OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

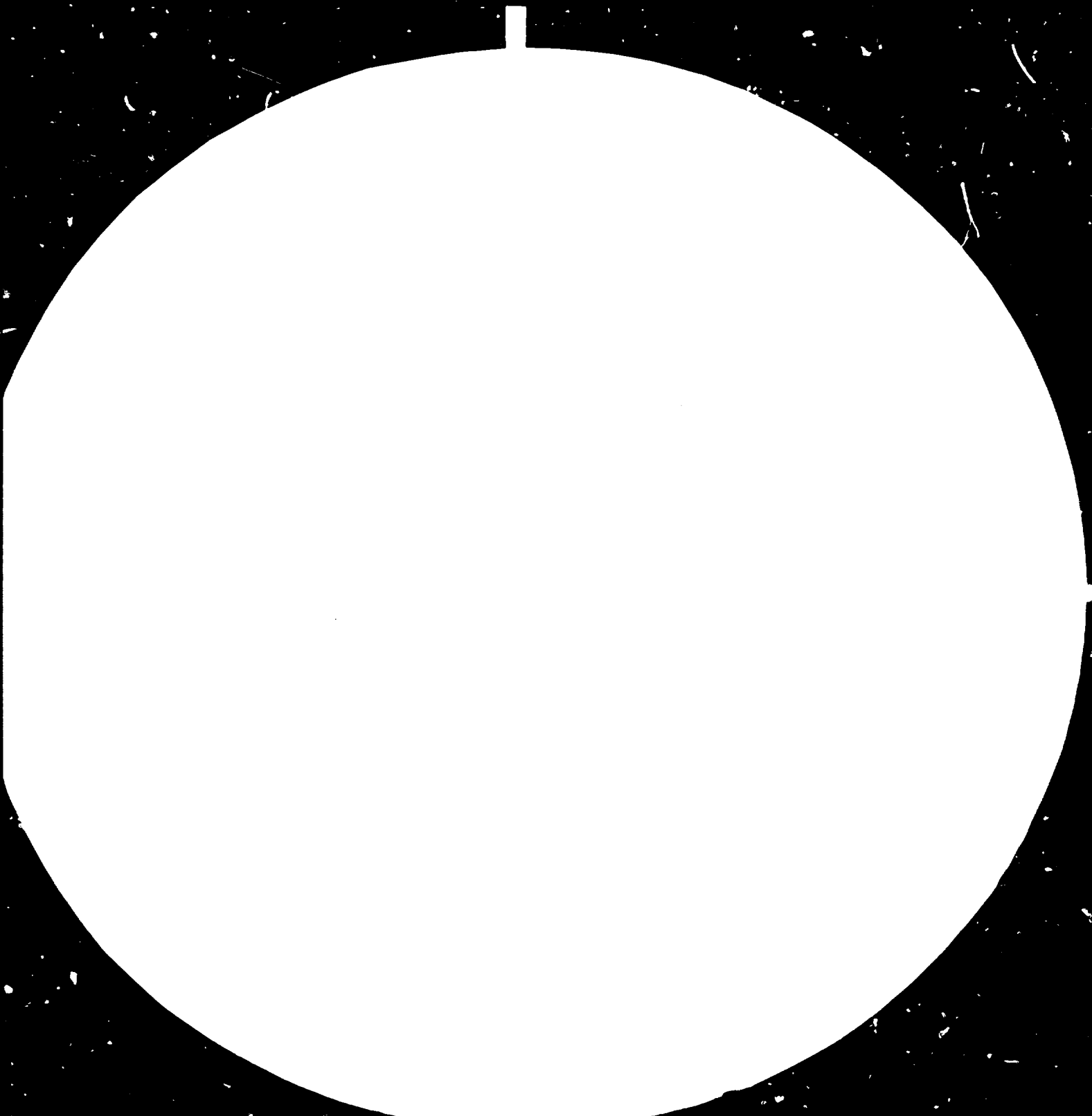
Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

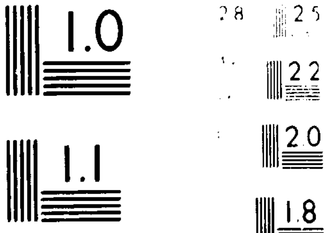
Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org




1.25
1.4
1.6


1.0
1.1
2.8
2.5
2.2
2.0
1.8

11396

Distr.
LIMITED

ID/WG.368/9
19 April 1982

ENGLISH

United Nations Industrial Development Organization

Petrochemical and Polymer Consultation Week
Porto Alegre, Brazil, 17-21 May 1982

THE TECHNICAL CENTRE IN AN INDUSTRIAL COMPLEX*

by

Alvin H. Weiss**

2874

* The views expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

** Professor of Chemical Engineering, Worcester Polytechnic Institute, Worcester, MA 01609 , USA.

V.82-24779

THE ESTABLISHMENT OF A TECHNICAL CENTER

1. Organization of the Industrial Complex

As a first step in defining the role that a Technical Center can serve in an Industrial Complex, consider Figure 1. This shows the business structure of a mall Complex. Ab initio, an Executive Organization exists in which the organizing parties are represented. Included are the parents of the operating companies, A,B,C, government agencies, financial interests, and perhaps, the companies X and Y that are committed to raw material supply and product purchasing. Presumably, only a fraction of the sales or purchasing of Companies X and Y depend on the Complex.

With a given raw material availability and product demand assured, the interactive capacity of the Complex is fixed. Financial agreements and contractual commitments are then made between the companies in the Executive Organization. Each of the operating companies shown must then select available technology to produce their product, license that technology, and engage Engineering and Construction firms to build their plants at the Complex. Companies X and Y probably do not need large scale new physical facilities at the Complex.

In that each operating company is a profit-making organization, internal decisions may be made to produce and market products beyond the level of commitment to the Complex. Thus, an operating company will ultimately have its own individual business activities proceeding in parallel with its commitments to the Complex.

The transfer of technology and business information between the operating companies will involve that information needed to meet their mutual contractual commitments. This occurs at a plant operating level, and is indicated by the transfer functions in Figure 1. Interactive information such as product quality, product quantity, and scheduled and unscheduled shutdowns must be transmitted and coordinated.

2. Technology at the Plants

Each of the operating companies will most likely have a turnkey plant designed and constructed. The licensor specifies catalyst and operating conditions and provides a start-up team who trains the local operators. Once

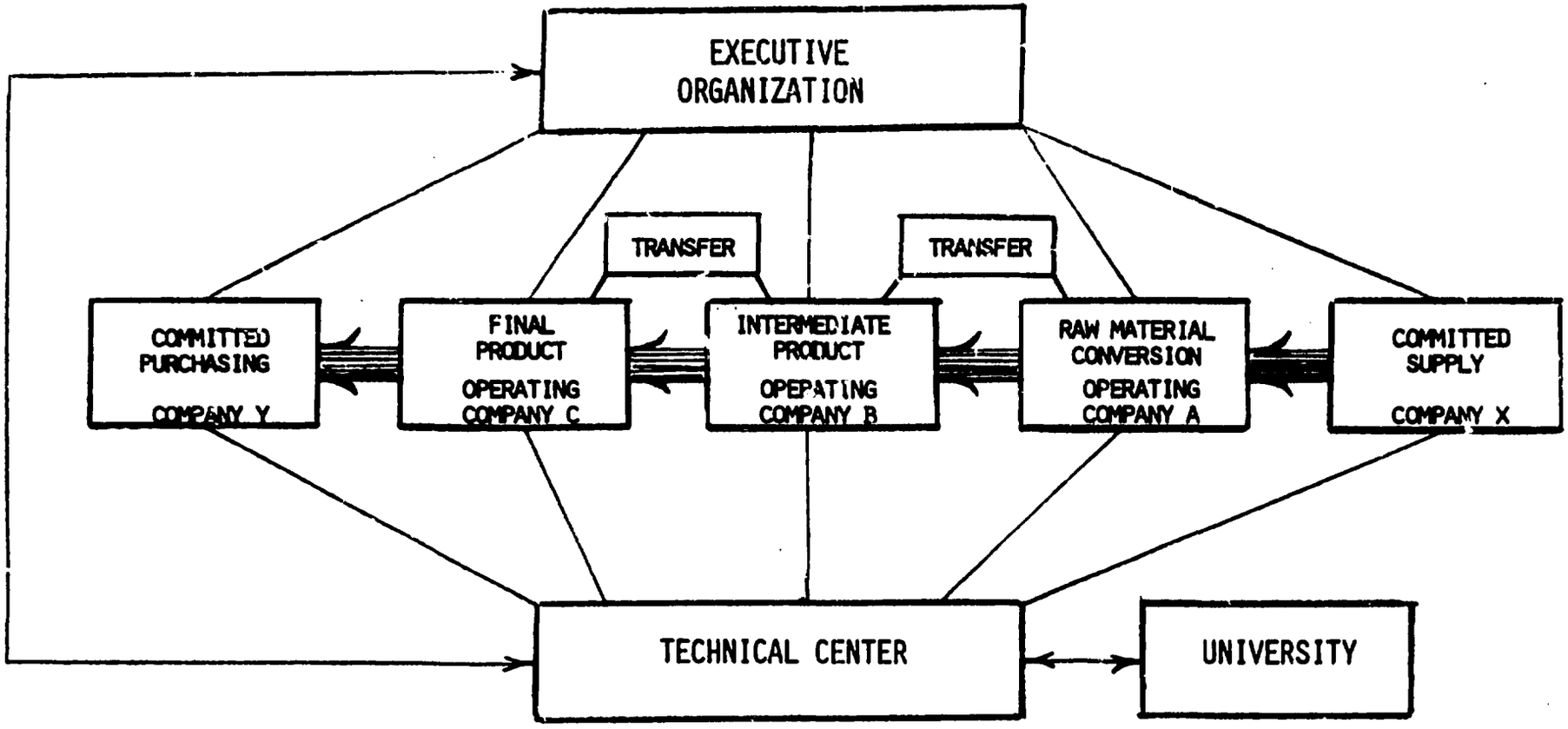


FIGURE 1: THE TECHNICAL CENTER IN AN INDUSTRIAL COMPLEX

the unit is operational, a "Guarantee Run" is made and operational responsibility is turned over to the local company.

All of the companies of the Complex, A,B,C and X and Y will require a level of technical expertise and capability associated with the technology of their plants and daily manufacturing operations. Thus, they will have laboratories, computation facilities, maintenance, engineering and technical service groups capable of handling daily problems in production, product quality, safety, health, pollution, corrosion, customer service, etc. In other words, in no way can a company abdicate any technical aspect of the care and operation of their plant or of the manufacture and sale of their product. They alone must maintain direct responsibility for meeting their regularly occurring needs.

However well these technical capabilities meet the needs of each plant, they do not accomodate the overall integrated needs of the Complex. Problems can arise involving more than one company - e.g. establishing central fire protection facilities, common instrument repair and machine shops, trade schools for journeymen in short supply. These require the continuous attention of the Executive Organization, which in general can authorize funds and activity to resolve an issue by forming an ad hoc action team staffed from the companies, at least initially.

3. Organizing a Technical Center

The Technical Center for the Complex is one such action team that is so large and expensive that it should not be organized by the operating companies, but by the Executive Organization. The need for a Technical Center should be anticipated from the very start, and its organization and implementation is at the time when financial arrangements and contractual commitments between the companies forming the Complex are made. In this way, the missions and scopes of the Technical Center are defined and its funding guaranteed.

If the Complex were a group of plants of one large diversified multiproduct company, such as duPont or Exxon, the Technical Center would be immediately visible as the corporate Central Research and Engineering Department. It would have a key policy position in the company's technical organization. In the case of a multicompany Complex, the Technical Center is not really part of any one company. Consequently, its policy impact

will be significantly weaker. It will be appropriate for it to work through the Executive Organization of the Complex on problems involving more than one company. On work directly with a specific company, interactions, of course, will be direct. Even so, the Technical Center, in the final analysis, will be accountable for its activities to the Executive Organization.

On a hierarchal basis, the Technical Center is a Service Organization for the operational and business activities of the Complex. It exists to help the Complex, but its functions are not critical to operation, such as those of each company are. This is suggested by its position on Figure 1, in that it reports to the companies as well as to the Executive Organization of the Complex. Note that the Technical Center will ideally be affiliated with a University, in order to take advantage of the University's supply of students and technical talent.

4. Functioning of the Technical Center

So far, the position of the Technical Center in the Complex is defined, but not its functions. If a one-sentence mission is desired, it might be: "The Technical Center will provide to the companies of the Complex every professional service that is efficient for it to render and that is outside of the realms of both normal operation and customer contact."

In other words, once again, the plants cannot abdicate their own responsibility for day-to-day operation, for maintenance, for quality control, for interaction with their customers. Everything else becomes a matter of decision - should a task be done in-house or by the Technical Center? Production and sales tasks cannot be passed to the Technical Center, except as well-justified exceptions.

The Technical Center requires a base level of funding to maintain its staff and activities. Typically, this might be an annual assessment from each company by the Executive Organization. The actual amount of funding could be a percentage of sales value, of capacity, or some other agreed-upon amount. Each company of the Complex is thus entitled to some level of access to the Technical Center's services. Specific jobs are done on a contract basis, at the same rate for all participating companies. The Technical Center must maintain high efficiency and low overhead, or it will lose business to the companies themselves. The companies always have the option to make the decision to have their own technical people do a task rather than contract it to the Technical Center.

It is conceivable that the Technical Center will benefit from executing contracts from outside of the Complex. Such tasks may smooth out fluctuations in activity or increase utilization of special equipment, etc. However, the first responsibilities of the Technical Center are the needs of the Complex. In only the rarest case can these be secondary to the pressures from outside contracts.

The position of the Technical Center with respect to ownership of patents resulting from its activities must be clearly defined, both for companies of the Industrial Complex and for outside contractors. The inside and outside positions may be different, but in the case of the Complex there should exist no unfavorable restriction that would cause a company to not be able to have the Technical Center work in certain areas.

Similarly for proprietary information. The companies will be placed, most likely, under strict secrecy constraints by their licensors. The agreements executed should include rights to information access - a need to know - by the Technical Center. Otherwise, the Technical Center will be precluded from rendering important help to the plants. On its part, the provisions to honor and safeguard (at the Technical Center plant) secrets and proprietary information should be foolproof.

FACILITIES AND FUNCTIONS of THE TECHNICAL CENTER

1. Computation

Pooled resources will be able to purchase and staff a far more sophisticated Computer Facility than an individual plant can justify. Professional programming projects or help to plant engineers can be provided by the Computation group. Courses in programming and computer application can be given either in-house in plants or at the Technical Center. Remote terminals at each plant can provide access either to open or to the plant's own proprietary data banks and routines. Commercially available design, thermodynamics, and other program packages can be purchased and used to the advantage of the overall complex. Most companies will need some level of in-house minicomputer capability. The Computer Facility will provide an extension of that capability for the special jobs that come up. As a consequence, the Technical Center itself will have at its disposal a major

computational facility to execute its projects.

2. Information Storage and Retrieval

Book purchases as well as subscriptions to services such as Current Contents, Citation Index, Chemical Abstracts, and to technical journals have become prohibitive in costs. Both cost savings and availability are obvious merits of having technical library and literature search capabilities of a Technical Center available for the entire Complex and Technical Center staffs to use.

The Library of the Technical Center is a clear example of a central facility's economic advantage in both avoiding redundancy and in providing justification for employment of a professional librarian. The services of such a person may not otherwise be economically possible for a single plant. The Library of the Technical Center, because of its specialization, will most probably evolve into an important resource for the entire geographic area that it is in.

3. Education and Training

One of the truly key roles of a Technical Center is Training. This takes many aspects, and can proceed even prior to construction of the plants of the Complex. Engineers from the plants - and from the Technical Center - need advanced training in technical areas of importance to the Complex. This can be highly formalized, such as fellowships to universities for advanced degrees. The fellowships can also be very practical - e.g. industrial fellowships to plants identical to those of the Complex. These types of fellowships usually last six months or longer and are administered through the Technical Center.

Shorter educational travel is also rewarding. There is great benefit in sending groups of future maintenance and operating technical personnel on trips to learn the details of units similar to the ones they themselves will soon operate. These trips arranged by a Technical Center, typically one month, are designated Study Tours. They and the Fellowships are the type of training activity funded by UNIDO. Fellowships and Study Tours are considered to be a key factor in developing production and Technical Center personnel quickly to the level of their peers in other parts of the world.

As mentioned before, there are advantages to be had if a local

university is available to either interact with the Technical Center or even to start the Technical Center. Many university Professors are the type of imaginative, competent engineers that are needed for the leadership roles in the Center.

There can be quite a synergism between a university and the Technical Center. Research instrumentation and laboratory facilities can be made available to both graduate and undergraduate students. Thesis projects can be selected to be the problems of the Complex. When the students graduate, they will have been well-trained to work in the companies of the Complex.

Outside experts can be brought to the Technical Center to consult with particular plants. While they are at the Complex, they can give courses in their specialty, both short courses and graduate courses. These can supplement in-house and in-plant short courses and academic courses given by Technical Center and plant staffs as part of on-going training and educational activities. Expensive process and control simulation training devices can be made available by the Technical Center to the plants.

The flux of technical people into and out of the area also makes the organization of technical meetings feasible. This is but one type of professional activity that the Technical Center can foster, with the ultimate goals of developing the level of expertise of staff at the Complex and of attracting professionals from other areas to work at the Complex.

No small impact of the Technical Center should be its employee turnover to the plants of the Complex. Engineers and scientists at the Technical Center will develop close working relationships with the plants. They will, in effect, be trained by the Technical Center to take a position in one of the plants. This turnover should be strongly encouraged where natural, but not forced.

4. Engineering and Economic Studies

Market Research and Market Development studies, new feedstocks and products, plant expansions, new plants for the Complex are the type of long range economic problems that can be addressed as projects at the Technical Center. Similarly, some share of on-going Engineering and Technical Service problems of the plants can become projects at the Technical Center. These would not necessarily be problems of the moment that are affecting plant

operation, such as equipment failures or off-quality product. Rather, longer range engineering studies for optimization or improvement are the jobs most likely to be delegated by the plants to the Technical Center.

Ferreting out plant problems or technical needs by the Technical Center is no small task. There must be close interactions, mutual respect, and good relations between individuals at the working level. And there must be absolute certainty that company secrets and proprietary information will not be divulged or leaked by the Technical Center. A good way to establish the necessary rapport between the Center and a company is for each party to assign liaison responsibility to a key staff member. The two individuals meet and interact constantly, and both are totally familiar with the plant in question. When a problem or potential project arises at the plant, both liaison engineers then bring together the appropriate people of the Center and of the plant to resolve and clarify the issues, agree on an approach, and where justified, to initiate a project.

Engineering and Technical Service projects may require considerable activity at the plants by the Technical Center personnel. Operating data may need to be gathered and analyzed, measurements taken, instrumentation or test devices installed and monitored. There should be no administrative hurdles impeding access to the plant, but, by the same token, on-site activities must be done safely and in coordination with normal production operation. Most (if not all) of the data analysis, computation, engineering studies, report writing, etc. can be done by the ad hoc Project Team off site at the Technical Center.

Not only the library, design, and computational facilities of the Technical Center are utilized for Engineering and Technical Service Projects, but also experimental capabilities may be called upon. Data may be needed from laboratory and pilot plant process variable studies, special analyses, tests, or method development. Obtaining necessary physical and chemical properties data are types of non-routine laboratory services that can be provided on Engineering and Technical Service problems by the Technical Center.

5. Research and Development

As mentioned, the processes that are used in a Complex are licensed generally as turnkey plants. This means that there is no need for any new

technology to be discovered to meet the guarantees of the licensors. In fact, the plants are generally so inflexible in design and construction that it is neither possible to apply new technology nor to make significant changes in the operation of the process. If the plant is operating at its design point, there is also little inclination or incentive by production personnel to make any changes. The most desirable situation in a Complex is that plants operate permanently at fixed conditions, producing products at designed yields.

However, incentives can develop. It may become necessary to increase throughput of the process. Or such a yield improvement can result from a change in operation or catalyst that it becomes worthwhile to take some risk and to try the change. New feedstocks may become available or the market may demand a different product quality.

The consequence is that a Technical Center may be obligated to build and operate pilot plant simulations of key process units. Constrained process variable and catalyst studies, as well as life tests for the purposes just described, are typical of the R and D support required by a commercial process. Corrosion studies, pollution, by-product disposal, energy conservation are other experimental areas where data must be obtained to solve plant problems.

The R and D described is directed to operational needs of the plants of the Complex and to product quality and application studies that are distinct from customer service. The R and D that the Technical Center does on behalf of the Complex is generally focused very tightly on the needs of the Complex, not on basic generation of knowledge. Thus, process development would be more reasonable if it were a process to neutralize effluents in waste streams, e.g., rather than a new process to make the product or intermediates.

Why is this? First realize that it is not the business of the Complex to divert its technical efforts into the discovery of a major new product or process. The business of the Complex is to manufacture its products, not to license processes. Aside from the prohibitive costs that are involved in process or product development, there are great technological and financial risks in implementation. Who will take the risk of investing in the first plant? Suppose it does not work? The conservative approach

for all but the very largest companies is to license existing and proven technology to manufacture conventional products. Unless one is in the process licensing business - and perhaps even then - a lucky accident may be the only thing that gives birth to a new process or product. How to capitalize on it becomes another business - not the business of the Complex.

In most cases, the situation is that of financially conservative companies manufacturing conventional products by conventional processes. There probably is a dearth of understanding of the specific technology because of the secrecy generally involved in the processes, even rather old ones. The licensees are in all probability committed to secrecy agreements with the licensors that will seriously restrict patent and publication rights on any R and D that is done. Basic and exploratory research that can be applied to useful ends by the Technical Center, because of this dependence on outside technology, is consequently constrained, even though there may be obvious gaps in knowledge.

In the Technical Center it will be necessary to have one or more outstanding Principal Investigators. They will lend their prestige and scientific leadership to the entire Complex and be the focus of basic research activities (either by permanent employees or by thesis students). Such individuals will have established their area of research expertise, and, of course, have an obligation to relate it to the interests of the Complex. But the principal benefits of the truly basic research to the Complex most often will be the training function and the image of a first-rate technical organization. A Complex producing polymers would indeed be well served by basic research that generates information of interest to the international scientific community on catalyst nature or rheological phenomena not before known. The Technical Center would be recognized as a Center of Excellence in its field, and the payoff is in values that will motivate and develop the Center. Basic research should really be basic, seeking knowledge mainly for its altruistic values. A Technical Center with no level of basic research will risk obscurity in the international scientific community, will miss attracting some of the finest people, and will, in effect, be forced to operate with a level of understanding omitted.

Applied Research is the backbone of the Technical Center. Process phenomena that have economic impact - e.g., catalyst deactivation, fouling of

surfaces, degradation of product - must be characterized. All of the Applied Research Projects are directed toward obtaining understanding and information that will be needed in a plant for one reason or another. Usually the need is not immediate, but is projected as a possibility in the future. Because of this extended time element, the Applied Research Projects generally proceed at a slower pace and on a smaller scale than do Technical Service or Development Projects. An example is the question "What must we do to avoid the harmful effects of increased impurity levels in feedstock - that we may buy at some time in the future? or - that we are now receiving?" The frenetic level of the activity and the type of tests required to answer the second question is the world of Technical Service, Engineering Studies, even Development. Anticipation of information needs is the world of Applied Research.

Development is last on our list of R and D functions, but it is first as a rule in size of staff and budget requirements at the Technical Center. Pilot plants with units large enough to provide practical simulation of the key processes are usually required to operate on a round-the clock basis to reach steady state. This requires a staff of operators and support personnel. The problems become very specific - reduce coking in a furnace, eliminate specks in a product, raise yield one percent, predict catalyst life - and so does the equipment become specific. Applied Research merges into Development as scale increases and time framework decreases.

Development obtains experimental information that is needed relatively quickly, but not at the very instant. Lab scale, pilot plant, or even plant scale experimentation is necessary to solve a Development problem. The responsibility for operation of pilot units and their scale means that the Development groups frequently find themselves doing experimental studies that are in effect Engineering and Technical Service problems of the moment.

Development, as its name suggests, also means the development of methods, of new processes, of equipment, process and product modifications. The development of any of the above, however, implies that the result is something that is needed by the Complex. Decisions for implementation or application proceed as soon as results are available.

The important differences in Basic Research, in Applied Research, and in Development are in the type of individuals involved, in the level of funding, in the scale of operation, in the timing for use of the information

generated, and, of course, in the reasons for obtaining the information. The differences are great enough to justify a structure in the Technical Center with three such activities separated, in spite of their frequent overlaps.

6. Product and Process Task Forces

When the technology is unique enough and sole purpose instrumentation and equipment are needed, there is justification to organize highly specialized groups in the Technical Center. Examples are polymer and corrosion groups. Because such a group is typically small, the activities will cross Basic Research and Applied Research and Development lines, depending on the problem of the moment. The technology of such a group is usually so tight and constrained that they do not have the flexibility to work on general problems in the Technical Center. It is important, in staffing and equipping these specialized task forces, to project a continuing level of need for the specialty.

CONCLUSIONS

An effort has been made to generalize the concept of organizing a Technical Center for an Industrial Complex. Admittedly, a Complex can function without such a Center, each company of the Complex handling all of its own needs. However, and this applies particularly to Complexes geographically distant from industrial regions, the first consequence is that the pool of high level expertise will be unavailable to each and every plant of the Complex. The manpower pool of the Technical Center doubles or even triples the on-site technical resources that a plant can call on.

As a practical matter, if there is no Technical Center, plants will make-do without certain particularly expensive facilities, without the supplemental training that could have been had, without the results of projects that are lower than crash on the priority scale.

There will be no way to really determine if, in the course of time, such an Industrial Complex will have experienced enough shutdowns, yield losses, or low product quality to have justified costs of the Technical Center many times over. However, if ab initio the cost structure of the Complex is so fragile that there is no way to afford a Complex, then one should wonder at the advisability of proceeding with the planned project. If projected costs are but a small fraction of the overall cash flow and investment of the Complex, then there is no way to rationalize away the technical benefits that are possible.