a

plant is required by Development Department to enable it to develop a new process, the plant thus being paid for out of their development budget, they are responsible. If a plant is required for production purposes, being paid for by a customer, Chemical Plant Design Group is responsible. Hence as a pilot plant's purpose is to develop or prove a process, and as it is paid for from Development Department's budget, Development Department is responsible, design work being done for them by the design group. A prototype plant is a production model, paid for by a customer; Chemical Plant Design Group is responsible, development work being done for them by Development Department. Development Department is responsible for pilot plants; Chemical Plant Design Group for prototype plants.

It is further clear that Development Department would not be charged with developing a new process were the relevant information already available to the organisation, and, similarly, a design group would not ask for development work to be carried out on basic data or design methods, should the information be available already. It follows that the function that has been assigned to Development Department is, in fact, the search into the unknown; that is, research.

If a design group is responsible for designing, it is responsible also for the quality of its design work. For example, the Chief Chemical Engineer is responsible for chemical engineering design, for commissioning and proving, for satisfactory operation and performance of the plants designed by his group. He is therefore responsible also for comparing actual results with predicted results and for correlating conclusions so as to improve future designs. It is this process of comparison, correlation and improvement which is called development.

At this point of the analysis, one may consider also the relations between Development Department and Research Department. Conflict may exist between these two work units also, Development Department attempting to take over research work. Similar conflict may exist also between Development Department and Mechanical Design Group.

The picture that may then emerge is that of a large work unit, namely Development Department, without real function, trying to find a purposeful existence and satisfying work, doing this by attempting to take over work from surrounding groups and thus coming into conflict with them. The overall picture would then be of an organisation under internal stress over an appreciable area of primary activity.

Design and Research

To ensure effective team-work between Research Department and the design groups, the division of work between them has to be clearly stated and functional relationships have to be defined, as indicated by the following example which defines the responsibilities of, and functional relations between, a Chemical Plant Design Group and a Research Department.

Definitions

In an effective organisation each work unit has to be responsible for, and carry out, a separate specialist function essential to the carrying out of the organisation's task. In the case of the chemical plant contractor, the organisation's task is to provide chemical plants and this task may be subdivided functionally into "direct" and "indirect" work tasks.

A direct work task is one which is directly concerned with the carrying out of the work of the organisation as a whole, examples being the designing of a plant for a customer, or research into new processes so as to extend the range of plants offered to customers.

The executive responsible for carrying out a direct work task is the "responsible" executive.

An indirect work task is one which is indirectly concerned with the work of the organisation as a whole. Examples are the work done by a personnel department or that done by an executive in one work unit who is providing a specialist service for the "responsible" executive in another work unit.

The executive responsible for carrying out an indirect work task acts as specialist adviser; that is, he is the "prescribing" executive.

Relationships between executives in different work units are functional relationships. Of the two executives concerned, one is "responsible", the other "prescribes". The responsible executive is fully responsible to his executive superior alone for obtaining specialist advice, for accepting or rejecting this, and for reporting useful results back to the prescribing executive. The prescribing executive is fully responsible to his executive superior alone for giving specialist advice and for the quality of his prescription.

The same executive may be responsible for the carrying out of both direct and indirect work tasks. Where this is not clearly seen, and when the difference between the two types of tasks is not understood, then difficulties may be expected. It is important, therefore, that the type of task be clearly realised, in each case, by the executive who is carrying it out.

Chemical Plant Design Group

The head of the Chemical Plant Design Group is entitled Chief Chemical Engineer. He is responsible for chemical engineering design and development, for commissioning and proving, for satisfactory performance and operation of the chemical plants designed by chemical engineers working in this group. By development is meant the comparing of actual with predicted results and the correlating of the conclusions so as to improve the quality of the group's work. All chemical engineering design work that requires to be done within the organisation is carried out by chemical engineers working in this group. Their work consists of both direct and indirect work tasks. Their direct tasks consist of chemical engineering work on plants for customers; their indirect tasks consist of carrying out similar work for the organisation's other work units.

Whilst carrying out a direct work task, the chemical engineer is the responsible executive. Whilst carrying out an indirect work task he is the prescribing executive.

Research Department

The head of the Research Department is entitled Research Manager. He is responsible for effectively searching for new processes. All research work that requires to be done within the organisation is carried out by scientists working in this department. Their work consists of both direct and indirect work tasks. Their direct tasks consist of searching for, and evaluating, new processes. Their indirect tasks consist of carrying out research work for the organisation's other work units.

Whilst carrying out a direct work task, the scientist is the responsible executive. Whilst carrying out an indirect work task, he is the prescribing executive.

Author's Note

We have defined here the division of work and the functional relationships between two work units, but not the complete activity of either, being concerned only with that part of each work unit's activity which may affect the relations between them.

REFERENCES

- Davidmann, M. "Problems in Organising Chemical Plant Projects." *British Chemical Engineering*, 1959, 4, 7, 403.
- Davidmann, M. "Planning the Work of a Design Group." *British Chemical Engineering*, 1959, 4, 11, 589.