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# **AC 2012-5378: PHILOSOPHY AND UNDERGRADUATE TEACHING AND LEARNING: THOUGHTS AND PERSPECTIVES FOR ENGINEERING EDUCATION**

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# **Philosophy and Undergraduate Teaching and Learning: Thoughts and Perspectives for Engineering Education**

## **Abstract**

During the last six years there has been growing interest in the development of a philosophy of engineering and a philosophy of engineering education as distinct from a philosophy of science education. There have been several international workshops and a number of papers on these topics that have been presented at the ASEE and Frontiers in Education (FIE) conferences. Those concerned with the philosophy of education have focussed primarily on the contribution that philosophy can make to the design of the curriculum and the use of the philosophical method in the study of engineering. Most of these discussions have been engineering-centric and taken place in the absence of any discussion of the more general aims of higher education. The purpose of this paper is to consider the role that philosophy might play in the achievement of the goals of higher education as expressed by such authorities as John Henry Newman. It is argued that a link between engineering education and these more general goals is to be found in the views of the Scottish philosopher John Macmurray on the relationships between theory, practice and action as expressed in his Gifford Lectures on “The Self as Agent” and “Persons in Relations.” It is argued that as much attention needs to be given to the affective domain as it does to the cognitive. Recent research shows the importance of the peer group, together with interaction with faculty to be the most important factors in student achievement and development. Faculty have a major role to play in helping engineering students overcome negative attitudes toward liberalism, as does mixing with students who have other interests. Enlargement of mind is helped by an acquaintance with the perennial problems of philosophy since the answers a person gives to them influence her/his thinking and behaviour. In the discussion that ends the paper, attention is drawn to recent research on the experience of students of their undergraduate education that supports some of the contentions made in this paper.

## **Recent developments in the study of philosophy, engineering and engineering education**

The last decade has been marked by an increasing interest among engineers and engineering educators in the philosophy of engineering education. In 2003 there were two major publications concerned with this matter. First, Billy Koen’s “*Discussion of the Method: Conducting the Engineer’s Approach to Problem Solving*” rooted in the use of heuristics that he claimed to be universal [1]. Second, Louis Bucciarelli explored the connections between philosophy and engineering especially engineering design, in a book with the formidable title of “*Engineering Philosophy*” [2]. A year later, Goldman argued the case for a philosophy of engineering as opposed to a philosophy of science [3]. A meeting at MIT in 2006 inspired a series of workshops on philosophy and engineering in which engineers met with philosophers to discuss common problems. The proceedings of the first workshop held in 2007 have been published [4]. In the same year several members of ASEE’s Education and Research Methods (ERM) Division taking a lead from an article published by Karl Smith [5] began a discussion at the annual Frontiers in

Education Conference (FIE) [6]. There was much interest generated and this prompted them to continue these discussions at successive conferences, to hold workshops and paper sessions. These culminated in 2011 in an invitation workshop sponsored by ASEE's ERM Division, Institution of Electrical and Electronic Engineers Education Society (IEEE Ed Soc) and the National Science Foundation (NSF). Their research showed there was a growing body of literature on the topic together with a very substantial literature in engineering ethics with which they had not engaged. This was made available to the workshop and published in the Proceedings of the FIE [7]. In parallel some participants in these activities presented papers at the annual conferences of ASEE.

In the ASEE Liberal Education Division's 2007 meeting, Grimson pointed out that given Wittgenstein's view that "*philosophy is not a theory, but an activity,*" there were many parallels between engineering and philosophy. He described engineering activities that corresponded to the five classical branches of philosophy, and in a paper that moved between a philosophy of engineering and a philosophy of engineering education he argued the case for a module on the philosophy of engineering education within the undergraduate curriculum. His intention was to show how philosophical understanding can lead to an improved engineering education [8]. This same rationale was behind the workshops given by Korte and Smith at the 2009 FIE conference when they attempted to demonstrate how the philosophical method could be used by undergraduates to improve their learning [9]. They used the method of Rescher as a background to their workshop [10]. The focus on the use of philosophy as a tool to improve learning in engineering is subsequently called engineering-centric. Similarly the study of the fundamental questions traditionally associated with philosophy that are focused on the person is called person-centric. The focus of this paper is on the person-centric dimension which has not received as much attention as the engineering –centric dimension of the student's experience.

In another dimension others showed how philosophy could lead to a more informed view of curriculum aims and objectives through an activity called "screening" [11]. This paper begins with a comment on the significance of aims for the teaching and learning experience.

### **The aims of education and their significance**

As indicated most of these discussions have been engineering-centric and have taken place in the absence of any discussion of the more general aims of education, a task that many years ago was central to the philosophy of education (e.g Whitehead [12]). This criticism applies as much to higher education more generally as it does to engineering. More generally the American educational philosopher Nel Noddings considers that talk of aims is a missing dimension in educational conversation [13]. Citing Whitehead to the effect "*that there is only one subject-matter for education and that is "Life in all its manifestations"*" Noddings points out that "*such statements demand full and lengthy discussion, but they give us a starting point to which we continually return*" [14]. Statements about aims naturally reflect the belief and value systems of those that make them so it is not to be expected that there will be a set of aims that will satisfy all

outcomes even within the education of engineers [15]. But this does not deny the importance of trying to formulate aims because to cite Noddings again “*we need to talk about aims because aims provide criteria by which we judge our choices of goals, objectives, and subject content.*” If we change the direction of the discussion such that developing aims is “*directed (more generally) at the larger society and its policies*” then “*as we ask deeper questions about our aims- why are we doing X? – we uncover new problems and new possibilities for the solution of our original problems*”[16].

In this case, the problem is the role of engineering education in the development of what is commonly called the ‘whole person’. For this purpose to be achieved it is necessary to change the direction of talk away from the engineering-centric model of the learner to a person-centric model, for it is the person, first, that philosophizes about the aims they wish to achieve. “*Right or wrong, a man must philosophize, for he philosophizes as he thinks*” [17, and the writer might have added ‘and as a person thinks so she or he acts’. But the conclusion is the same, – a university that ignores this characteristic of the person and denies them “*the invigorating exercise of a right philosophy,*” [18] is not worthy of being a university. The study of skill in philosophy as a means of the improvement of learning in engineering is not a sufficient condition for the development of the person *qua* person.

### **John Henry Newman and the aims of university education; the person *qua* person**

Fundamental to the rationale of a university is the belief that through the study programs it offers a person will change. Crudely put, it is a behaviourist institution. There are those who express a professional-centric view of its purpose: for example, the American psychologist Jerome Bruner wrote, “*We teach a subject not to produce little living libraries on that subject but rather to get a student to think mathematically for himself, to consider matters as a historian does, to take part in the process of knowledge getting*” [19], which is to suggest we are training students to be professional people of one kind or another. Throughout the 19<sup>th</sup> century issue was taken between those who expressed this view but in general terms of the utility function of education and those who believed in an education that would discipline the mind. The most celebrated description of the outcomes of the latter is to be found in the discourse on knowledge and professional skill in John Henry Newman’s 1873 revision of his 1852 discourses that founded the Catholic University of Ireland (predecessor of University College Dublin). In the box (exhibit 1) the final paragraphs of the discourse in which he defined university training (and he used the word ‘training’) are given. The original is continuous, but for convenience here, it is broken into three sections (I, II and III). While many argue that Newman’s thesis has had its time, others would argue that universities achieve such goals within the studies and environment they offer. But it is hard to see these achievements reflected in societies that have large numbers of graduates distributed throughout the population. Simple reflection suggests that they remain important aims that have yet to be achieved. So what does an education have to do to achieve those aims? Newman answers at length in the second section.

The first sentence of this section is a call for reflective thought which today is considered to be one of the major aims of higher education. It is then followed by a series of phrases that would readily translate into any of today's taxonomies or classifications of critical thinking. They are followed by social skills, and in engineering terms, skills that relate to the management and leadership of people, and team work. In recent years these have been called "Personal Transferable Skills" in the UK. But, it is argued, they cannot be developed in the absence of a breadth of knowledge, which Newman thought was universal, and not simply a disparate grouping of subjects. "*One thing is unquestionable, that the elements of general reason are not to be found fully and truly expressed in any one kind of study, and he who would wish to know her idiom, must read it many books*" [21]. Elsewhere he provides an epistemological basis for his thinking which he also illustrates practically in the discourse on "Knowledge Viewed in Relation to Learning" (No 6). In that discourse he demonstrates how the idea (aim) of a university is the 'cultivation of the intellect' or the 'enlargement of the mind', and at the same time provides an epistemology in support of that view [22].

(I) " .. a university is the great ordinary means to a great but ordinary end; it aims at raising the intellectual tone of society, at cultivating the public mind, at purifying the national taste, at supplying true principles to popular enthusiasm and fixed aims to popular aspiration, at giving enlargement and sobriety to the ideas of the age, at facilitating the exercise of political power, and refining the intercourse of private life". (II) "It is the education which gives a man a clear conscious view of his of his own opinions and judgments a truth in developing them, an eloquence in expressing them, and a force in urging them. It teaches him to see things as they are, to go right to the point, to disentangle a skein of thought, to detect what is sophistical, and to discard what is irrelevant. It prepares him to fill any post with credit, and to master any subject with facility. It shows him how to accommodate himself to others, how to throw himself into their state of mind, how to bring before them his own, how to influence them, how to come to an understanding with them, how to bear with them. He is at home in any society, he has common ground with every class, he knows how to speak and when to be silent; he is able to converse, he is able to listen; he can ask a question pertinently, and gain a lesson seasonably, when he has nothing to impart himself; he is ever ready, yet never in the way; he is a pleasant companion, and a comrade you can depend on; he knows when to be serious and when to trifle and he has a sure tact which enables him to trifle with gracefulness, and be serious with effect". (III) "He has the repose of a mind which lives in itself, while it lives in the world, which has resources for its happiness when it cannot go abroad. He has a gift which serves him in public, and supports him in retirement without which good fortune is vulgar, and with which failure and disappointment have a charm. The art which tends to make a man all this is in the object which it pursues as useful as the art of wealth or the art of health, though it is less susceptible of method, and less tangible, less certain, less complete in its result"[20].

The third section is clearly a picture of the personality that should result from this process. While Newman eschewed the idea of character building it is difficult to believe that character would not be influenced by this process. His for this picture of university education is a painting of development that in today's jargon is as much dependent on the 'affective domain' as it is on the cognitive. It is reliant on the acquisition of interpersonal skills, and elsewhere in the discourses Newman has recognized that it is not obtained by class work alone, but that it is dependent on the total environment of what he conceives a university to provide [23]. Taken together a

university helps a person obtain a philosophical disposition, or as Newman says among other descriptions in the discourse a “*healthy intellect*”.

Newman argues that general culture of the mind is the best aid to professional and scientific study [24]. I would wish to maintain this principle and argue that while the education that is completed in high school is an education in an agreed set of subjects, it is not cultivation of the intellect. Therefore, prior to professional training a higher education should concentrate on the development of the person’s intellect. This is an opposite view to those who would argue that this development will take place only after a course of professional study. The implications of this view for the curriculum in all its dimensions are profound. An engineering education that requires a liberal component will only be successful if those who embark on its study have been exposed to an education that ‘enlarges the mind’.

Newman was very conscious that education took place within the wider society for “*a parallel teaching is necessary for our social being, and it is secured by a large school or college; and this effect may be fairly called in its own department an enlargement of mind*” [25]. There is as Walgrave has shown a substantial social psychology in Newman’s other writings notably in his writings on the development of ideas [26]. Newman recognizes that we are social beings, which is evident from the statement in exhibit 1 and that our place in the social system or environment as might call it today is a factor in the completion of our personality. The student needs, therefore, to mix with and learn from a diversity of persons.

The argument thus far has been that when the aims of education are discussed as a pre-requisite of the higher education curriculum that, irrespective of subject, a new approach is required to the formation of the professional person. The declaration of aims considered were those of John Henry Newman and from them it is deduced that attention to the affective (in a broad use of the term) is as important as the cognitive domain of human behaviour.. It would be possible to extend this discussion into Newman’s epistemology and its consequences for the broad curriculum he advocated. Equally it would be possible to demonstrate the importance of aims through discussion of Albert North Whitehead’s celebrated essays on the topic [27]. For example Whitehead’s theory of rhythm in education can be used to support the argument presented. However, the purpose here has been to present the view that a person-centric approach to philosophy in the engineering curriculum should precede an engineering-centric approach. That is, a person should become acquainted with the perennial questions of philosophy, and how the answers given by the person to those questions influence his/her thinking and behaviour. But this cannot be achieved without attention to the affective domain. With this in mind John Macmurray’s concept of the person is considered.

### **John Macmurray**

John Macmurray was a Scottish philosopher who lived through the first three-quarters of the twentieth century (1891 – 1976) Largely forgotten by philosophers his reputation received a

boost when Tony Blair the British Prime Minister said that if you want to understand what I mean by “community” read John Macmurray. During the last decade Canadian Jesuits have taken an interest in his work and one has written an authoritative biography of this Quaker scholar [28]. Since he had been the first philosopher in the UK to make regular radio broadcasts about philosophy on the BBC (between 1930 and 1934) it is perhaps surprising that he has been forgotten. One of the reasons must be that he eschewed the establishment. In today’s jargon he would be described as a ‘bit of a loner’. He did not belong to the mainstream of analytic philosophers then prevalent, indeed he criticised them. He was well versed in both the sociology and the psychology of the day, and he well understood the impact of culture and changes in culture that is, in the attitudes and beliefs it imports on the person.

### **Questioning the instrumental-technical viewpoint**

In a series of lectures when a tutor at Oxford, Macmurray argues “[...] *you will never understand a great thinker if you start where he starts – in this case the Cogito (Descartes). Instead you want to know first the assumptions, usually unconscious, with which he starts...by his assumptions I mean the floating atmosphere of outlook and feeling which is the current ‘opinion’ of his time. There is a ‘public opinion’ in science as well as in politics. The philosophic discoverer has found an important flaw in it [...]*” [29]]. Apart from the fact that almost all of this statement could easily be inserted in Newman’s statement (exhibit 1), Macmurray was concerned with the pervasive effect of the instrumental, technical viewpoint on the unquestioned formation of opinion at the time. This was immediately after the first world-war, in which he served in the battlefields the experience of which was to have a profound effect on this thinking. He was eventually to challenge that unquestioned opinion in his lecturing and writing.

### **Engineering and science as social processes**

Most significantly from the perspective of this discussion he argued against the dualism that predominates western philosophy, and in the notes against one of his lectures is to be found the comment ‘*Cogito non ergo sum*’. This immediately set him outside the mainstream of western philosophical thinking. His search was for an adequate conception of “human knowledge, freedom and action”. The culmination of Macmurray’s thinking came in the Gifford lectures of 1953 [30] and 1954 [31]. From the perspective of engineering education, to quote Thomas Torrance a distinguished twentieth century theologian, “*he has destroyed the old dichotomy between reason and experience, theory and practice, throwing greater light than anyone else on what we mean by reason and rationality, and the search for truth for truth’s sake*”.

Macmurray did not write about engineering specifically but he did write about the philosophy of science, and to quote Torrance again, argued “*that science is possible only within a larger framework of non-scientific issues and concerns for the activity of science is embedded in a much deeper realm of human experience*” [32]. It seems that this is precisely the same thing that Bucciarelli is saying about engineering and engineering design. “[...] *in the big world [...]*

*attributing value or quality to a technical product is always a social process [...] to think that technology 'has a life of its own' may be in order in the object-world of replicating automaton, but it is romantic nonsense to think and talk this way out here in the big world. [...]*" The vision of technology that sets itself apart and aloof, distant and seemingly out of reach of ordinary people is flawed [...]. *"As citizens, we ought to know and do better"* [33]. Clearly this has implications for curricular in engineering literacy.

### **Reason and emotion**

Costello reports that while at Balliol Macmurray began to study Kant and the German Romantic philosophers [34]. It is not surprising, therefore, to find that that having discussed what he means by the crisis of the personal, the lectures on 'The Self as Agent' begin with a discussion of Kant and Romantics. The Romantics opposed the positivist view of knowledge as found in Cartesian rationalism and suggested that aesthetic intuition and creative imagination were more full and pure forms of knowing. For Macmurray the most important of the German romantics was Hamann because of the faith philosophy he had developed with Herder. Macmurray wrote that *"we can best define Hamann's contrast of faith and reason by saying that 'reason' is that in us which enables us to produce science; while 'faith' is our capacity for aesthetic experience. Hamann's proposal whether he is aware of it or not, is to substitute the artist's standpoint for the scientist's, as the basis of our knowledge of the real"* [35].

From the Romantics Macmurray had confirmed in him the view that reason must include feeling as well as intellect. One consequence of this is that in the penultimate chapter of 'The Self as Agent' he considers not only intellectual reflection but emotional reflection and in a small way anticipates the debates of the last decade about emotional intelligence [36]. From Kant, Macmurray learnt to *"cherish the need for all forms of knowing to respect some form of 'rational' method"* [37] Since within any group of people there will be different ways of knowing it is incumbent on individuals to understand that that is the case. If they are not exposed to these differences then the possibility of effective communication is diminished and their understanding of people's behaviour limited. Thus, the IBM decision to employ researchers from the humanities and social sciences in preference to engineers because they would better understand the thinking patterns of people for whom they wanted to design electronics of one form or another is to be regretted [38]. But there is much more to his study of Kant than this and from it one point is taken that has a bearing on the subject of this paper- engineering.

### **The relevance of the practical; understanding engineering reasoning**

*"It is only when we turn to consider our practical experience as agents, and not our theoretical experience as thinkers, that we discover the true character of reason. This is the final and quite revolutionary conclusion of the Critical philosophy. Reason is primarily practical. It is not a faculty of cognition, but a faculty of rules. If it has a secondary, theoretical function that is because thinking is something that we do; so that Reason is necessary to provide the rules that*



*guide our search for knowledge. The understanding, which is theoretical, is, as it were the viceroy of reason in the theoretical field. Reason itself is the ultimate legislator. This is the dignity of reason. For Kant –and as a philosopher- action is more important than knowledge. If it was important to distinguish science from art, it is much more important to distinguish morality from art. The major danger which Kant saw in the uncritical idealism of the romantics was this confusion- the danger of substituting aesthetic for moral standards in the determination of conduct. Indeed science itself, as a human activity, depends on practical rationality” [39].* Embedded in this comment and more so in Macmurray’s general discussion is clearly a portrayal of ‘engineering reasoning’. The differences between science and engineering arise from the practical ends they have to serve. Most recently these practicalities have been defined in terms of the problems that on the one hand, scientists’ (physicists), and on the other hand engineers have to solve. ‘Engineering reasoning’ leads to a different kind of knowledge to that of science. It is about the results of engineering design.

Macmurray argued that *“there is a necessary interplay, in all human activities, between theory and practice. It is characteristic of Man that he solves his practical problems by taking thought; and all his theoretical activities have their origins, at least, in his practical requirements. That they also find their meaning and significance in the practical field will command less general assent; yet it is, in my belief, the truth of the matter, and one of the major theses to be maintained here. Activities of ours which are purely theoretical, if this means that they have no reference to our practical life, must be purely imaginary-exercises of phantasy which are not even illusory unless we relate them to the practical world by a misplaced belief. The truth or falsity of the theoretical is to be found solely in its reference to the practical”*[40].

Macmurray substitutes ‘I do’ for ‘I think’. One of his public lectures on the primacy of action over thought was titled ‘*Cogito Ergo Non Sum*” [41]. The Self as subject then is not part of the world it knows’! [42]. If this is taken to be the position of engineers and engineering in the real world then epistemological studies in the absence of an understanding of what it is that engineers do as an activity are irrelevant to the central problems of engineering education.

### **Persons in relation**

Finally, a short remark on ‘The Self as Agent’, the central theme of Macmurray’s first group of lectures. *“Consider now the Self in relation to the world. When I act I modify the world. Action is causally effective, even if it fails of the particular effect that is intended. This implies that the Self is part of the world in which it acts, and in dynamic relation with the rest of the world. On the other hand, as subject the Self stands ‘over against’ the world, which is its object. The self as subject then is not part of the world it knows, but withdrawn from it, and so, in conception, outside it or other than its object. But to be part of the world is to exist, while to be excluded from the world is to be non-existent. It follows that the Self exists as agent, but not as subject”*[43]. In the second group of lectures on “Persons in Relation” Macmurray argued that the “Self is a ‘person’ and *“persons only develop as persons in relation to other persons. We*

*come to be who we are as personal individuals only in personal relationships*” [44]. The outcome of Macmurray’s philosophy is that it challenges the “*primacy placed on individuality and therefore self interest, creates an inevitable primacy for competition over cooperation, to say nothing of communal trust and affection, in public relationships*” [45]. For Macmurray all competition is for the sake of cooperation, and all cooperation is for the sake of communion. These are issues that are at the very heart of current debates about capitalism in the western world.

And so we come full circle to Newman, for Newman thought that when young people of all kinds come together they learn as much from each other as they do in more formal settings. “*When a multitude of young men, keen, open-hearted, sympathetic and observant, as young men are, come together and freely mix with each other, they are sure to learn one from another, even if there be no one to teach them; the conversation of all is a series of lectures to each, and they gain for themselves new ideas and views, fresh matter of thought and distinct principles for judging and acting, day by day [...]*” [46]. To enable the freedom for mixing was the reason for establishing small residential communities in a university [47]. It is a major reason for mixing engineers with students from the liberal arts as happens in some service courses. Where there are no such structures these needs are a prima facie case for cooperative learning irrespective of the claims that are made for it as an agent of cognitive learning. Many engineering students want to study privately and work by themselves but Macmurray from a general philosophical perspective, and Bucciarelli philosophizing from an engineering standpoint lead us to the understanding that engineering is a community (social) activity. What is required of a university is that the challenge presented through instruction is such that they take it with them to their communities for discussion.

## **Discussion**

In recent years engineering educators have begun to discuss the relevance of the philosophy of education to engineering education. Its value in the determination of aims of education through the activity of screening has been demonstrated. In this paper it is argued that when the aims of education are discussed as a prerequisite of the higher education curriculum that, irrespective of subject, a new approach is required to the formation of the professional person. In support of this view a more traditional expression of the aims of higher education was considered. In this case, the goals considered were those expressed in Newman’s *Idea of a University*

In these discussions engineering educators have shown how engineering can illuminate the traditional areas of knowledge embraced by philosophy, and how in their turn they can illuminate the study of engineering. In another dimension it has been argued that using the methods of philosophy in the study of engineering can enhance that study. All of these approaches are engineering-centric in that the focus is on how philosophy can be used to enhance the quality of engineering through changes in approaches to its study – teaching and curriculum.

In contrast the argument of this paper is person-centric. It stems from the notion that for the development of the ‘whole person’, every individual should be exposed to a well-founded liberal education. The concept of liberal education presented here derives from the position taken by John Henry Newman in *The Idea of a University*. In brief the argument is that general culture of mind is the best aid to professional and scientific study. Its pre-requisite is “enlargement of mind”.

Enlargement brings about a philosophical disposition that is the result of philosophising or reflective thought. Thus prior to a professional training higher education should concentrate generally on the development of the person’s intellect. This would require that in some way the person becomes acquainted with the perennial questions of philosophy, and how the answers given by the person to these questions inform her/his thinking and behaviour. It has not been part of the purpose of this paper to discuss how this might be done. There are a great many of relatively simple ways of achieving this goal.

But Newman and the other philosopher discussed in this paper John Macmurray are insistent that account has to be taken of the affective domain in the intellectual and personal development of students. This has implications for the way the curriculum and in particular teaching is organized. It also has implications for institutional structures..

In the first place recent attention in higher education has and continues to focus on the need to develop what have been called personal transferable skills. Some argue that this can be achieved through specific attention to them in each of the subjects that make up the engineering curriculum, (or for that matter any other curriculum). This may involve some teachers in making radical changes in their approaches to teaching. Others argue that yes, there is evidence that this can be done but they would be helped by extra supporting studies.

It is questionable whether all the personal transferable skills can be developed by the student in isolation of other students. Both Newman and Macmurray emphasised the fact that we are social beings. Macmurray argued that persons only develop as persons in relation to the other person. We come to be who we are as personal individuals only in personal relationships. Both point to the fact that our place in the environment is a factor in the completion of our personality, hence the importance of educational communities to our personal and professional development. This is consistent with much recent research. In the US Astin’s most extensive study of the experience of college led him to the view that “ *the student’s peer group is the single most potent-source of influence on growth and development during the undergraduate years [...] students’ values, beliefs, and aspirations tend to change in the direction of dominant values, beliefs, and aspirations of the peer group*” [48]. These views receive considerable support from Pascarella and Terenzi’s 2005 synthesis of research on the affect of American colleges on their students. They found that “*the impact of peer interaction was greatest when peers challenged beliefs, attitudes, and values, forcing introspection, reflection and re-evaluation*” [49]. Clearly that was what Newman hoped would happen, an aspiration that was undoubtedly influenced by

his experience of the colleges at Oxford and the way they were physically structured [50]. To be successful such groups have to offer a variety of opinions, beliefs and dispositions and of varying socio-economic status if they are to be challenging [51]. The question is how can they be brought about in the modern non-collegiate university? [52]

Linked to this is Astin's finding that is supported in Pascarella and Terenzi's 2005 study, that the second most important factor affecting student development in college is student- faculty relationships. Sadly Astin found that in many institutions undergraduate teaching and student development was neglected. The same would true of many faculty in universities in Britain and Ireland. Pascarella and Terenzini summarise their findings thus; "*consistent evidence indicates that institutional environments with a scholarly or analytical emphasis foster both learning and general cognitive growth. Moreover, such an emphasis was not determined by, nor merely a proxy for, institutional selectivity. Replicated evidence also suggests that critical thinking, analytic competencies, and general intellectual development thrive in college environments that emphasize close relationships and frequent interaction between faculty and students as well as faculty concern about growth and development [...]*" [53].

Macmurray adds to this debate in two ways. First, his view that there are many ways of knowing, and that all ways of knowing must be cherished directly supports the need for students to participate in broadly based educational communities. In the United States there are service courses that would appear to do just this. Second, he considered that reason must include feeling as well as intellect which supports the contention that the affective is as important as the cognitive in the development of the individual.

By questioning Cartesian dualism Macmurray provides an epistemology that might be called the 'engineers epistemology'. It is an epistemology that begins with the view that reason is primarily practical. It follows that engineering reasoning arises from the practical problems that engineers have to solve, and the role of theory is to help engineers solve problems in the same way that individuals use theories to solve their problems. They do not start with theories but with a problem, and these problems have a social origin. Macmurray recognised this to be the case with science.

He argued that science is only possible within a larger framework of non-scientific issues and concerns for the activity of science is embedded in the much deeper realm of human experience. Newman's epistemology comes to saying much the same thing. Even if it does not, Macmurray's point is surely true of engineering, for as Bucciarelli has forcefully argued, engineering design is a social process, and for designers to appreciate their role in that process they need to begin by understanding themselves as agents in the creative process. For this they have come to terms with their identity as a person which is the first step in the enlargement of the mind. The second step is to come to terms with their identity as engineers In the first place they need a liberal education that they use to reflect on themselves as human beings, and subsequently on the problems they face as engineers.

Given Astin's finding confirmed by much anecdotal evidence that liberalism is negatively affected by the pursuit of an engineering major, as are attitudes to feminism, the promotion of racial understanding, cultural awareness, and writing ability: and given that many engineering students do not like liberal studies and regard them as a necessary evil, the task of changing the culture is truly enormous. Yet, changing patterns in the labour-force suggest that increasingly everyone will need a broad education prior to specialist education, and that such an education should include engineering (technology), and in one way or another it should engage the student in the perennial questions of philosophy. There are many ways of achieving this goal. There is a need to bring together relevant practice, and there is a need to experiment. In terms of the organization of the curriculum and the need for mixed learning communities the need for divergent visioning is great.

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### **Notes and references**

- [1] Koen, B. V (2003) *Discussion of the Method. Conducting the Engineering Approach to Problem Solving*. Oxford University Press, New York
- [2] Bucciarelli, L. L (2003). *Engineering Philosophy*. DUP Satellite, Delft, Netherlands.
- [3] Goldman, S. L. (2004) Why we need a philosophy of engineering. A work in progress. *Interdisciplinary Science Reviews*. 29, (2), 163 – 176.
- [4] van de Poel, I and D. E. Goldberg (2010) *Philosophy and Engineering. An Emerging Agenda*. Springer, Dordrecht, Netherlands.
- [5] Smith, K. A (2003) Educational philosophy. *Journal of Engineering Education* (Academic Bookshelf) July pp 203 – 205.
- [6] Heywood, J, Smith, K. A and R. McGrann (2007) Can philosophy of engineering education improve the practice of engineering education. *Proceedings Frontiers in Education Conference T1f – 1 and 2*.
- [7] (a) Heywood, J (2011) A historical overview of recent developments in the search for a philosophy of education. *Proceedings Frontiers in Education Conference* 24 pages.  
  
(b) Heywood, J., Carberry, A., and W. Grimson (2011) A Select and Annotated Bibliography of Philosophy in Engineering Education. *Proceedings Frontiers in Education Conference*, 35 pages.

- [8] Grimson, W (2007) The philosophical nature of engineering. A characterization of engineering using the language and activities of philosophy. *Proceedings of the American Society for Engineering Education Annual Conference*. AC 2007- 1611, 14 pgs.
- [9] Korte, R and R. K. Smith (2009) Developing engineering student's philosophical inquiry skills. *Proceedings Frontiers in Education Conference M4A*, 1 – 6.
- [10] Rescher, N (2001) *Philosophical reasoning. A Study in the Methodology of Philosophizing*. Blackwell, Maiden, MA.
- [11] (a) Heywood, J (1981) The academic v practical debate. A case study in screening *Institution of Electrical Engineers Proceedings Part A*, 128, (7), 511 – 519.
- (b) McGrann, R (2008) Philosophy of technology in engineering education, *Proceedings Frontiers in Education Conference*, S4H, 29 – 34.
- [12] Whitehead, A. N (1932) *The Aims of Education and other Essays* (2<sup>nd</sup> Edition, 1950 with a foreword by Lord Lindsay of Birker). Ernest Benn, London.
- [13] Noddings, N (2009) The aims of education in D. J. Flinders and S. J. Thornton. *The Curriculum Studies Reader*. 3<sup>rd</sup> edition. Routledge, New York p 425.
- [14] *ibid* p 431
- [15] Schubert, W. H. (1997) *Curriculum. Perspective, Paradigm and Possibility*. Prentice Hall, Upper Saddle River, NJ. He suggests that those who promote curriculum orientations fall (crudely) into three particular schools which he labels intellectual traditionalist, social behaviourist, and experientialist. Some embrace more than one orientation and he cites himself as an example. In his classification Mortimer J. Adler would belong to the first orientation, Benjamin Bloom to the second and John Dewey to the third.
- [16] *loc.cit* ref 13. pp 414 and 415 (ie that is all the quotations in the preceding two sentences).
- [17] Hamilton, Sir William (1852) On a reform of the English Universities with special reference to Oxford : and limited to the Faculty of Arts in- *Discussions on Philosophy and Literature, Education and University Reform* cited by McGrath, F (1962) *The Consecration of Learning. Lectures on Newman's Idea of a University*. Gill, Dublin. Pp39 – 45. McGrath notes that Hamilton who was Professor of Logic and Metaphysics at the University of Edinburgh is not to be confused with his contemporary Sir William Rowan Hamilton the eminent mathematician of Trinity College Dublin.
- [18] *ibid*
- [19] Bruner, J (1966) *Toward a Theory of Instruction*. Norton, New York.
- [20] Newman, J. H (1873) *The Idea of a University. Defined and Illustrated*. 1947 edition, Edited with an introduction By C. H. Harrold. Longmans, Green & Co. New York. Pp 157 and 158
- [21] *ibid*. p 155. For a discussion of personal transferable skills in the U.K see Heywood, J. (2005). *Engineering Education. Research and Development in Curriculum and Instruction*. IEEE/Wiley, Hoboken, NJ. pp 41 ff.
- As defined by a working group of the KK Employment Department circa 1990 and cited in Heywood (2005)

## Cognitive knowledge and skills

1. **Knowledge:** key concepts of enterprise learning (accounting, economics, organizational behaviour, inter and intra-personal behaviour)
2. **Skills:** The ability to handle information, evaluate evidence, think critically, think systematically (in terms of systems), solve problems, argue rationally, and think creatively.

**Social skills:** as for example the ability to communicate, and to work with others in a variety of roles both as leaders and as team member.

**Managing one's self:** as for example, to be able to take initiative, to act independently, to take reasoned risks, to want to achieve, to be willing to change, to be able to adapt, to be able to know one's self and one's values, and to be able to assess one's actions.

**Learning to learn:** To understand how one learns and solves problems in different contexts and to be able to apply the styles learnt appropriately in the solution of problems

[22] *ibid.* See for example pp 118 and 119.

[23] *ibid* p 128.

[24] *ibid* p 129-133 and the chapter that follows on knowledge viewed in relation to professional skill. See p 148 "I say that a cultivated intellect, because it is good in itself, brings with it power and a grace to very work and occupation which it undertakes [...]"

[25] *ibid* p 129.

[26] (a) Walgrave. J –H (1960) *Newman the Theologian*. Geoffrey Chapman, London. See part 4 The Social Psychology of Development. Newman's social psychology begins in the essay on the development of Christian – see (b).

(b) Newman, J. H. (1845 and 1878) *An Essay on the Development of Christian Doctrine* J. Toovey London and Longman, Green, London. Newman completely revised the second edition. J.M. Cameron provides a long introduction to the 1845 edition which was reprinted by pelican Classics (Penguin) in 1975. Walgrave's study is based on the 1878 edition.

[27] *loc.cit* ref 12.

[28] Costello. J. E (2002) *John Macmurray. A Biography*. Floris Books, Edinburgh.

[29] *ibid.* Quoted from the section on the Jowett lectures p 112,

[30] Macmurray, J [1957] *The Self as Agent*. Faber and Faber, London.

[31] Macmurray, J [1961] *Persons in Relations*. Faber and Faber, London.

[32] *loc cit* ref 28. The Appendix written by T. F. Torrance pp 422 and 423.

[33] *loc cit* ref 2. Precis of the last two paragraphs of the book. P 101.

[34] Copleston, F (1960) *A History of Philosophy Vol VI. Modern Philosophy*. Image Edition 1994, Doubleday, New York. Gives a comprehensive account of the French Enlightenment and Rousseau, the German Romantics, and Kant. Costello ref 27 (pp 130 -137) gives a short summary and shows how the romantics and Kant influenced

Macmurray's thinking, causing him to "seek out the best of both inspirations; the fullest scope of reason, on the one hand and, on the other, the need for a disciplines, appropriate and varied exercise of reason. He knew beyond doubt that although science, art, morality and religion are not identical they can come together in the same person, and therefore ideally, can and must come together in theory and in society" p 135). But Macmurray's explanation of the Romantics and Kant's commentary on them in the 'The Self Agent' seems to this writer to be equally readable. For example, p 40. "The pioneers in this philosophical movement were, Lessing, Hannan and Herder. Between them they enunciated the main structural ideas of romantic thought. Lessing contributed the ideas of productive imagination, and of development; Hamann the notion of reality as a tension of contradictions; herder that of nature as an organic unity [...] Hamann was the founder of the faith philosophy [...] Hamann maintained that reason is an illusory guide to knowledge : we can know reality only by means of faith. The ground for this judgement is that reason works by the law of contradiction, and so uses the absence of contradiction as the guarantee of truth. Faith on the contrary, reveals reality as a tension of contradictory elements etc".

[35] *loc.cit* ref 30 p 42.

[36] See discussion in Heywood, J (2005) *Engineering Education. Research and Development in Curriculum and Instruction*. IEEE/Wiley, Hoboken, NJ pp 165 – 170.

[37] *loc.cit* ref 28 p 135.

[38] Heywood, J (2007) "Think...about how others think". Liberal education and engineering. *Proceedings 37<sup>th</sup> Frontiers in Education Conference* T3C- 20 to 24. Inspired by a short article in *IEEE Spectrum* December 2006. P 6.

[39] *loc.cit* ref 30 p 54.

[40] *ibid* p 21.

[41] *loc..cit* ref 28 p 323.

[42] *ibid* p 325. Costello summarise the full structure of personal logic as follows1. The Self is agent and exists only as agent. 2 The self is subject but cannot exist as subject. It can be subject only because it is agent. 3. The Self is subject in and for the Self as agent. 4. The Self can be agent only by being also subject. See ref 29 pp 100 – 102.

[43] *loc.cit* ref 30. p 91.

[44] *loc.cit* ref 28 pp 326 -327

[45] *ibid* pp 328 – 329..

[46] *loc.cit* ref 20 p 129.

[47] But the provision of a hall of residence is not a sufficient reason for universities to claim they offer a liberal education. See Astin, A. W (1997) *What Matters Most in College. Four Critical Years Revisited*. Jossey Bass, San Fransisco.

[48] Astin, A. H (1993). *What Matters in College. Four Critical Years*. Jossey-Bass, San Fransisco. p 398.

[49] Pascarella, E. T and P. T. Terenzini (2005). *How College Affects Students. Vo 2. A Third Decade of Research*. Jossey-Bass, San Fransisco. p 614.

[50] In Newman's time the colleges were very small and he would have envisaged small communities. They were arranged around staircases and the students had rooms around each staircase. The colleges, as now, were made up of students and faculty from all the disciplines. As Oxford and Cambridge have grown so they have added to the



number of colleges. Astin (ref 47, p 413) writes “In many ways the British “college” supplied the prototypical model for undergraduate education in the United States. The colonial colleges and many hundreds of private colleges that were founded in the next 250 years were in several respects predicated on that model: a primary commitment to educating the undergraduate, a residential setting that not only removes the student from home but also permits and encourages close student-student and student –faculty contact, smallness, and a sense of history and tradition that generates a strong sense of community. This sense of community is manifested in many ways, including alumni loyalty, the strong student interest and involvement in team sports, and the friendly rivalries that evolve between neighbouring colleges.”

“This study (Astin’s) has shown, once again, that this traditional model of undergraduate education leads to favourable educational results across a broad spectrum of cognitive and affective outcomes and in most areas of student satisfaction. Perhaps most important, however, is the finding that institutional structure as such, is not the key ingredient; rather, it is the kinds of peer groups and faculty environments that tend to emerge under these different structures.” (And the pages that follow).

It would be interesting to study Trinity College Dublin from these aspects. Founded in 1592 by Queen Elizabeth I on the Oxbridge system and as the first college of the University of Dublin it remained a small college until the middle of the twentieth century when it began to grow. By 1973 when the author joined the college it had around 4000 students. It was small, there were mixed peer groups and there were good student-faculty relations. However, it has grown to about 16,000 students and seems to be much more like a major American public research university that has considerable prestige.

[51] There are problems with groups that are too diverse. See Astin’s discussion of this matter p 415 *et sec*.

[52] This writer examined similar problems to these in the UK Colleges of Advanced Technology in the 1960’ s and concluded that there were possibilities. Heywood, J. (1969). *An Evaluation of Certain Post-War Developments in Higher Technological Education*. Thesis. University of Lancaster., Lancaster, UK.. Astin gave a few examples in his study..

[53] *loc cit*. ref 28, pp 599 & 600.

## **Appendix;**

Short biographies of Newman and Macmurray

John Henry Newman (1801 -1980) Victorian Sage and controversialist thought by some to have been the greatest writer of English prose in the nineteenth century. An Oxford Don and Vicar of the University Church he was a leader of the Tractarian Movement. This movement was concerned to ensure that the doctrine of the Apostolic Succession in the Church of England was maintained. They were also concerned with the integrity of the prayer book. Their goal was to expound Anglo-Catholicism (within the Church of England). One of the methods they used to promote their cause was the publication of tracts. The 90<sup>th</sup> Tract written by Newman in 1839 caused him to consider his position. Of the 39 articles of the Church of England he concluded that they did not offend catholic teaching except in a partial opposition to Roman dogma; they opposed the dominant errors of Rome. This Tract caused the movement to be banned and in 1843 he resigned his living at Oxford. He then wrote his first major work- *An Essay on the Development of Christian Doctrine* and when it was completed in 1845 he was received into the Church of Rome. In 1851 he was asked to found a Catholic University in Ireland, and in 1852 he gave the discourses that form the first part of the book now called *The Idea of a University*. He established the university and remained with it until 1858. In 1864 his integrity was impugned by Charles Kingsley and he responded with an autobiography that continues to be acclaimed –*Apologia Pro Vita Sua*. His major theological work *An Essay in aid of A Grammar of Assent* was published in 1870. He was a voluminous writer of letters, sermons and tracts. His works strongly

influenced some of the documents of the second Vatican Council, In 1879 he was created a cardinal. In 2010 he was Beatified.

The most recent of several major biographies is by John Cornwell. *Newman's Unquiet Grave. The Reluctant Saint* (2010) Continuum, London.

John Macmurray (1891 – 1976). After completing his undergraduate studies in 1913 at Glasgow University he went up to Oxford on an exhibition to Balliol College. The college had a reputation for socialist thinking and liberal philosophy. During his year he was tutored by A. D. Lindsay later Master of the College, and subsequently founding Vice-Chancellor of the University of Keele. He completed his year at Oxford and was immediately brought face to face with whether or not to enlist for war service. He chose to join the Royal Army Medical Corps and was assigned to a field ambulance unit. He went to France in 1915 and was commissioned in 1916 and took part in the battle of the Somme. His experience of the war led him to commit himself to find how to achieve justice and peace in the world. After the war, having completed a short spell at Manchester University he was elected a Fellow of Balliol where he remained until 1928 when he was invited to accept the Grote Professorship of Mind and Logic at University College London. In 1944 he accepted the Chair of Moral philosophy at Edinburgh where he remained until his retirement in 1958. Macmurray was a committed Christian but anti-organizational Christianity. Politically he was towards the left, a social democrat who abhorred communism and fascism. His lifetime's thinking is brought together in the Gifford Lecture of 1954 and 55 at Glasgow University. He was the first person in Britain to give regular talks on BBC radio on philosophy intended for a general audience (between 1930 and 1934 – see Costello chapter 9).

Costello, J. E.(2002). *John Macmurray. A Biography*. Floris Books, Edinburgh. For an assessment of Macmurray's contributions to philosophy and theology see the appendix to this book (pp 422 and 423) which is written by Professor Thomas F. Torrance