is determined by logical combinations of structural fragments or elements in the molecular formula. These chemical classes and the necessary logic for retrieval are specified on input cards queried by the computer. A final miscellaneous class consists of those compounds in the file not included in any of the designated chemical classes. The report is then printed, grouped by chemical class, with each compound number and name followed by the appropriate test names and data. The program for the report organized by use test inverts the file and prints under each test name, the names, numbers, and test results of the compounds tested. Under each test the compounds are sequenced by qualitative test results, best-to-worst.

Multicomponent systems are described by an extension of the compound system. Each multicomponent system is identified by a formulation number pertaining to the whole composition. This formulation number is carried by each card with data on the multicomponent system. Figure 7 shows an example of a printout of data on polyurethane foam. Composition, size of preparation, preparative conditions, and characteristics of the resulting multicomponent system are listed. Subgroups of components used in different stages of preparation of the foam are identified as "a" and "b" etc. It has been found useful to record the quantity of each component as a per cent of the total system. Total percentages of individual compounds are identified in the printouts by the letter "t." The presence of a component in more than one subgroup can be indicated.

By having information that pertains both to whole formulations (tied together by formulation number) as well as information pertaining to individual components (tied together by compound number) and the relative quantities of the components, performance characteristics of whole systems and their parts can be related. For example, lists can be made of all foams prepared from polyethers having a hydroxyl number over 200. Besides polyurethane foams, emulsions and industrial formulations are recorded by this aspect of the system.

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The Literature of Food Science and Technology*

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Received January 2, 1968

Some of the information sources used to accommodate scientists and technologists involved in the study and the production of food are discussed.

Information on food chemistry and technology is found in languages from Albanian to Zulu as well as in forgotten languages carved on tombs and ancient edifices. Also, tools and residues left by prehistoric man are clues to food technology before writing was invented. Because food is life, its literature has a long history, which has been written by people of diverse nationalities and disciplines. As with all literature, the literature of food science and technology is accumulating at a very rapid rate. The dispersed, voluminous, and expanding nature of the literature poses problems for its efficient use in research, development, and business.

My assignment in this symposium is to examine the literature of food science and technology with respect to requirements and availability in an industrial research environment, such as that of Swift & Co., as observed through the eyes of a literature scientist.

In the meat business, standard textbooks, handbooks, reference books, and current and backfiles of scientific and specialty journals and magazines must be available for the research staff which comprises: analytical through physical chemists; agriculture school graduates, such as: animal husbandmen, meat scientists, dairy technologists, home economists, dietitians; and other professionals, such as various engineers, microbiologists, physiologists, physicists, toxicologists, parasitologists, zoologists, geneticists, statisticians, and veterinary pathologists. There are also chefs, bakers, and candy makers. In addition to research and development activities, the scientific information needs of business and public relations are accommodated.

In current awareness activities, fundamental information is garnered from scientific and technical journals, but application information and considerable technological information are scattered throughout technical and trade magazines, the press, trade literature, and patents. A major food company's technical information staff may scan 200 to 400 periodicals to issue daily, weekly, or monthly citations or abstracts for its clientele. About 50% of the journals are scientific. The others are trade journals and magazines which occasionally contain information of fundamental or technical usefulness to the research and development staff. These two sources may furnish 70 to 80% of the current awareness citations intrinsic to the interests concerned. Further items are garnered from Chemical Abstracts Service which stretches the limits of sources where the food information has chemi-

*Presented before the Divisions of Agricultural and Food Chemistry and Chemical Literature, Symposium on the Literature of Agriculture and Food Sciences, 155th National Meeting of the American Chemical Society, San Francisco, Calif., April 2, 1968.

cal implication to about 12,000 serial publications. This last mentioned check may be very comprehensive or a sort of spot-check in limited sections of Chemical Abstracts or pertinent parts of the indexes. In addition, some 30 to 50 abstract services and many abstract sections of specialty journals on food, nutrition, meat packing, fisheries, dairy products, collagen, vitamins, fats and oils, sugar, etc. are useful and convenient in limited areas. They may also find use under more comprehensive literature activities. For example, the German meat industry magazine, *Die Fleischwirtschaft*, contains abstracts and summaries of considerable importance which are not cited in domestically produced indexing or abstract services. These concern abstracts of papers that appeared in obscure foreign periodicals, abstracts of theses, abstracts of papers on meat subjects read at international and national conferences, and reports issuing from Hungarian and Yugoslavian meat research organizations. Among various abstract services there is some recent improvement toward including such obscure material. For example, they are giving attention to information issuing from the Slavic Institutes on Meat Technology concerned with post mortem changes in meats. Within my own department, discoveries such as these have led to regular accession of annual reports and publications of food research organizations in England, Scotland, Finland, Denmark, Czechoslovakia, and Australia. There are other countries, even developing lands, whose food research institute reports may rate inclusion into food information files.

There are areas in domestic literature where information gathering is tedious. Each year the American Society of Animal Science and the Poultry Science Association publish numerous abstracts of papers presented at their meetings. Only a limited number of these papers are subsequently published in full. Consequently, many are not documented in the usual searching indexes. This is also somewhat true of abstracts of papers presented at meetings of the Institute of Food Technologists and Federation of American Societies of Experimental Biology. We check these, because some of the information in the abstracts of the papers that are not published in full text is important to research and patent work even though the papers have been culled in selection for publication in full. There are also full text publications in book or pamphlet form of papers read at International Congress of Food Science and Technology, World Association of Veterinary Food-Hygienists, Feeders Day Meetings at several State Agriculture Experiment Stations, Distillers Feed Conferences, High Lysine Corn Conference, and many others which are best reached directly. There is some guided access to these through Nutrition Abstracts and Reviews (Aberdeen University Press Ltd., Scotland) where tables of contents are published, and authors and subject matter are indexed.

Retrospect search of literature on food is cumbersome. The information on meat post mortem and effect of ante mortem conditions on post mortem changes is a good illustration. In a 1948 review on the subject, Bate-Smith (*1*) displayed astonishment at the amount, changing conceptions, and rate of growth of this literature. Eleven years later, another reviewer, Whitaker (*2*) estimated the number of papers published on the subject to be in excess of 500 per year and increasing each year. As the fundamental facts and concepts are applied to observations on meat flavor, tenderness, water binding capacity, storability, shrinkage, color, and the freezing, canning, salting, curing, and cooking processes, we begin to understand the problems faced by food scientists when they approach the literature for information in even these small areas of interest.

Special avenues of access are available for miscellaneous types of food information. Federal stock catalog, military, and commercial standards and specifications do not pose too much difficulty because they are cumulative catalogs listing these by subject. There are also many other standards, such as for chemical analyses, chemicals, and farm and mill products which are developed by scientific and trade organizations for convenience, uniformity, and as a basis for trading rules.

Statistical information is voluminous from government sources. However, for the question "How many cows were artificially inseminated in the United States last year?" the answer may be obtained from the National Association of Artificial Breeders. This activity has food implications. Much can be said for trade associations as sources for information.

One can obtain suggestions on what soybean varieties are best for a specific location from State Agricultural Experiment Stations. They develop and distribute information on local crops, livestock and their production, care, and processing.

It is interesting to note that early source information on uses of synthetic emulsifiers for improving the volume and texture of bakery products are the old crime records of localities where it was illegal to include soap among batter or dough ingredients. Food laws and regulations have posed problems of accessibility, and their ultimate interpretation may depend on court-of-law decisions. Difficulties here are easing along all channels of sources. There is even a weekly publication, *Food Chemical News* (601 Warner Building, Washington, D. C. 20004) which provides in-depth information in the area of food and drug regulations, food and drug actions and seizures, and future regulations being considered.

The Center for Information Resources, Inc. (2431 K St., N. W., Washington, D. C. 20037) and Science Information Exchange (Smithsonian Institution, Suite 360, 1730 M St., N. W., Washington, D. C. 20036) can tell us, to an amazing extent, who is researching what; respectively, in biomedicine and in government, academic, and other laboratories. Various annual reviews and advances on many subjects and disciplines are quick sources of contemporary interests and activities. Abstract services on specific subjects, such as gas chromatography, sugar, fisheries, honey bees, packaging, fats and oils, etc., are convenient to individuals with limited reading time and limited areas of interest. Several selective abstract services on food in general from limited high quality sources are also available. Some firms regularly issue abstracts as part of their public relations. We must not forget congressional committee hearings, antitrust cases, patents, and other numerous and scattered sources of information.

Some generalization on the literature organization, evolution, and prospects are in order. Complaints on literature accessibility are yielding to greater efforts. Tardiness in abstracts appearance is being alleviated somewhat by key-

word in title or in text indexes. The language barrier is yielding to translations of parts or complete journals and to listings and indexing of translations available for distribution.

The outstanding, most used, and broadest of all literature services for the food industry is Chemical Abstracts Service. They process about 12,000 serial publications. Information is condensed and integrated into a large inventory of chemical knowledge. This unit is used in toto; and the system has the capability of mechanically separating units on polymers, biochemistry, foods, or a single chemical, food, or beverage. Although this contains the biggest inventory of knowledge on food, there are separate plans in the development stage to serve the food industry's needs in all their ramifications. This could include information of farm and food industry mechanical developments, marketing, packaging, food laws, etc. There are also activities toward integrating all information.

To conclude briefly, may it be said that the types of literature required by the food industry scientist and technologist are dispersed among the writings of many different peoples and disciplines. It is hoped the small number of samples mentioned here indicates this situation.

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History, Evolution, and Status of Agriculture and Food Science and Technology*

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Received January 12, 1968

Agriculture and food science and technology are characterized by a series of revolutions. The elements of these revolutions are delineated from early man's success in being the hunter and not the hunted to the current efforts of research and development towards the fabrication of food for the space age. One of the current efforts is the management of information in all areas of and related to agriculture and food science and technology.

Evidence for the importance of agricultural and food science and technology is seen almost daily in newspapers, magazines, books, and scientific journals. Hunger and famine are, of course, news. The somber facts are that the population of the hungry world is increasing at the unprecedented rate of over 3% per year while food production is increasing at less than 1% per year. Famine is now predicted for 1975. Although the great famine is yet to come, the Food and Agriculture Organization of the United Nations estimates that every day 10,000 people die of starvation and two billion people are hungry or malnourished. The world population now totals 3.4 billion, and by the year 2000 the population is expected to exceed 6.5 billion. (*6, 10, 17*)

Two possible solutions are apparent: population control and increased food production. Both directions surely will be taken. It is our hope that this symposium will contribute materially to the second—increased food production.

If science and technology are to be mobilized for the war against hunger and famine, we should at least be aware of what we do not know, what we have done, and what we are doing. In short, is there a literature of agriculture and food science and technology? Is it well defined in terms of awareness and retrieval? Or is knowing what is known one of our problems? The participants in this symposium think that this is the situation, and, taken together, they present a convincing case for the need to harness the literature. Let us first, however, take a perspective look at the history, evolution, and current status of agricultural and food science and technology.

Prehistorical man was of necessity a food gatherer and hunter. He differed from others in the animal kingdom by his ability to improvise and to devise tools for his foraging, hunting, and fishing. The degree of his success in devising the spear, bow and arrow, blow-gun, fish hook, and trap was a measure of his control of his environment. At least he could be the hunter rather than the hunted.

One of the great discoveries of man was fire, probably discovered by Paleolithic man during the period 1 million to 8000 B.C. Fire supplied him with heat, provided him protection against animals, and, once he learned to apply it to the preparation of food, augmented his diet of fruits and roots with cooked meat. Fire allowed him to preserve food, and thus extended further control of his environment. Just as fire led to cooking and preservation of foods, so cooking led to the invention of cooking utensils, braziers for heating, and, eventually, to pottery and metallurgy.

The importance of salt as a food preservative, particularly for meat, was another great discovery of prehistoric man, so great that salt became a prime item of trade and remained so well into modern times.

*Presented in Symposium on "The Literature of Agricultural and Food Sciences—Problems and Some Solutions," jointly sponsored by the Divisions of Chemical Literature and Agricultural and Food Chemistry, 155th Meeting, ACS, San Francisco, Calif., April 1968.