PERCEPTIONS OF THE CHEMICAL ENGINEERING PROFESSION – RESULTS OF AN INTERNATIONAL SURVEY

David C. Shallcross [1]

Abstract *¾ During 2000 and 2001 more than 2500 undergraduate chemical engineering students in fifteen universities in Australia, Canada, New Zealand, Thailand, the United Kingdom, the United States and Vietnam were surveyed on their perceptions of the chemical engineering profession. The survey sample was drawn from all year levels and included students who had left their home country to study chemical engineering. Generally students at the US universities strongly agreed with the statements that the chemical engineering profession is both well respected and well paid while Vietnamese students did not. Course satisfaction levels were highest amongst Thai and Vietnamese students and lowest amongst students from some UK universities. Across students from all universities there was very high agreement that chemical engineering is important for the well-being of society and to the sustaining of the environment. This paper will present the results of this survey by gender, origin and year level.*

Index Terms ¾ chemical engineering, survey, undergraduate

INTRODUCTION

What do chemical engineering students think of their future profession ? Do they believe that it is a well respected profession ? Are they happy with their choice and would they recommend others to study it ? As the chemical engineering profession celebrates its first century it is timely to study exactly how chemical engineering students view their evolving profession.

Very few surveys have been conducted amongst either engineering students or graduates which study their perceptions of the profession. While engineering graduates have been surveyed to identify the factors which led them to study engineering at the undergraduate level [1], or at the postgraduate level [2], and to identify the main work activities in their profession careers [3], no studies have been reported in the literature which study the career choices of currently-enrolled chemical engineering undergraduate students.

Between October 2000 and October 2001 over 2500 undergraduate chemical engineering students studying at 15 universities in seven countries were surveyed. The survey sample was drawn from all year levels and included students who had left their home country to study chemical engineering. The aims of the two-page survey were threefold:

- to investigate student perceptions of the chemical engineering profession
- to investigate the key factors which influenced the students to become a chemical engineer
- to determine which of a list of 15 industrial sectors the students most and least wish to work in on completion of their degrees.

SURVEY METHODOLOGY

The survey consisted of a single sheet, two page form as shown in its English language form in Figure 1. The survey was also prepared in German, Russian and Vietnamese. It was only administered to students currently enrolled in an undergraduate chemical engineering course. In completing the survey students were asked to nominate their gender, university year level, and whether they were a local student who came from the same country as their university. Table 1 summarises the universities surveyed and the number of respondents.

Some thirty universities in a range of countries including Australia, Canada, Germany, New Zealand, Russia, Thailand, the United Kingdom, the United States and Vietnam were contacted and asked to participate in the survey. A number of universities declined to participate in the survey for a variety of reasons including university policies against conducting external surveys and concerns over the privacy rights of their students. Fifteen of the sixteen universities that agreed to participate in the survey are listed in Table 1. The University of Hanoi also participated in the survey, completing about 500 forms. Unfortunately these were lost by the Vietnamese postal service and were not received for processing. Table II summarises the number of respondents by gender, university year level and origin.

There are eleven university chemical engineering departments in total in Australia and New Zealand so that the four participating in the survey provide a statistically significant sample of the student population from this region. The same is true for the United Kingdom in which five of the twenty undergraduate chemical engineering programs are sampled, and for both Thailand and Vietnam which each have only three major chemical engineering programs. Within the United States there are approximately 160 undergraduate programs of which only two are sampled by

[1] David C. Shallcross, University Of Melbourne, Melbourne, Victoria 3010 Australia dcshal@unimelb.edu.au

THE UNIVERSITY OF MELBOURNE

International Survey of Undergraduate Perceptions of Chemical Engineering

We are asking for your help in learning more about why students choose to study chemical engineering and what they believe about the profession. Please respond to the following items as honestly and carefully as possible.

Please use a cross in the appropriate box. ☒

Please tell us about yourself:

Gender Female ☐ Male ☐

Engineering year level 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5+ ☐

What degree(s) are you presently enrolled in _____

Please state your University or Institution **University of Alberta**

Are you a Study Abroad or Exchange Student (i.e., this is not your permanent Institution) ? Yes ☐ No ☐

Have you come to the Canada to study at this University (i.e., you are not a permanent Canada resident) ? Yes ☐ No ☐

Please indicate the extent to which you agree or disagree with these statements:

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Chemical engineering is a well paid profession.	☐	☐	☐	☐	☐
Chemical engineering offers scope to express my creativity.	☐	☐	☐	☐	☐
I am happy with my choice of chemical engineering as a career.	☐	☐	☐	☐	☐
Chemical engineers are concerned with sustaining/enhancing the quality of our environment.	☐	☐	☐	☐	☐
Chemical engineering is important to the well-being of society.	☐	☐	☐	☐	☐
Chemical engineering will allow me to work and travel internationally.	☐	☐	☐	☐	☐
Chemical engineering is different to what I thought it was when I applied to enter the course.	☐	☐	☐	☐	☐
Chemical engineering is a well respected profession.	☐	☐	☐	☐	☐
Chemical engineering is of more value to society than other forms of engineering.	☐	☐	☐	☐	☐
Chemical engineers need communication skills of a high standard.	☐	☐	☐	☐	☐
I would recommend others to study chemical engineering.	☐	☐	☐	☐	☐
I expect that within ten years of graduating I will have moved out of engineering into a management role.	☐	☐	☐	☐	☐

Please turn over

FIGURE 1

THE FIRST PAGE OF THE ENGLISH LANGUAGE FORM OF THE SURVEY. AFTER PROVIDING INFORMATION CONCERNING THEMSELVES THE STUDENTS WERE ASKED TO RESPOND TO A SERIES OF STATEMENTS REGARDING THEIR PERCEPTIONS OF THE CHEMICAL ENGINEERING PROFESSION. THE EXAMPLE SHOWN WAS PREPARED FOR THE UNIVERSITY OF ALBERTA.

TABLE I
SUMMARY OF UNIVERSITIES SURVEYED

Institution	Country	Language of Survey	Number of Respondents	Institution Code
Monash University	Australia	English	98	Monash
University of Melbourne	Australia	English	300	UMelb
University of Queensland	Australia	English	130	UQld
McMaster University	Canada	English	82	McMaster
University of Alberta	Canada	English	158	UAlberta
University of Canterbury	New Zealand	English	65	UCant
Prince of Songkla University	Thailand	English	87	Songkla
Imperial College	United Kingdom	English	337	Imperial
University of Birmingham	United Kingdom	English	125	UBirm
University of Loughborough	United Kingdom	English	53	ULough
University of Nottingham	United Kingdom	English	124	UNott
University of Surrey	United Kingdom	English	65	USurrey
Clemson University	USA	English	42	Clemson
Iowa State University	USA	English	235	IowaState
Ho Chi Minh City University of Technology	Vietnam	Vietnamese	683	HCMCUT

TABLE II
SUMMARY OF RESPONDENTS BY CLASS (SEE TABLE 1 FOR EXPLANATION OF CODES).

Institution	Total	Gender			Engineering Year Level						Student Origin		
		Male	Female	Not Stated	Year 1	Year 2	Year 3	Year 4	Year 5	Not Stated	Local	Foreign	Not Stated
Total	2584	1538	1037	9	374	627	688	714	164	17	1940	459	185
Monash	98	63	35	0	0	25	35	38	0	0	57	39	2
UMelb	300	150	150	0	73	84	84	58	0	1	230	69	1
UQld	130	90	39	1	0	39	39	51	0	1	114	15	1
McMaster	82	44	38	0	0	26	31	15	9	1	72	7	3
UAlberta	158	95	63	0	0	59	29	49	21	0	148	3	7
UCant	65	39	25	1	7	30	25	1	0	2	57	2	6
Songkla	87	50	37	0	0	39	17	31	0	0	82	0	5
Imperial	337	247	90	0	100	76	74	85	1	1	195	138	4
UBirm	125	83	42	0	35	36	53	1	0	0	89	34	2
ULough	53	34	19	0	30	16	2	3	2	0	45	6	2
UNott	124	92	32	0	42	40	24	18	0	0	87	36	1
USurrey	65	43	21	1	25	12	23	4	0	1	32	31	2
Clemson	42	24	18	0	0	0	0	26	16	0	41	0	1
IowaState	235	140	94	1	60	44	47	67	15	2	213	12	10
HCMCUT	683	344	334	5	2	101	205	267	100	8	478	67	138

the survey. Only two of Canada's twenty programs have been surveyed. As a consequence while the data for Australia, New Zealand, Thailand, the United Kingdom and Vietnam may be considered to be representative of the countries the same is not true for the North American data.

In the survey students were asked to indicate the extent to which they either agreed or disagreed with twelve statements. The survey responses were scored:

strongly agree	5
agree	4
neither agreed nor disagree	3
disagree	2
strongly disagree	1
no response	0
more than one response	0

To illustrate how the survey results might be analysed consider the following example. Of the 593 students from Australia and New Zealand institutions surveyed 588 non-zero responses were recorded to the statement 'Chemical Engineering is a well respected profession.' Of these 42, 7.14 % strongly agreed (5), 41.7 % indicated that they agreed (4), 36.7 % indicated that they neither agreed nor disagreed (3), 9.9 % indicated that they disagreed (2) and just 4.6 % indicated that they strongly disagreed with the statement (1). The average score for this statement is 3.74 and is based only on the non-zero responses.

SURVEY RESULTS

In order to present the survey results in a compact manner some of the survey responses are grouped together by country or region. Thus, the University of Canterbury is grouped with the three Australian universities, the five United Kingdom universities are grouped together, while the two Canadian universities are grouped together as are the two United States universities. Because of the large number of responses from Ho Chi Minh City University of Technology that university is considered separately. As there is no logical grouping into which to place the Prince of Songkla University responses, and as the numbers of respondents are relatively low the results from this university will not be compared with the other country groupings.

The average response scores for each of the twelve statements are presented in Figure 2 for the five country groupings. While for most cases the variations in scores between countries is relatively small, significant differences are observed between United States and Vietnamese average scores.

In response to the statement, 'Chemical engineering is a well paid profession', the US average score is 4.47 with 97.8 percent of respondents agreeing with the statement to some degree. In contrast, the average score in communist Vietnam is 3.10 with only 28.8 percent of respondents either agreeing or strongly disagreeing with the statement. The responses to this statement from Australia, Canada, New Zealand and the United Kingdom are all similar to one another being between 3.75 and 3.85. Gender has little effect on the average response scores. In North America and the UK in particular there is a downward trend in the average scores with increasing year level with UK scores dropping from 4.14 in first year to 3.27 in fourth year.

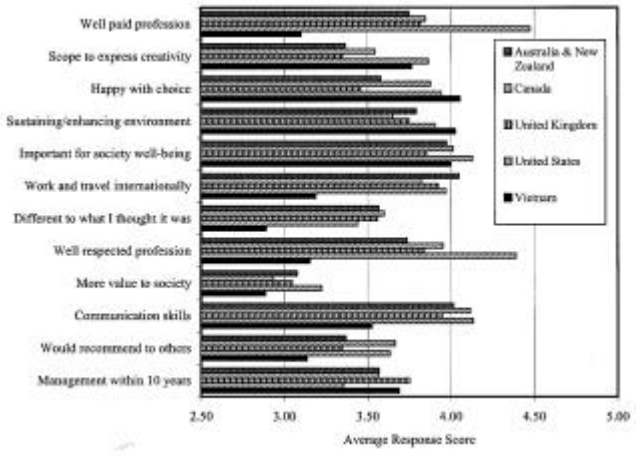

FIGURE 2
AVERAGE RESPONSE SCORES FOR EACH OF THE TWELVE STATEMENTS FOR THE FIVE COUNTRY GROUPINGS.

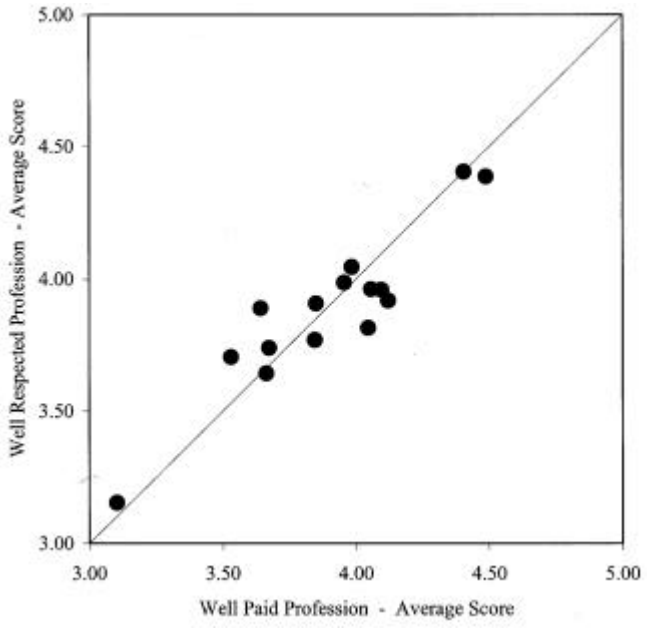

FIGURE 3
COMPARISON OF AVERAGE RESPONSE SCORES FOR THE TWO STATEMENTS, 'CHEMICAL ENGINEERING IS A WELL PAID PROFESSION', AND 'CHEMICAL ENGINEERING IS A WELL RESPECTED PROFESSION'. DATA SHOWN ARE THE AVERAGE RESULTS FROM THE FIFTEEN PARTICIPATING INSTITUTIONS.

Responses to the eighth statement on the survey, 'Chemical engineering is a well respected profession' are very similar to the 'well paid' statement. Figure 3 shows how highly correlated the results from the fifteen institutions are for the two statements. Again gender has little effect on the average response score but this time there are no significant variations in responses across the year levels.Just half the respondents in Australia and the United Kingdom either agreed or strongly agreed with the statement 'Chemical engineering offers scope to express my creativity', with Thai, US and Vietnamese students recording the strongest levels of agreement. These results must be of concern to chemical engineering educators in all countries as they indicate that a significant proportion of the class do not appreciate the extent to which creativity and imagination is important to the success of a profession chemical engineer.

Three-quarters of North American respondents agreed to some degree with the statement 'I am happy with my choice of chemical engineering as a career' while the corresponding figure from Vietnam is 86.4 percent (average score 4.06). The lowest average scores recorded were at two of the five UK institutions. Since a student who is happy with their choice of a career will be more likely to recommend that career to another student, than one who is unhappy it is not surprising that the average scores for the statement 'I would recommend others to study chemical engineering' are related to the 'happy with choice' statement. Figure 4 shows how correlated the results from the fifteen institutions are for the two statements. This suggests that satisfied students are amongst the profession's best ambassadors when it comes to recruiting new students into the undergraduate courses.

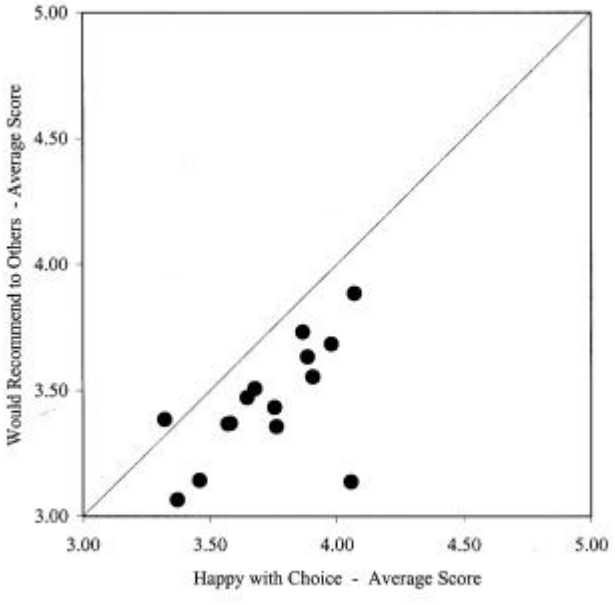

FIGURE 4
COMPARISON OF AVERAGE RESPONSE SCORES FOR THE TWO STATEMENTS, 'I AM HAPPY WITH MY CHOICE OF CHEMICAL ENGINEERING AS A CAREER', AND 'I WOULD RECOMMEND OTHERS TO STUDY CHEMICAL ENGINEERING'. DATA SHOWN ARE THE AVERAGE RESULTS FROM THE FIFTEEN PARTICIPATING INSTITUTIONS.

The level of agreement with the statement 'Chemical engineers are concerned with sustaining/enhancing the quality of our environment' is slightly stronger for female students than it is for male students. Around the world three-quarters of all students agreed to some degree with this statement.

Students generally recognised the importance of the profession to society with all fifteen institutions recording strong levels of agreement to the statement 'Chemical engineering is important to the well-being of society'. Average responses scores were in the relatively narrow range of 3.76 to 4.17. No significant gender differences were observed.

With the exception of students in Vietnam the majority of students agreed to some degree with the statement, 'Chemical engineering will allow me to work and travel internationally'. These responses are not surprising given the global nature of the employment market. Typically Australian and New Zealand students recognise that to gain valuable work experience they may be required to travel overseas, while travel for UK-based students within the European Union is straightforward.

The statement, 'Chemical engineering is different to what I thought it was when I applied to enter the course' was agreed with to some degree by about half of all students with only Vietnamese students recording significantly levels of disagreement. In all countries the levels of agreement tended to increase with increasing year levels. This suggests that as the students progress through the course their concepts of what engineering involves changes. This is not necessarily a bad outcome as levels of career selection satisfaction are high. This outcome may suggest that more work needs to be done within the secondary school communities from which the undergraduate students are drawn to better inform the students of the profession.

At all the institutions participating in the survey chemical engineering is just one of the engineering disciplines available for study. It might be expected by some that chemical engineering students might consider that their own profession is of more value to society than the other engineering disciplines. This is not the case. When asked to indicate their level of agreement with the statement, 'Chemical engineering is of more value to society than other forms of engineering', most students neither agreed nor disagreed. Typically just 20 percent of students indicated some level of agreement with this statement.

Eighty percent of all students outside Vietnam indicated that agreed to some degree with the statement, 'Chemical engineers need communication skills of a high standard'. This figure was observed for both genders across all year levels.

Many chemical engineers gradually move into management roles several years after graduation. Students were asked to indicate their level of agreement with the statement, 'I expect that within ten years of graduating I will have moved out of engineering into a management role'. The degree to which this will occur depends upon the particular industry and job the students intend to seek after graduation. There was little variation in responses between the 15 institutions. There was a slight increase in the level of agreement with this statement with increasing year level. For example, in the UK the average response score of first year students was 3.08 while at fourth year the score had risen to 4.05. Similarly in Australia and New Zealand, the average response score rose from 3.33 for first year students to 3.79 for fourth year students.

Within Australia in particular combined degree programs are increasingly popular. These programs, described more fully elsewhere [4], allows students to study for two undergraduate degrees simultaneously. At the University of Melbourne alone some 60 percent of undergraduate chemical engineering students are enrolled in combined degrees simultaneously studying chemical engineering and either arts, commerce, law or science.

The survey asked students to indicate to indicate the degrees in which they were presently enrolled in. Analysis of the completed questionnaires allowed the combined degree students to be identified. Only in Australia were the numbers of combined degree students participating in the survey statistically significant with 38.6 percent of respondents indicating that they were studying for two degrees. There were few differences between combined and single degree students. Single degree students agreed more strongly than did combined degree students to the statements 'Chemical engineering offers scope to express my creativity' and 'Chemical engineering is different to what I thought it was when I applied to enter the course'.

CONCLUDING REMARKS

Overall undergraduate chemical engineering students are very positive about their chosen profession. They tend to believe that it is a both a well respected and a well paid profession. They are largely happy with their choice of it as a career and would recommend it to others.

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