Reviewing the situation:

Food Science and Technology in today's world

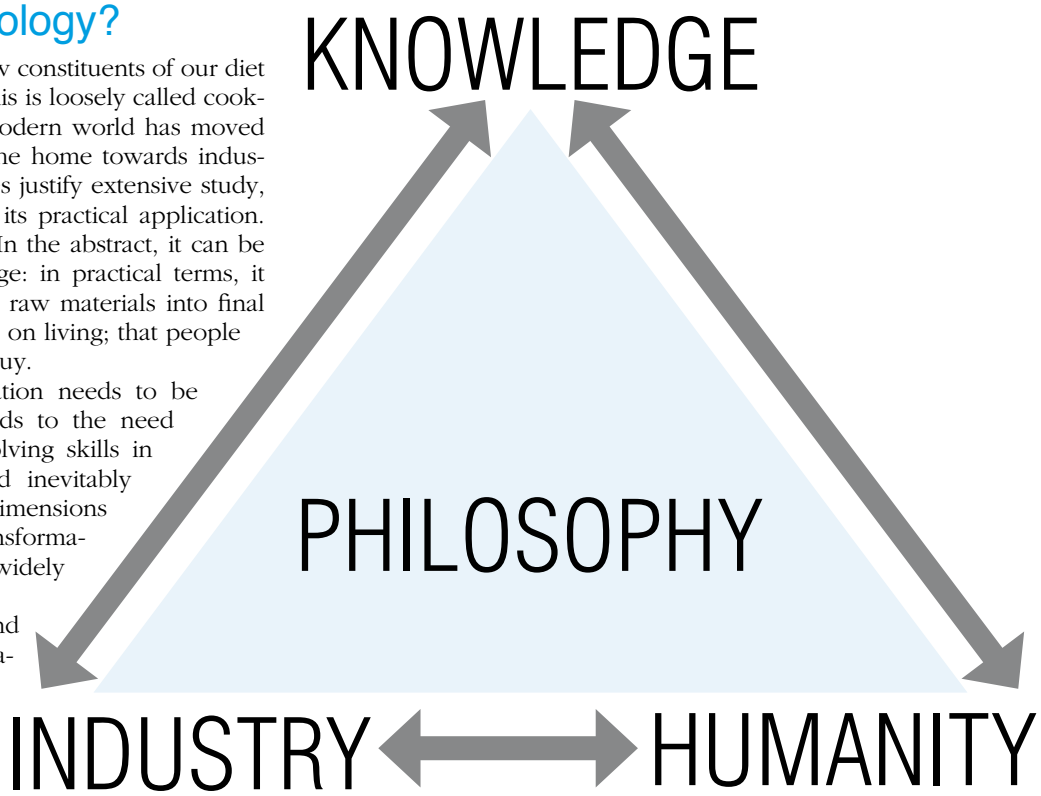
Mary and Dick Earle

So, what is food technology?

Preparation of food changes the raw constituents of our diet into what we eat. Done in the home this is loosely called cooking; it is a skilled art. However the modern world has moved this very major human activity from the home towards industry. In industry, the scale and resources justify extensive study, based on knowledge but focused on its practical application. This study is called food technology. In the abstract, it can be seen as the study of controlled change: in practical terms, it is everything needed to transform the raw materials into final products that people need to eat to go on living; that people wish to eat; that people can and will buy.

For industrial use, the transformation needs to be systematic and controlled, which leads to the need for quantitative skills and problem-solving skills in manufacturing and food service, and inevitably includes human and organisational dimensions well beyond the technicalities of transformation. Therefore food technology is widely multi-disciplinary.

Science is systematic knowledge and method. It must withstand tests for validity. It has gained much credence and respectability in the last 100 years and created the scientific age, which is now growing into the technological age. Science was extended to become applied science, regarded perhaps as diluted and somewhat less refined. Technology is broader. It is based on fundamental knowledge, but the concentration is on application. The emphasis shifts from knowledge to doing and accomplishing. In our view, the professional application of systematic principles to food transformation is food technology, differing in scope and emphasis from food science. However as Keith Farrer has commented in his book on food science and technology in Australia that one should always write "Food Science and Technology is" because in his view the coupling is both necessary and inescapable; they come together as one whole. Members of NZIFST have both to know and to do, thus making it appropriate to examine just what is implied. It includes looking at knowledge, industry, and humanity, and moving towards a philosophy.



The Coupling Triangle

Knowledge

Food science and technology is multidisciplinary and hence unusual in a world orientated towards separate disciplines. Many people, especially in the USA, call themselves food scientists and concentrate on a particular area, in earlier times mainly chemistry, but gradually over the years microbiology, sensory science and nutrition joined in; and then food engineering expanded as an important area. These groups call themselves food scientists and food engineers. But what of those multidisciplinarians who design and control the foods, food processing and distribution - the food technologists? Somehow they have been seen as a more lowly form of practitioner of these sciences. To us, this seems an inversion of importance; the highest knowledge should surely be taking the basics into action - technology providing food and health to humanity and incorporating all the skills needed for this.

A problem in partitioning off knowledge areas such as science and engineering is that it makes it difficult to combine this knowledge and then use it, through scientific application, to develop products, production, and marketing which will meet consumers' needs. In the days of the craftsmen, development used past experience. Sadly, craftsmen have long disappeared from the larger food manufacturing operations. Food processing in large plants is often run by people who do not have the long

and varied experience needed to build knowledge, especially today with amalgamations, take-overs and closure of plants. So there is a need to expand the multi-disciplinary knowledge over the total area; in fact right along the whole food chain from land and sea to the final consumer of the food.

Technologists use not only scientific research as a basis for development but also their experience built over the years. The difference between the craftsman's and the technologist's use of experience is that the technologist has so much more background, the chemical, physical, biological and mathematical knowledge, to scientifically describe the changes and the causes and their relationships. The technology they recognise is wide and multidisciplinary. It is not narrowly concentrated as most people see science. So in food science and technology we are ahead of many other sciences because we do recognise that there are no divisions into well defined areas. But we still have to establish the multidisciplinary whole.

This is what was attempted in developing the Bachelor of Technology degrees at Massey University. Around us were strong academic forces leading the university into ever narrowing areas of science and engineering. But an attempt was made to build a broader basic knowledge which would serve both the needs of industry and of humanity, and also provide the understanding and skills to identify problems and solve them. Food technology was the first course and by now it has had the time to develop into an identifiable knowledge area recognised widely throughout Australasia and South East Asia. It needs to develop in new areas in the 21st century. More importantly, the knowledge needs to be transferred to the food industry and expanded by experience. There are a few large multinational companies who have a significant part of the knowledge in food science and technology today and the research and development facilities to transfer it into practice, but there are large sections of the food industry which have neither the skills nor the knowledge.

Industry

Major changes have occurred in food production, processing and marketing. Small farms, factories and grocery stores have developed into large agricultural organisations; and multinational processing, fast food and supermarket companies, have been created in order to produce large quantities of cheap food. A major outcome has been the dominance of the supermarkets in this chain - not only specifying the products that consumers can buy, but also controlling processing, by contracting production right back to the farms and by increasingly having plants of their own. This has seen a contraction of processing by some of the large multinationals with a consequential decrease in the related research and development. There is global food production, processing and distribution, but at the present time it is not universal for all humanity's needs and it is proving unstable with the recent large increase in energy crops.

Another change is the move to more self-regulation in the food industry and less government involvement in enforcement. Food safety is an area for which the company is responsible. Self-regulation demands higher ethical standards and also that there be greater knowledge at the production and processing levels. An added factor is the need for certification throughout the food chain. This self-regulation needs an increase in technological knowledge and in education, or the government will have to take over again.

The increased interest in nutriceuticals and functional foods at the research level will also sharply increase pressure on tech-

NZIFST expands its online educational resources

New, free online textbook - *Fundamentals of Food Reaction Technology – the Web Edition*, by Richard L. Earle and Mary D. Earle, www.nzifst.org.nz/foodreactiontechnology/

When Professor Dick Earle's book Unit Operations in Food Processing was published by NZIFST as a free online textbook in early 2004, the people behind the project had no idea how popular it would turn out to be. Originally published in 1966, the English version was by then 13 years out of print.

Four years later, Unit Operations in Food Processing – the Web Edition is accessed by 850 people each day, from all around the globe.

Based on this success, the authors Dick and Mary Earle are pleased to announce that another, related text has been published free online by NZIFST with the kind permission of the copyright holders, Leatherhead Food International Limited. Web editor is Chris Newey.

Fundamentals of Food Reaction Technology, which discusses reaction technology in food processing, was originally written as a companion text to Unit Operations, and was published in 2003 by Leatherhead Food International and the Royal Society of Chemistry.

It is essentially an introductory course in reaction technology for all interested in food technology, food engineering and food science. In this book, for example, perhaps the most extensively used of the unit operations – heat transfer and its applications – moves across to cooking and preservation.

There are many other important transformation processes. They all have the same quantitative bases which can be treated systematically and explained under the unifying system of reaction technology. The observed changes can be sensory, physical, microbiological, but basically they are chemical changes, and the rates of change can be followed using quantitative kinetics analysis. This is the knowledge included in Fundamentals of Food Reaction Technology.

The book has been published so that individual Chapters can be downloaded and printed (as Flashpaper files), but like Unit Operations, the text will eventually be expanded into a complete set of web pages, including a set of answers to worked problems available to teachers on request.

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nological knowledge. In the past, if someone recommended a diet, the industry would try to supply products for this diet. There would be a cry for lower fat, sugar, or salt and we would see fat replacement, sugar substitution and lower salt or salt replacement. Today, there needs to be greater co-operation between the industry, nutrition researchers and dieticians to build reliable knowledge to prove the benefits of reformulations and new products, not only on one aspect of health, but on the total health of the consumers. In other words the food industry needs to move towards the standards demanded of the pharmaceutical industry.

Humanity

Humanity is moving to a dichotomy - rich, over-fed populations and starving populations. Yes, there are political and economic causes, which food scientists and technologists can only influence but cannot counteract. But we can build the knowledge, and its implementation, to help overcome the problems of each group.

In the rich populations, there is a tendency for the consumers to blame the food industry and therefore the food technologists for their obesity because of the convenient, cheap, high calorie foods that are marketed to them. There are societal/consumer concerns about production and processing methods and specific ingredients. Of course governments also become concerned and put more regulations on to the food industry. There are requirements for labels to include ingredients, nutritional values and, now, the place where the food was produced. In other words, consumers and society want more knowledge of what they are eating and also information and advertising that are truthful.

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Poor populations, in both the rich and poor countries, need calories and provision of the basic nutritional needs such as protein, vitamins and minerals, lack of which lead to deficiency diseases. In the rich countries, poor people are moving back towards the state of the European and American populations before World War 2. During World War 2, there was a real effort in Britain to provide everyone with their nutritional needs so that the health of many was actually improved by the end of the War. This showed how co-operation between nutritionists and food technologists in research, development and production leads to a balanced diet for many. 'Nanny state' maybe, but the results were demonstrable. Knowledge of combining nutrition, food processing and food products had increased markedly by the end of this period, but were subsequently lost.

In the wider context of poor nutrition and, indeed, starvation throughout the world, there is a need for coordinated effort to apply the knowledge developed over the years in the richer countries to the people lacking the basic knowledge to preserve and process food.

The philosophy of Food Science and Technology in the 21st century

Knowledge, industry and humanity are combined in building a philosophy for food science and technology in the future. There is a need for a modern philosophy to maintain, build, use and transmit the knowledge and skills of food science and technology with the moral aims to maintain the health and safety of the population at an affordable cost.

The multidisciplinary knowledge of food science and technology is developed by scientific research of nature and of the technology itself. Industry develops from this knowledge base but is of course driven by economic, commercial and indeed political forces. It can be driven by creative innovation, as can be seen in other technologies such as information technology and indeed in the food industry in the 1960s and 70s. There is a need for innovation today. Over the last 40 years a great variety of scientific research has been published in the food area but how can this be translated into innovation in the food industry?

Food technologists need to systematise and problem-solve, but they also need to be creative and innovative. For example, different food manufacturing processes have been broken down to unit operations and the effects of different conditions can be studied. Problems in processing can be identified and new processes developed to give different and improved products. Knowledge about food reactions, both in processing and in distribution is growing and gradually using reaction technology, systems are being developed which can control the development and the production of food products with known and measured qualities.

There is a need to balance knowledge and innovation so that the new developments do not lead to consumer or societal ill-health or other problems but instead to the adequate diet that we all need to remain healthy. Food science and technology professionals need to have moral standards and ethics which are the basis for their research, development and production of food products. There also must be a moral understanding of the effects of food production on the society such as changes in the environment and the long term sustainability of food chains.

The philosophy for the future in food science and technology should be to seek multidisciplinary knowledge and apply it in production, processing, and distribution so that everyone has access to safe food that provides the nutrition necessary for health at a price that can be afforded. This means that food science and technology professionals must be aware of the wider ramifications of their work as well as of the specialised knowledge needed for their particular area.

Apply the knowledge

So all in all the food professionals should focus on application: on understanding it and how it can be implemented, on the measurement and prediction that brings it under control, on the systems which empower and reinforce inspiration and creativity, and on balancing the physical and human aspects so necessary for solving the problems of giving people the food they desire and need.