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A possible reconceptualization of food engineering discipline

Keshavan Niranjan

Department of Food and Nutritional Sciences, University of Reading, Whiteknights PO Box 226, Reading RG6 6AP, UK

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ABSTRACT

Food industry is critical to any nation's health and well-being; it is also critical to the economic health of a nation, since it can typically constitute over a fifth of the nation's manufacturing GDP. Food Engineering is a discipline that ought to be at the heart of the food industry. Unfortunately, this discipline is not playing its rightful role today: engineering has been relegated to play the role of a service provider to the food industry, instead of it being a strategic driver for the very growth of the industry. This paper hypothesises that food engineering discipline, today, seems to be continuing the way it was in the last century, and has not risen to the challenges that it really faces. This paper therefore categorises the challenges as those being posed by: 1. Business dynamics, 2. Market forces, 3. Manufacturing environment and 4. Environmental Considerations, and finds the current scope and subject-knowledge competencies of food engineering to be inadequate in meeting these challenges. The paper identifies: a) health, b) environment and c) security as the three key drivers of the discipline, and proposes a new definition of food engineering. This definition requires food engineering to have a broader science base which includes biophysical, biochemical and health sciences, in addition to engineering sciences. This definition, in turn, leads to the discipline acquiring a new set of subject-knowledge competencies that is fit-for-purpose for this day and age, and hopefully for the foreseeable future. The possibility of this approach leading to the development of a higher education program in food engineering is demonstrated by adopting a theme based curriculum development with five core themes, supplemented by appropriate enabling and knowledge integrating courses. At the heart of this theme based approach is an attempt to combine engineering of process and product in a purposeful way, termed here as *Food Product Realisation Engineering*. Finally, the paper also recommends future development of two possible niche specialisation programs in Nutrition and Functional Food Engineering and Gastronomic Engineering. It is hoped that this reconceptualization of the discipline will not only make it more purposeful for the food industry, but it will also make the subject more intellectually challenging and attract bright young minds to the discipline.

1. Introduction:

The discipline of Engineering – more than other disciplines – constantly requires to respond to a variety of demands, and progressively develop its educational programs by innovatively adapting its learning objectives and contents to the most recent findings in science and practice. But increasingly, engineering education is challenged by additional demands: 1) globalisation, which makes transferable skills and social competences of graduates much more important; 2) the focus on independent life-long-learning through professional practice and ICT based technologies; 3) societal demands relating to environmental, sustainability and ethical issues, whilst contributing to economic developments; and finally, 4) decreasing student enrolment into engineering programs (Heitmann, 2005). In addition, regional changes in educational

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framework in different parts of the world, such as the implementation of the Bologna protocol in the European Union, have set new goals for the whole higher education system; and engineering education has been compelled to respond by including provisions for harmonised quality assessment for university courses, introducing changes in teaching and learning methodologies, and developing frameworks for the exchange of students and academics. Thus, new approaches have been recommended in various engineering disciplines; e.g. Mechanical Engineering (Fernandes Teixeira et al., 2007), Electrical Engineering (Wilson et al., 2011), Civil Engineering (Murray and Tennant, 2014) and Chemical Engineering (Glassey et al., 2013). It is somewhat unfortunate that there are relatively few articles in published literature analysing food engineering education and training per se, and virtually no article which attempts to develop an educational program which responds to the challenges that food engineering discipline faces today. This article attempts to redress this situation.

Several attempts to review different facets of Food Engineering discipline have been made in the past, including the recent past. Saguy et al. (2013) have attempted to cover a broad range of factors influencing the discipline of food engineering and identified challenges and opportunities associated with it. The challenges addressed by these authors are essentially social challenges, such as world population growth, ageing, obesity, which have a broad vision span. Hence, the opportunities and solutions identified, although relevant to Food Engineering, are not exclusive to the discipline. The paper also gives an overview of Food Engineering education and makes recommendations on what more could be done to make the subject more relevant and responsive to our needs in the future. It may be noted that this paper is essentially based on the views and opinions expressed at a discussion session held during the Conference of Food Engineering 2012, in Leesburg, Virginia, USA. As a result, its narrative is somewhat fragmented and diffused, perhaps because it is more faithful to the discussion which took place, instead of addressing the subject in a sharp and concise manner. Nevertheless, this paper gives a very good snap shot of the range of views and opinions held by key academic and industrial personnel in the field of Food Engineering.

A range of authoritative views and opinions on Food Engineering could also be gained from the papers presented at the International Congress of Engineering and Food, ICEF8, presented as a compilation by Welti-Chanes et al. (2002) under the sub-section title "Vision"; the authors in this section included some eminent names like Jowitt, Lund, Swartzel, Trystram and Bimbenet amongst others. Prior to this, Karel (1997) reviewed the history and future of Food Engineering; and Niranjan (1994a) and Holdsworth (1971) reflected on the links between Food and Chemical Engineering. Undoubtedly, many other papers have been published on this subject, and this paper is not intended to be a critique of the published narratives.

Like every other live discipline, Food Engineering is constantly evolving. But it would not be inaccurate to suggest that, until recently, the evolution of the subject, globally, has been more serendipitous. With progressively decreasing levels of funding, and increasing financial accountability, most developmental activities have had to be justified and prioritised against stipulated outcomes, which may have constrained the "natural" or "organic" evolution of the subject, but given it a sense of direction with identifiable key drivers. As in the case of all scientific disciplines relating to food, the key drivers for evolution in Food Engineering are: *health*, *environment* and *security*. These three drivers are not necessarily mutually exclusive, but discipline developmental activities can be conveniently organised under these three drivers, which also provide grounds for justifying any specific activity and enable resources being allocated to undertake the activity. Thus, the evolution of food engineering has undergone a major transition: it's growth is no longer "organic" or unconstrained with blue skies as the vision, but evidently steered by the three stated drivers. Given this philosophical transition which has occurred, it is time to take stalk of the situation and review the state of Food Engineering as a discipline. The main purpose of this paper is to reconceptualise what we mean by Food Engineering, so that: 1) we are able to meet the key challenges facing the practice of the discipline today, 2) identify subject-knowledge competencies of food engineering fit for this day and age, and 3) develop a framework for higher education programs to train food engineers of tomorrow.

2. Challenges facing food engineering

Before embarking to reconceptualise the discipline, it would be worthwhile pausing to reflect upon the challenges facing the discipline in some detail. Of course, food engineering faces all the challenges which other engineering disciplines face, and these have already been mentioned in the opening paragraph and elegantly summarised by Heitmann (2005). In addition, food engineering also faces challenges which are of a societal nature, such as the water-energy-food security nexus (2014) and obesity, which cannot be tackled exclusively by the food engineering discipline, and require a concerted response from a number of other disciplines. The rationale behind the selection of challenges facing food engineering discipline in this paper is based on: (1) its current status within higher educational establishments and (2) its changing role in industrial practice, both of which, the author believes, can be addressed by the discipline itself.

With regard to the status of Food Engineering within higher educational institutions, it is worth noting that there are relatively few countries with a norm for universities to have full-fledged food engineering departments on par with, say, mechanical, electrical, civil or chemical engineering departments. Brazil, Chile, Thailand and Turkey are the examples of countries where food engineering has thrived under independent academic departments. In China, the discipline conducts itself within the so-called "food science and engineering" departments, whereas in India, food engineering is a part of agricultural engineering and is more often taught in Agricultural Universities. One of the main problems faced by Food Engineering discipline within higher educational institutions – especially in Europe, USA, Australia and New Zealand – is that the discipline is invariably run by other engineering departments, such as chemical engineering, mechanical engineering or biosystems engineering, and therefore considered to be their subsets. Food Engineering is inevitably perceived to be, and often conducted as an abridged version of another branch of engineering, which has not only thwarted its autonomous growth and development, but also discouraged recruitment of bright young minds into the discipline. Thus, the need to give Food Engineering discipline a strong identity of its own is an absolute imperative.

With regard to the challenges faced in the industrial practice of food engineering, Niranjan (2014) has addressed