# TECHNICAL SERVICE

## 1. Introduction

The fundamental objective of technical service in the chemical industry is to provide timely and professional information and support to downstream customers regarding the uses of chemical products. It is neither cost-effective nor necessary for a consumer of chemical products to develop a staff of specialists having detailed expertise in all aspects of chemical raw materials and their uses, particularly in a time of increasingly complex and rapidly technology-driven economies. Rather, this variety of expertise is provided in the chemical marketplace by technical service professionals whose knowledge and skills are made available by chemical product suppliers. As such, successful chemical companies provide technical service as a critical element of their offerings to the marketplace making use of this aspect of the value chain to enhance their competitive position.

Technical service as a field of endeavor within the chemical industry is a relatively recent phenomenon, largely relegated to the period from the 1920s to the present. The great European chemical companies began providing petroleum-based raw materials and dyes and pigments in the latter half of the nineteenth century (1). During the first half of the twentieth century, many breakthroughs, eg, nylon, rayon, polycarbonates, penicillin, fluorochemicals, and antiknock additives, were made (2–4). The manufacture and supply of chemicals rapidly diversified and entirely new materials became items of commerce. The barrier for research and manufacturing personnel in embryonic industries, eg, synthetic fibers, polymers, and large-scale organic syntheses of agricultural and pharmaceutical materials, to remain fully knowledgeable regarding the nature of raw materials and intermediates provided to their operations by other firms became effectively insurmountable. It therefore became incumbent on these suppliers to develop a means by which answers to questions regarding these materials could be readily obtained. This situation was a primary driver in the origins of what has become known as technical service.

As the twentieth century progressed, Dow, Monsanto, DuPont, Union Carbide, Bayer, BASF, and other large firms began training personnel to provide both direct technical service to customers and to participate in a wide variety of developmental programs aimed at improving financial performance by providing greater value to their customers (5). An example of the support of these efforts was the construction at DuPont in the 1950s of the Chestnut Run Technical Service Laboratory near Wilmington, Delaware. This complex was constructed to support personnel involved in direct technical service interactions and to provide laboratory and testing facilities (laboratory-scale through semiworks, in many cases) for a broad range of DuPont products. It was deliberately constructed near the home of DuPont's Central Research and Development Division, thus allowing for ease of interaction between personnel at the two sites (6). A large level of support was also reflected in the actions of Union Carbide, as the firm designated its Tarrytown, New York, site as a technical service laboratory in the early 1960s. The presence of a formal technical service function in the U.S. chemical industry rapidly became ubiquitous.

The general focus of technical service in the chemical industry was, at the outset, largely tied to a firm's direct sales and marketing efforts. As applications became more complex, however, and customer requirements became increasingly specific, a need evolved in many areas of the chemical industry to provide in-depth technical support having direct ties to the research and manufacturing functions. This allowed rapid responses to the increasingly demanding needs of customers. Some firms took the approach of placing the technical service function into the research and development organization. This could be viewed as placing the three critical aspects of what is generically looked upon as the research function, ie, research, development, and technical service, into a single function. An example of this was the Development and Technical Service function within Dow. Other firms created stand-alone technical service organizations. The stated mission of these organizations was originally restricted to direct customer support. Some firms trained their field sales personnel to act also as technical service professionals, a practice used by many companies up to the present time. Experience has demonstrated that regardless of what the technical service function calls its home organization, the integrated organization generally surpasses the performance of one that is held as a physically separate function (7).

## 2. The Spectrum of Technical Service

Some firms have seen fit to blur the distinction between technical service *per se* and the research function. Others maintain a technical service organization as a stand-alone function while maintaining a high level of integration with other functions such as sales, marketing, research and development, and manufacturing. This integration is a critical structural element in ensuring the provision of up-to-date technical information to customers and in allowing the preservation of a two-way conduit between supplier and customer for information allowing, eg, product improvements and the rapid solution of customer problems.

The issues arising from the question "what uses are there for this product?" became chronic as the diversity of products available from the chemical industry began to increase in the mid-1900s. In order to properly address this question, a customer needed to know the possible uses and the value a new material might bring to their business. Again, such questions were typically answered by research personnel prior to the advent of specifically defined technical service organizations. A negative aspect of this approach was that the lack of specific training for research personnel in the processes utilized by customers sometimes led to fragmentary or incorrectly formulated answers. In similar fashion, sales representatives did not generally possess the training required to allow them to address technical issues raised by their customers.

One factor accelerating the development of the modern technical service organization was the dilution of effort resulting from the use of research personnel to answer questions regarding the nature of and possible applications for new products. Research organizations must provide support over a large manifold of responsibilities (6,8). Given a plethora of interests and responsibilities, a migration toward the formation of technical service organizations that could provide focused support for functions closer to the customer began and had its end point in technical service.

A well-integrated technical service function having strong ties to the sales organization at the customer interface and to the research and manufacturing functions at the production interface allows a company to provide rapid and accurate responses to customer needs as a singular function. The success level of such efforts using only sales personnel or only research personnel has not been considered to be particularly high. This generally results from the lack of linkage among persons needed to provide support rather than a fundamental fault on the part of the persons involved in the information chain.

The level of technical service support provided for a given product generally tracks in large part where the supplier considers their product to be located within the spectrum of commodity to specialty or differentiated chemicals. Technical service support levels for pure “commodity” chemicals usually provided in large quantities for specific synthetic or processing needs, eg, ammonia, sulfuric acid, formaldehyde, oxygen, etc, are considerably less than for more complex “specialty” or “differentiated” materials or blends of materials provided for multistep downstream processes. Examples of the latter are many polymers, colorants, flocculants, impact modifiers, associative thickeners, etc. For the former materials, providing specifications of purity and physical properties often comprises the full extent of technical service required or expected by customers. These materials are termed undifferentiated chemicals (9), although the term “commodity chemicals” is a more common usage. For the latter materials, technical service support is considerably more complex.

## 3. Technical Service Functions

The largest number of technical service inquiries from customers involve questions regarding the performance of an existing product already in use by the customer. A typical question is whether product X would work in application Y. The answer may be quite straightforward, or it may require a substantial applications research effort. For example, a customer produces a rigid poly(vinyl chloride) (PVC) compound. In this instance the compound is a pre-mixed powdery material, containing PVC, an impact modifier, $TiO_2$, colorants, and other additives, that is used as a feedstock to an extruder and postformer to produce textured rigid vinyl siding, for use in the manufacture of woodgrain vinyl siding for home construction. If the customers wishes to investigate an alternative impact modifier to the one used in the formula, a common practice would be to call the supplier of the alternative material to determine specifications, availability, comparative performance data, and related information. The customer would then produce multiple samples of the vinyl compound. Some would contain the impact modifier under usage, others, the new material. At this point, the producer often works directly with a member of the supplier’s technical service staff to carry out both in-house and external, ie, at the supplier’s laboratories, evaluations. The intent is to obtain highly accurate performance data on vinyl siding produced using the various sample compounds. Test results can be relatively quick and easy to obtain, eg, impact strength, or lengthy and considerably more difficult, eg, exterior photodurability. Once the results have been obtained and discussed with the supplier's technical service personnel, the customer can make an informed decision regarding the use of the newer impact modifier in their vinyl compound. Whereas this may seem to be an exceptional amount of work, because much of the vinyl siding sold in the United States is guaranteed to last 30 years, most manufacturers are reluctant to make raw material changes. Similar issues exist for automotive and industrial coatings, as well as for certain polymers used in automotive applications (10).

Another typical customer question is "why did product X do Y in my process?" This is the troubleshooting, consultative part of the technical service function. The range of effort required to answer this question is as broad as for the first example. Consider the case of a converter firm that produces acrylonitrile–butadiene–styrene (ABS) compounds containing carbon black for use in the downstream manufacture of telephone housings. The customer reports that the L*, ie, a color measurement parameter (lightness), of a large batch of compound was too high for sale. Upon visiting the customer, the technical service person investigates the situation and finds that the mixers used to prepare the compound were not being operated in a manner to ensure a proper level of shear during mixing. As such, the level of dispersion of the carbon black in the ABS was not sufficient, leading to the drop in color as determined by a measurement of L*.

Both prototypical questions related illustrate the need for a successful technical service professional to have a strong understanding of the customer's applications and processes, within proper intellectual property considerations. This need for a thorough understanding is not always straightforward. A common example of the complications that can arise is provided from the coating industry (11). If, eg, a calcium carbonate supplier would like a coating manufacturer to use their material versus a competitive one, the onus is on the supplier to show that the material can be successfully used in the coating formula of interest. However, many such formulas are held as proprietary. The technical service professional therefore does not know the components of the coating. This would lead to an unworkable situation from an evaluation standpoint save for the fact that the coating company may supply a millbase or other intermediate form of the coating to allow a proper comparison of carbonates to be carried out. Thus mutual benefits can result and no loss of proprietary information occur.

Simulation of a customer process at the laboratory scale is sometimes requested, usually to allow the ready surveying of a variety of raw materials or the evaluation of the impact of process changes at a scale more economical than full-plant capability. This is simple for certain requests, ie, the evaluation of a series of antioxidants in a given polymer formulation, yet nearly impossible for others, ie, studies of flocculation–dispersion phenomena at plant-scale shear rates in multicomponent systems. Generally, laboratory-scale efforts are of the survey variety. These are quite valuable, as they provide a means to identify any gross incompatibilities or other system problems prior to carrying out plant-scale changes. This is a typical approach for, as an example, the substitution of a pure compound from one supplier with that of another supplier in a batchwise chemical synthesis. Even in this simple case, however, it is important that such parameters as mixing and heat transfer are faithfully replicated in the laboratory-scale system.

A common requirement of the technical service professional is the support of either semiworks or full plant-scale trials of a material in a new application at a customer's site. This is often a very demanding responsibility. An example is the evaluation of the use of a new associative thickener in an established line of architectural coating. The technical service person must be familiar with the customer's processing equipment, operating practices, and raw materials if a smooth evaluation is to be ensured. As for any complex manufacturing process, experimental design is a crucial aspect of a successful line evaluation, both for the execution of the test and for the evaluation of data from the test (12). It is sometimes necessary for the technical service professional to spend an extended period of time at the customer's site. In fact, renting nearby lodgings for weeks at a time and working essentially full-time side-by-side with a customer's manufacturing and technical staff is uncommon.

Plant-scale trials are indeed quite common in the chemical and converting industries. This is largely because a true quantitative understanding is rarely known for a great many manufacturing processes. As such, it is common to run a full-scale plant or line trial in order to evaluate a new raw material head-to-head versus a raw material in use, while holding all typical operating parameters at identical control points. In so doing it is possible to detect relatively minor changes in downstream product performance or process performance upon substitution of the new raw material. An example is to change an optical brightener being used in a coated paperboard application and thence to look for changes in the behavior of recycle streams, runnability, printability, and appearance of the final board stock, and other process- and product-related variables that, to the uninitiated, might seem to be totally unconnected from the change in process feedstocks (13). A full-scale mill trial of this type is the only means by which seemingly unrelated variables can be tested in a manner that provides meaningful real-world results for many chemical and manufacturing processes. Semiworks and laboratory methods are progressing rapidly, however.

New product introductions are generally heavily supported by the technical service function. Many customers using chemical feedstocks to produce multicomponent products for the consumer market require extensive on-line evaluations of new raw materials prior to their acceptance for use. An example of this would be the use of a new engineering polymer for the fabrication of exterior automobile structural panels. Full-scale fabrication of the part followed by a detailed study of parameters, such as impact strength, colorant behavior, coating receptivity, exterior photodurability, mar resistance, and others, would be required prior to making a raw materials change of this nature.

Similar requirements exist for the evaluation of a new raw material versus the performance of a current competitive material. Support from technical service personnel can range from experimental design of the line trials through use evaluations. Coordination of evaluations and data analyses resulting from downstream customer testing is also often required. Acquisition and coordination of specialized use or other physical testing is almost always the responsibility of the technical service professionals. For instance, microstructural studies using atomic force microscopy (AFM) are hardly commonplace. However, a supplier of raw materials to the microelectronics industry that can provide this powerful tool to a customer has a competitive advantage over a supplier who cannot do so.

An often-neglected aspect of the technical service function is the value technical service personnel can bring to the direct marketing and advertising functions. Accurate and detailed technical information are becoming more a part of print advertising as product cost/performance ratios become increasingly important and as the communication of the performance advantages of a given product becomes a more critical aspect of a successful sale. Such information is generally provided either by research and development personnel or by technical service personnel. In many companies, the latter are more heavily involved in applications research, particularly that involving actual customer formulations. Thus these are often in a superior position to provide the sort of information needed. Even a brief perusal of trade magazines, eg, *Chemical Marketing Reporter* or *Plastics Engineering*, yields a substantial fraction of chemical advertisements that contain well-selected technical aspects of the product being advertised.

Many chemical companies also place into the technical service function the responsibility for the generation of a wide variety of printed materials containing customer-oriented information. These may range from a simple one-page technical specification handout to lengthy publications on application tips and recommendations for a broad range of uses (14). The sales value of such materials, when well prepared, is quite high. Most firms provide such information via mail, telephone, or fax order, by providing them to their field sales personnel, or at booths and hospitality suites at conventions and trade shows. The cost of physically preparing these documents has dropped precipitously owing to the advent of desktop publishing technology.

In-house training at a customer site is another valuable technical service function. Often this training is not restricted to the performance and uses of a given raw material, although this is the most common variety of in-house training. Almost every experienced technical service professional has a set of presentations on topics germane to the instruction of typical customers for a given line of products. Generally targeted to a broad audience at the customer's site, these are usually well received. In-depth presentations and follow-up discussions of presentations previously given at trade shows or technical meetings may also be provided as a service to the customer. Another extremely valuable area is operator training. This may involve product safety, safe handling of potentially hazardous and/or toxic materials, receipt and unloading of unusual or new types of product packaging, operating parameter selection, and any other topics of value to the customer's operating staff.

More general training in a given field in which the technical service professional possesses expertise and is of value to the customer is often provided. Examples are training in flocculation phenomena for persons involved in water treatment, optics for companies using dyes and pigments, and overview courses in areas such as experimental design and process troubleshooting for a wide variety of downstream customers. Most customers find these types of presentations useful, both as a result of the information imparted to the organization and owing to the generally high cost of obtaining an outside expert to provide similar support.

It is important to recognize that even specialty chemicals have a product life cycle (Figs. 1 and 2) driven by changes in technology and other factors (15). As such, proper provision of detailed technical information on product performance and applications is critical to an extended life cycle for the product. The level of technical support for a material is generally highest at its introduction, drops somewhat in mid-cycle, and picks up again sharply in the latter stages of the product life cycle.

**3.1. Technical Service Organization.** There are a tremendous number of possible structures for technical service organizations. This leads to tailoring of the structure within any given firm or product line. Requisite elements of a successful technical service organization generally include the following: (*1*) highly trained technical professionals having a high level of expertise; (*2*) appropriate support staffing, ie, laboratory technicians, and clerical staff; (*3*) sufficient physical facilities, such as a laboratory, instrumentation, computational support, etc; (*4*) strong integration with other company functions, such as manufacturing, marketing, sales, engineering, and research; (*5*) the ability to leverage support from others; and (*6*) responsibility and authority to make major decisions regarding products.

Some organizations are constructed such that technical service reports to the research function, others to sales, and others to marketing. The line of reportage is not as important as ensuring that the requisite level of functioning capability is in place for the organization. A manager having prior experience in several business functions is best suited to providing balanced support to such an organization (16). A well-rounded perspective is crucial to the success of a technical service organization.

**3.2. Training Requirements for Personnel.** It is the practice of most chemical firms to provide only personnel having a solid technical background for the provision of technical service regarding the use of their products. The most common academic training for such personnel is a 4-year degree in chemical engineering, although other fields of engineering and the physical sciences, chemistry in particular, are also typical. Some firms also have the opportunity to assign Ph.D.-level scientists and engineers to technical service roles.

It is generally of great value to assign personnel to technical service after they have had multiple experiences elsewhere in a business. As an example, a technical service person having a background including assignments in research and manufacturing can provide a balanced response to queries from customers regarding the possible creation and production of a new product. Another common request from customers is for a material with specifications tighter than those typically provided for product release. A technical service person with a varied background is in a better position to quickly ascertain the level of difficulty associated with such a customer request and to work both with the customer and internally to find a way to meet the customer needs in a commercially acceptable manner.

Specialized training is an absolute requirement for technical service personnel. A typical example is a person involved in supporting a polymer for which the use is the manufacture of rotationally molded consumer products. The technical service person is expected to be reasonably familiar with topics, such as polymer rheology evaluations, gel-permeation chromatography, rotational molding, color science, regulatory requirements for use, mechanical and photochemical behavior of the pigmented polymer, optics, and so forth. Expertise of this variety cannot be expected to be obtained without careful planning and execution of tailored training for technical service personnel. Both internal and external resources are used to provide specialized training in appropriate areas.

The area of regulatory requirements is of particular importance. The extreme complexity and constant changes of regulations applying to chemicals used in commerce dictate that personnel providing technical service support be well versed in regulations specific to the product(s) they support. They should have access to the *Code of Federal Regulations* as well as to either in-house or outside experts possessing in-depth expertise in regulatory matters. Many customers require written documentation from suppliers regarding suitability-for-use of a given material in a particular use, eg, use of a particular ionomeric polymer in a food packaging application. Although most companies make use of in-house or outside professionals to handle such requests, the technical service professional is often a part of the communication loop leading to the successful generation and delivery of such documentation. As such, familiarity with requirements, for this and many other reasons, is a necessity. It is not reasonable, however, to expect technical service personnel to also function as legal professionals in this or in any other sense. Similarly, it is essential that technical service personnel be well aware of other requirements for products, including disposal considerations, toxicity behavior, impact on effluents, special shipping and handling requirements, and other similar factors with regulatory aspects.

The value of mentoring, ie, the practice of providing a seasoned professional to assist in the training and development of less-experienced personnel, cannot be overstated (17). The typical technical service professional in the chemical industry must have at least a reasonable grasp of a broad variety of technical areas. Interaction with a senior member of the technical service staff to obtain guidance in the types and depth of understanding required to meet the needs of customers in a technical service role environment greatly facilitates the learning process. This also helps to ensure an accurate portfolio of "tools in the toolkit" for the less-experienced person, thus providing higher value to the customer via more rapid turnaround of information and higher quality of responses. Finally, the more senior member of the staff accrues a developmental benefit from the mentoring interaction.

Many firms tend to staff their technical service efforts with personnel that have experience solely in the particular business involved. It is often of value to consider individuals having experience in related industries, both to provide a different set of skills and to provide a different perspective than that of in-house experts. This is particularly important in the specialty chemicals arena, where formulations experience is generally of paramount importance. This variety of knowledge is often largely experiential, as much of the treatment and behaviors of formulations in the chemical industry are empirical or experience-based rather than quantitatively understood. It is therefore extremely difficult to train personnel in dealing with the often nebulous aspects of formulations technology.

*Participation in Trade and Professional Organizations.* Participation in appropriate trade and professional organizations by technical service personnel can provide a myriad of benefits to both the supplier and the customer. Participation can include a wide variety of activities. Examples are the presentation of technical papers, organizing and chairing technical sessions and workshops, serving as officers, attending local and national section meetings, and publishing in refereed professional journals or trade magazines. Examples of professional organizations typically considered to be appropriate for persons working in the chemical industry include the American Chemical Society (ACS), the American Institute of Chemical Engineers (IAChE), the Materials Research Society (MRS), the International Union of Pure and Applied Chemistry (IUPAC), the American Crystallographic Association (ACA), and the American Physical Society (APS). Examples of trade organizations include the Federation of Societies for Coating Technology (FSCT), the Society of Plastics Engineers (SPE), and the Technical Association of the Pulp and Paper Industry (TAPPI). Many more examples of both types of organizations exist.

Many companies provide support for both their research personnel and technical service personnel to participate in these types of activities. Even a policy of one conference per person per year, if applied correctly, provides a great deal of value to the individual and to the organization. The returns on this investment include intangibles, such as additional technical contacts and enhancement of the technical reputation of the company, as well as tangibles such as personnel possessing the latest information in their fields of endeavor, allowing them to better address customer concerns and needs, and developing ideas for process and product improvements.

The value of presenting original work, whether curiosity-driven or applied, should not be overlooked. A great many technical service professionals have extraordinary expertise in some areas of substantial specialization. It is not often straightforward to identify persons with such expertise in a given area. Presentation of a paper or conducting a seminar in one's field of expertise can provide a critical link in the search process customers use to seek assistance on technical issues.

Finally, there is great value in providing access to contemporary and archived technical journals and trade magazines to technical service professionals. This can be achieved in a number of ways, whether by generation of an in-house library, use of nearby university or governmental facilities, support of individual subscriptions, or some combination of the above. Internet access to on-line journals is also valuable.

## 4. Technical Service and the Development Process

The technical service function acts as the interface between the user and the research and manufacturing arms of the supplier for many firms. A consequence of this is that the technical service function can act as a conduit of information between the customer and personnel involved in the development process.

Many companies make use of multifunctional teams to drive the development process (18). This is true both for new products and for enhanced performance characteristics for existing offerings. The time required for either a significant enhancement of an existing product or for the launch of a new product can be greatly reduced by making intelligent use of the technical service organization as an information conduit. This generally results in both a greater financial reward for the supplier and in valuable product enhancements for the user.

It is not unusual for the technical service function, or a subset of it, to act as the clearinghouse for new or improved product ideas and provide technical leadership for the evaluation and ultimate implementation of those ideas. Because technical service personnel generally possess the greatest familiarity with customer experiences and needs coupled with a strong understanding of internal company capabilities, they are in a unique position to provide guidance toward an accurate assessment of what is and is not feasible.

The troubleshooting aspect of technical service *de facto* results in the technical service professional having the best perspective on any faults that may be identified by a customer for a given application. Taking timely action on such observations enhances a supplier's credibility with a given customer and quite often provides an improvement to the product of general value to other members of the supplier's customer base. Technical service professional work with colleagues in research and manufacturing to develop process improvements, identify more appropriate specification ranges, identify necessary product enhancements, and provide support to other related efforts aimed at addressing the need identified as a result of technical interchanges at a customer's site. A completely accurate understanding of the true needs of the customer is an incontrovertible requirement of a new product development process that provides maximum value both to the customer and the supplier (19). The costs of an ill-defined set of product characteristics can be catastrophically high in capital investment, time, and supplier reputation.

A critical, but often overlooked, aspect of the technical service function is the value of relationships that develop between more senior members of the technical service staff and their colleagues at customer sites. Professional relationships provide value both to supplier and customer by virtue of the trust and respect generated in a successful technical service interaction, analogous to the types of mutually valuable relationships that can develop between supplier sales personnel and a customer's purchasing personnel. A more efficient process of gathering and dispersing new and useful technical information can result from these relationships, because the persons involved work in different environments and are exposed in the course of their work to different external sources of information.

## 5. Technology

**5.1. Computers.** It is difficult to envision how technical service in the chemical industry could be carried out without computer technology. The increase in availability of low cost computing power has greatly enhanced the problem-solving capability of the technical service professional. The availability of highly portable laptop computers allows great freedom to transport substantial computational support anywhere in the world. The applications of this relatively new capability are myriad. Some examples include the ability to rapidly carry out complex fluid mechanical calculations in modeling a customers' mixing problem, using finite element analysis to determine the probable source of structural failures in large ceramic bodies and polymeric parts, or carrying out high level statistical analyses on-site using actual customer data in real time and directly interfacing to customer processing equipment to allow either an in-shop or after-the-fact analysis of data obtained during process disruptions. Some remote control aspects of computers include the ability to access, via telephone line connections, databases in the suppliers' computers, using powerful in-house computers to remotely execute molecular mechanics simulations of reaction pathways, or carrying out gas chromatographic analyses while away from the laboratory. The latter function has become increasingly routine as laboratory information management systems (LIMS) have evolved into very flexible installations allowing ready manipulation of multiple instruments while physically away from the laboratory.

**5.2. The Internet.** One of the most important changes in the manner in which technical service is provided to customers of the manufacturing and service industries is the advent of the Internet and its use in providing direct access to a wide range of technical service and related information. It is possible, either through the use of an in-house computer acting as a server or by renting space on a server at an internet service provider (ISP) site, to provide almost any sort of information that a customer might request. Most chemical companies have created extremely detailed web sites containing a vast array of information (20). As the costs associated with accessing the Internet have dropped, many firms have moved to provide full-time access to their technical staff members. This practice is cost-effective even for small companies having limited resources.

It has also become quite cost-effective to provide a substantial portion of typical technical service information via the Internet owing to the advent of inexpensive desktop computers possessing large amounts of storage capacity and the capability of acting as servers. At the time of this writing (2006) it is possible to purchase a fully configured system capable of meeting the needs of companies from small to intermediate size for <$10,000. Finally, there are several powerful operating systems available (21) that allow sophisticated use of this new tool without extensive formal computer training. Using authoring software, information, including audio and video, if desired, can be placed directly into a web site with minimal training.

In its simplest form, a technical service site on the Internet can provide a set of answers to queries that can generally be expected for the industry involved. For the chemical industry it is common to provide such information as material safety data sheets (MSDS), compositional information, simple applications information, lists of available materials, returns policies, shipping information, purity, and regulatory status. It is also common to provide a query form that can be filled out electronically by the person accessing the site to obtain information not directly available from the site. These are then automatically forwarded to members of the technical staff for the formulation and communication of responses to the query. This capability is becoming increasingly popular. Less common, but still growing, is the use of expert systems architectures to lead a customer through a series of questions to obtain answers to, for example, simple formulations issues associated with feedstock changes.

A large amount of information can be provided on a technical service Internet site by means of hyperlinks, ie, clickable terms or addresses that allow the reader to access multiple layers of information by a simple click of a control device. Some companies have provided their entire library of open literature on their products in the form of material stored within a hyperlinked page. The reader can either browse this information directly on the site or download it to their own computer to be read at their convenience.

## 6. The Next Stages of Technical Service

The need for well-trained technical service professionals is expected to continue as an essential aspect of the chemical industry, despite the phenomenal growth in electronic methods of information storage, retrieval, and transmission. Advanced troubleshooting of complex customer processes and accelerated accurate product development and market introductions should continue to be principal elements of technical service personnel duties. Increased levels of integration, perhaps blurring the lines between supplier and customer, may come to pass. There are already instances of personnel swapping between customers and suppliers for extended periods to allow cross-fertilization of ideas and provide more accurate perspectives for the companies involved in these efforts. Technical service and research personnel have been those persons most directly involved in such efforts.

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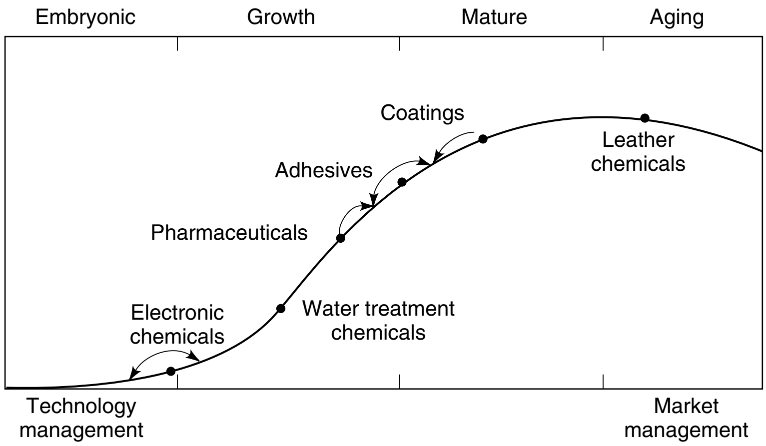


**Fig. 1.** Life cycle of selected chemical specialties.

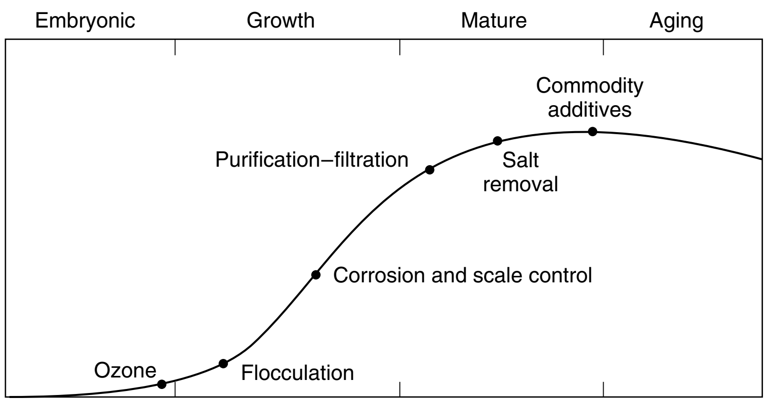


**Fig. 2.** Life cycle of selected water treatment chemical business areas.