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Vertically integrated projects and the importance of organisational culture amongst the student body

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The organisational culture of the student body has a powerful influence upon the quality of undergraduate education. Furthermore, the importance of cultivating an appropriate organisational culture amongst the student body is certain to increase. This will occur naturally as university departments introduce more 'student directed learning initiatives' with on-line components and assessments, amalgamate subject offerings and reduce academic staff numbers. This paper discusses the importance of the organisational culture of the student body in a relationship marketing framework, then describes a vertically integrated design and build project specifically targeting organisational culture amongst Mechanical Engineering students.

INTRODUCTION

THE TOPIC OF THIS PAPER is a vertically-integrated design project in the Department of Mechanical Engineering run with the explicit aim of improving the organisational culture amongst the student body. As will be described, the project is one of several measures being undertaken in the Department to improve student/student and student/staff exchange and create a sense of Departmental membership. The probability exists that, in the medium term, these measures will pay significant dividends in terms of course and graduate quality.

WHY DEVELOP THE ORGANISATIONAL CULTURE OF THE STUDENT BODY?

There is a broad relationship between organisational culture and employee perception, and the way that this perception creates a pattern of beliefs, values and expectations. One expert defined culture in the following way [1]:

> *A pattern of basic assumptions . . . invented, discovered, or developed by a given group as it learns to cope with the problems of external adaptation and internal integration . . . that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to these problems.*

The earliest popular management texts (see, for example, [2–4]) were full of anecdotal evidence about the powerful influence organisational culture had upon individuals, groups and processes within the corporate arena. Twenty years on, organisational culture is clearly not enough to guarantee success. Considering that a large percentage of the companies considered in [3] are no longer in business, no one would argue that an 'appropriate' culture is necessary for an organisation to thrive.

The influence that the organisational culture of the student body has upon the quality of undergraduate education is as powerful as any of the popular documented culture/company interactions. Furthermore, the importance of cultivating an appropriate organizational culture amongst the student body is certain to increase. This will occur naturally as university departments introduce more 'student directed learning initiatives' (also known as 'learning outside of formal lectures'), a popular theme in many university learning and teaching plans. It is necessary in order to clarify this point to consider the role of the student in tertiary education.

There is a popular conception that students are in the interesting position of being both customers and products of the university system. These dual roles form a natural relationship, since a high quality product (graduate) will most likely result from a highly satisfied customer (the student during the period of tenure in the university). In relation to the role of product, comment from this Department's industry advisory panel mirrors what has been written about engineering graduates in general [5]: that technical competence is a necessary skill, but not a sufficient skill. 'Other' skills that must accompany technical knowledge include the ability to understand how technology fits into the business equation, the ability to communicate, and a breadth of vision, flexibility, customer focus, and business orientation. These

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are in part developed through broad-ranging student/student or student/staff interaction and communication.

In their role as a customer, the product (education) purchased by students clearly possess the traits of a service [6]. In-house surveys of Mechanical Engineering students show major components of the students' value proposition to be:

- '*hands-on work*' (read this as augmentation of theory with practical)
- '*meeting lecturers*' (read this as academic/student interaction)
- '*getting a job at the end*' (read this as acquisition of skills relevant and important to industry).

Student satisfaction with their chosen course or subjects reflects the service provider's ability to satisfy this value proposition.

A major challenge for universities and university departments in the current financial and social climate is to achieve congruence between the dual product and customer roles of the student, and in so doing produce a high quality and highly satisfied graduate. Appropriate organisational culture amongst the student body is a necessary element for success.

Returning to the role of the student as a customer, relationship marketing researchers talk about excellence in service quality being achieved by a three way relationship between the organisation, employees and customers [7,8,9]. Traditional marketing, or the giving of promises to the customer, alludes to the link between the organisation and customer. The interactive marketing exchange that occurs between employees and the customer is analogous to 'fulfilling promises'. Note here that the content of the courses on offer makes up only a portion of the promises; other components include hands-on work, student/academic interaction, student–student interaction in group projects and interaction with university resources (IT, library, etc).

Figure 1 demonstrates how to customise the relationship marketing framework for undergraduate education. The sketch shows the vertical interaction between students in differing year levels specifically for the customer section, as this interaction has the potential to enhance the students'educational experience. The success or otherwise of interaction along the student/student and student/staff links in the framework of Fig. 1 is critically dependent upon the organisational culture of the student body.

Summarising, staff/student and student/student communication has the potential to improve both the course offerings 'purchased' by the student in their role as customer, and improve the quality of graduates. An appropriate organisational culture amongst the student body is necessary for this communication to take place.

Negative Pressures on the Organisational Culture of the Student Body

It is worthwhile at this point considering how current pressures on the higher education sector influence the organisational culture of the student body in a tertiary institution, and what the ramifications are in terms of the relationship marketing framework.

It is easy to show that engineering undergraduate teaching activities in the author's department are money losing exercises using the activity-based costing methodologies recommended by government bodies [10–12]. Current underfunding is of the order of 20% at present, and anecdotal evidence points to this being a universal theme in the Australian higher education sector. There is a compulsion for departments attempting to remain solvent in this environment to cut both costs and supplement teaching resources. Cost cutting usually translates into an amalgamation of subject offerings, particularly in the early years where subjects tend to be general and there is overlap between disciplines. This leads to an often substantial increase in the student numbers for each class, and generally occurs in concert with a reduction in staff numbers, through attrition or redundancy. The result is that academics teach more, research less, and become increasing elusive to the now greater numbers of students for out-of-classroom

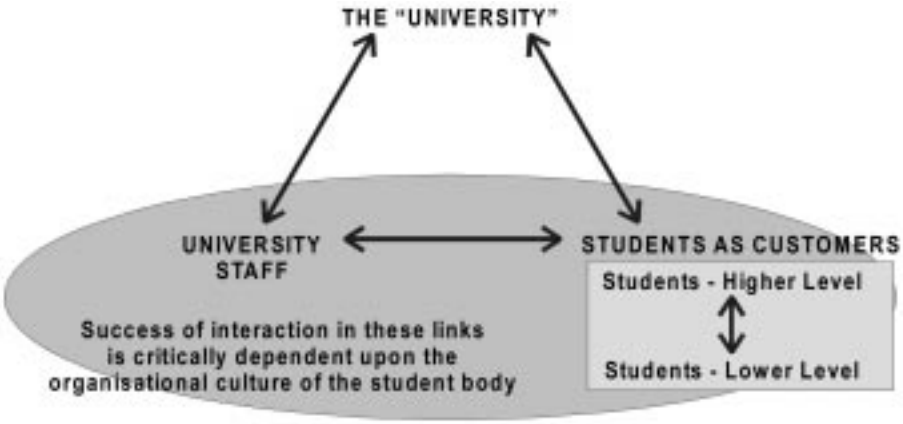

Fig. 1. The relationship marketing approach as applied to undergraduate education.

consultation. At the end of this process the subject offerings take on the feel of a commodity rather than a service, and the students lose any sense of belonging to a particular department. In a recent internal survey, one first year student stated:

> '*First year students don't have anything to do with the department; it's just an office to me*'.

Supplementation of teaching resources often translates into an increased use of external lecturing staff on a piecemeal basis. This can greatly diminish the quality of the flow of a subject stream and further complicate out-of-classroom consultation by students.

How does this scenario impact upon the organisational culture of the student body? Internal surveys show that students enter the institution with high expectations of hands-on work, fruitful interaction with academic staff members, and being equipped with skills that will see them leave as marketable for employment. However, all too often these basic assumptions change, to the great disappointment and disillusion of the student and, often, the student's family. The organisational culture of the student body takes on a negative posture, with the consequent decrease in communication along the student–student and student–staff communication links, (see Fig. 1).

No realistic academic would argue that it is possible to stem the tide of economic rationalism sweeping through the higher education sector. It is therefore imperative that deliberate measures be introduced to counter the negative impact of economic rationalism on the organisational culture of the student body. Speaking about successful chemical firms, the former head of ICI said that 'they have developed the ability to provide a chemical service to customers, rather than selling a product in a bag' [13]. All universities are subject to pressures that act to do the opposite: move tertiary instruction from an education service to a commodity, a 'course in a bag'. Successful universities and university departments will find ways to counter these pressures to meet financial requirements while still producing high quality and highly satisfied graduates.

DEVELOPING ORGANISATIONAL CULTURE

As outlined, the organisational culture of the student body is more or less what the students perceive, and this perception creates a pattern of beliefs, values and expectations. While different researchers may adopt different taxonomies, all agree that organisational culture consists of different 'layers', or categories, ranging from superficial to core. One classification [14] has three layers:

- **artefacts**, (visible and audible components)
- **values**, (of the people in the organisation)
- **basic assumptions**, (about human nature, etc).

Each of these layers has in itself a number of components. Given the complexity of organisational culture, it is intuitive that it takes a significant period to establish and stabilise change. A once-a-year project, whatever its quality, will not be enough by itself.

One framework that analyses the evolution of organisational culture and its outcome is the 'HOME' model [15]. The basic components of the model are:

1. **History:** to develop a sense of history.
2. **Oneness:** to develop a sense of oneness in the organisation.
3. **Membership:** to promote a sense of membership within the organisation.
4. **Exchange:** to increase exchange amongst members.

In line with this list, a number of measures have been, or will soon be, implemented. Their explicit aim is to develop an organisational culture amongst the student body that is appropriate for the present operating environment. These include the establishment of horizontal (single year level) focus groups of all students. These groups meet with an academic staff member twice a year for approximately one hour, and examine basic issues, including:

- What is good and bad in the course.
- What additional material would be useful.
- What material the students view as useless.
- Reasons for selecting the course for study.

The academic staff member then becomes the point of contact for students in the focus group throughout their undergraduate period.

The value of focus groups

In addition to promoting staff/student and student/student exchange and developing a sense of oneness and membership, evidence suggests that focus groups are extremely valuable for course improvement. Students are very good at appreciating the subtleties in subject streaming, and can quickly point out when, for example, prerequisites are missing or duplication is present. They are also very good at providing holistic constructive criticism, which does not register on simple student evaluations of teaching of a single subject.

The establishment of at least one 'Mechanical Engineering only' subject in the first year of the course.

It quickly became apparent, during the first set of focus group meetings, how completely the Department 'loses' its students during the first year of their course. By placing students into a common engineering first year comprising large

classes with mixed disciplines, the Department misses the opportunity to start establishing a culture at an early level. Students often leave the first year of the course without knowing another Mechanical Engineering student or staff member, and are often disillusioned with the process by the time they enter their second year of study. The establishment of even one non-common subject will help to rectify this problem and create a sense of membership amongst this sector of the student body.

The establishment of a vertically integrated design and build project during the first week of the school year:

The topic of the remainder of the paper, this project will improve exchange amongst the student body, particularly between year levels, and create a sense of membership and oneness. With some luck, it will also lead to the establishment of a sense of history.

THE PROJECT

With the aim of improving the organisational culture amongst the student body, the Department cancelled all afternoon classes in week 1 of semester 1. In place of this they ran a vertically integrated design and build competition. The student body split into 31 teams of roughly ten students, with membership taken from year levels 1–4 (each group had between 1–3 students from each year level). The captain, (who was also the 'organiser' of each group), was a level 4 student selected at random, while the point of contact assigned to each group was a postgraduate student.

Besides the actual design and build exercise, there were specialist lectures and workshops on a range of topics. There was a winner-take-all prize of $1500 cash, from a corporate donation, for the overall best team score. Final team scores also counted towards a grade in the laboratory subject stream for students in year levels 2–4.

The project itself was the design, construction and flight of a cardboard and paper aircraft, combined with project documentation of less than 1000 words. The aircraft had to fit within a volume of $1m^3$, and at least one length dimension of the craft (length, width or wing span) had to be 0.5m or greater. The aircraft was be launched by hand from the ground, and to be no more than 2 metres off the ground at the time of launch. Construction materials provided to the groups included:

- As much 80 gsm or lighter paper as needed. The Department supplied used photocopy paper as required, and each group would receive two sheets of tissue paper. The groups were responsible for organising their supply of other paper.
- Two sheets of cardboard, approximately 900mm × 600 mm.
- Two plastic propellers and rubber bands.
- PVA glue, supplied by the Department.

Groups could augment these supplies with any other materials they liked, provided that the total weight of items supplied by the Department accounted for at least 50% of the total weight of the aircraft. Students could use any type of glue and fastener although they could not use explosives, chemical propellants or lighter-than-air devices. Compressed air could only be used if the pressure was below 100 kPa, effectively eliminating it as an option.

Assessment of team performance was on the basis of five criteria:

1. Length of time in the air.
2. Distance travelled.
3. Originality and quality of design.
4. Quality of documentation.
5. Teamwork and organisation.

Each category had 10 points assigned to it with points for the first two criteria being distributed on a proportional basis:

1. Ten points for the group with the longest distance and/or time,
2. All other groups gained a proportional score based on the fractional time and/or distance that they achieved compared to the winner.
3. A judging panel that consisted of the Dean and two industry-based engineers awarded points for the third criterion.
4. Points for the fourth criterion were based on grading of completed documentation.
5. Postgraduate students awarded points for the fifth criterion on the basis of regular team meetings.

It is of particular interest that this is not the first vertically integrated aircraft design and build project [16]. It does, however, differ from other projects in that its principle concern is cultivating organisational culture. Although the students built aircraft, that was not the central issue; it was the process that was key, not the outcome.

HOW THE WEEK PROGRESSED

As stated earlier, time set aside for building the aircraft and attending specialist activities replaced the Department's normal afternoon classes of the project week. The exception was that students taking subjects run by other departments, such as maths subjects, basic science subjects, and engineering subjects taught by other departments, still had to attend the scheduled classes and activities. Students had access to three pre-booked rooms during the afternoons.

Organisation of specialist activities occurred on a horizontal (year level) basis, rather than a vertical group basis. Activities included:

- A one hour lecture by an expert on model aircraft building, given to level 3 students.
- A half-hour 'ideas' lecture, given to level 2 students.
- A three hour 'team-building' session given to level 4 students on Monday and level 2 students on Tuesday. This session was run by an external corporate team-building 'guru', and was the single most expensive part of the week.
- A two hour lecture on 'effective writing', given by a professional technical manual writer to level 3 students.
- A barbecue for level 1 students and academic staff. This provided a first opportunity for students to meet their academic contacts, the staff member who will convene their focus group.
- Tours of the Department and University facilities by level 4 students for their level 1 group members. These tours were a required part of the week's activities, and were timetabled by mutual agreement.

The thinking behind these ideas was that by giving different information to different year levels, all (vertical) group members would have to contribute to produce the best outcome.

As mentioned previously, the point of contact for each group was a postgraduate student, with each participating postgraduate serving in this role for 2 or 3 groups. The postgraduate served as a monitor and facilitator, providing materials and advice, passing on information, checking the quality of group organisation, arbitrating unresolved disputes and helping with recalcitrant students who simply did not appear. Meetings between them and their postgraduate supervisor took place at least once per day for approximately 15 minutes.

At the start of each day the postgraduate students received 1–2 pages of information. The information included such things as rules clarifications, information on specialist activities or organisational 'quizzes' to be given to the groups. The latter included simple tasks such as testing whether group members knew each other's names, getting each group member to point out a contribution to the project and more subjective components such as how well the group meetings were organised. The post graduate student awarded the points the Teamwork and Organisation criteria based on these meetings.

Academic staff members rotated from group to group during the afternoons, providing advice and stimulating discussion.

Before discussing outcomes, it is worth mentioning the topic of loophole searching. For many student groups the technical challenge of the project was in finding the most exploitable loophole. The project outline was deliberately not restrictive to encourage originality of design. However, the amount of effort spent on looking for loopholes was well above expectations. The most common allowed loopholes included:

- *Using glue.* Materials included a bottle of glue for each group to stick pieces of paper and cardboard together. However, it frequently appeared as ballast and even as an aircraft itself (two groups threw the glue bottle). Since the Department supplied the glue bottle, interpretation of the rules suggested inclusion the glue in the 'as supplied' weight, and not in the external materials weight.
- *Launching the vehicle by swinging it around on a string.* As long as the string was 'part of the plane', not separate, this was legal.
- *Flexible interpretation of the 1 m^3 requirement.* The rule that 'the aircraft had to fit within a volume of 1m^3, assumed that finished aircraft fitted a 1m $\times$ 1m $\times$ 1m cube. However, the rules did not specify perimeter dimensions, so many groups had long and skinny aircraft that would fit in a volume less than 1 m^3, but not in a 1m $\times$ 1m $\times$ 1m cube.
- *The use of pre-fabricated model aircraft components.* These could be used, provided that the weight was within the limits specified. It is, however, worth mentioning that the groups that adopted this approach did not come close to winning, and were penalised in the 'originality' judging criterion.

JUDGEMENT DAY

Judging and flight trials of the aircraft took place on Friday. The time limit for the documentation component was 10 a.m. Documentation from each group was to cover:

1. An overview of the aircraft and how it functioned.
2. How the group developed and balanced the first three criteria: distance, time, originality. (In other words, how the group expected to win)
3. A description of what was original in the design.

Groups were to record the precise number of words used. Assessment of the documentation was on the basis of overall presentation and layout, basic grammar and the concise conveying of concepts.

Postgraduate student monitors met with the academic organiser at 12:00 to moderate their teamwork assessments. The exercise proved valuable for both the students and the organiser, with the students comparing thoughts and providing feedback.

Flight trials and design judging took place on a large sports ground and inspection began at 2.00 p.m. The judging panel questioned the teams for 2–3 minutes. Flight trials began at approximately 2:30 p.m. There were two parallel launch sites operating on the day, and groups launched their craft from a 2 m diameter circle. On notification of their launch time, each group had three minutes to get their craft airborne. Groups could

launch their craft any number of times within the three minute period, with the best distance and time results obtained during the three minutes recorded, (these may not have occurred during the same run, although modification of the craft, during the launch period was forbidden apart from tuning and repairs). Most groups split their teams into launch and retrieval sections, to obtain the maximum number of launches possible. The winning group used two riders on bicycles in combination with two retrievers on foot. All groups had launched their aircraft by 3:45 p.m., and the prize was awarded at 4:00 p.m.

Before discussing the outcomes of the week, it is worth mentioning a few subjective observations. Firstly, it proved very advantageous to have a project that required a 'big' space to trial. With 300+ people involved in the trials, viewers were certain to have missed some of the intricacies in design and application. Students want to 'see things fly' and, yes, crash and break into pieces. At the end of the afternoon participants agreed that if the project vehicle needed to run on an intricate track, or was required to perform some precision movement, students would have not been able to adequately view the activity and would have gotten bored and left. As it was, almost no one left before the prize giving.

The judging panel proved to be quite valuable on the day. Forcing students to defend their outcomes both focussed their attention and bonded the groups.

Walking around on the day, it was obvious that a high degree of vertical integration had occurred during the week. Students were sitting around the sportsfield in their groups, rather than splitting ad hoc into year levels. There were a number of group photographs occurring, which is encouraging from the standpoint of cultivating the history component of organisational culture. Students were asked to pick up the rubbish from the sportsfield and put it in the Departmental trailer at the end of the day. This included a large number of broken planes and 800 soft drink cans supplied by the Department. Somewhat amazingly, the sportsground was virtually spotless before the majority of students left. Although this may seem somewhat trivial, it is a good indication of the extent to which the feeling of 'oneness' had been instilled.

STUDENT FEEDBACK

Students given questionnaires immediately before the flight trials were asked to return them on the same day. A total of 233 questionnaires came back out of a group of slightly more than 300, and the figure. gives a summary of the results from several of the fixed response questions. For these results, a value of 1 corresponds to 'strongly disagree', while a value of 7 corresponds to 'strongly agree'.

Referring to Fig. 2, the activity appears to meet its objectives. Overall, the students enjoyed the activity (4.9). The positive impact upon attitudes towards study at the University was marginal (4.5), as expected, but this activity is only one in an overall program of organisational culture change. Students found the exercise to be a useful way to meet new people (5.8), found the interaction with group members useful (5.3), and the first year (freshman) students found the one-on-one tours given by the level 4 students worthwhile (4.8). The groups felt that interaction with the postgraduate

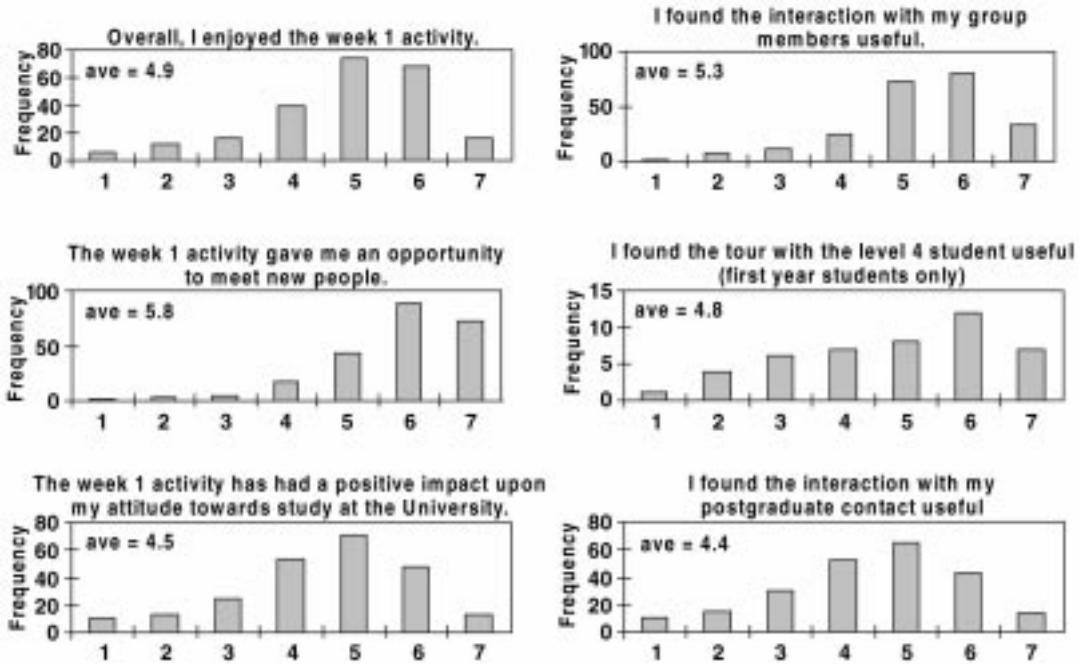

Fig. 2. Summary of main results from fixed response questions. A value of 1 corresponds to 'strongly disagree', while a value of 7 corresponds to 'strongly agree'.

students was less valuable (4.4) since the postgraduates only had responsibility for providing organisational, not technical, input. The free answer questions and comments indicated that students saw this interaction as a distraction from the 'main activity' of building the aircraft. However, from the standpoint of organising the event, keeping the groups on track, and providing feedback to the academics, the postgraduates were invaluable.

The questionnaire also asked students a variety of open ended questions besides the fixed response questions. When asked what motivated them to get involved and try their best, the majority of students responded in one of four ways:

- the $1500 prize (75 responses),
- the laboratory subject grade contribution (45),
- the technical challenge (41), or
- contributing to the team and/or meeting new people (30).

When asked later about how to improve the exercise, several students suggested awarding prizes for second and third place, as opposed to the 'winner take all' format adopted here. However, it is possible that a smaller cash prize could have reduced significant motivating factor.

The overwhelming response from students when asked about the most useful aspect of the exercise was, 'getting to know new people'. As this was the point of the exercise, with the broad aim of improving organisational culture, the response suggests that the activity was a success.

The most common response from the students when asked about the least useful aspect of the exercise was, directed at activities that ate into the time available for building the aircraft such as meetings or classes that were outside of Mechanical Engineering, (and so could not be cancelled, specialist lectures and activities, etc). The overwhelming response when asked to make one suggestion about how to improve the exercise was to give students more time. However, this is almost impossible to do without it having a negative impact upon coursework. Schedules for the afternoons of the first week of semester were mainly either laboratory classes or the first tutorials of subject. Postponing these items until later in the semester would not createa negative impact. To move into later weeks, or cancel more lectures, would put the students too far behind.

It is important to remember that the project was not a technical exercise. The project of 'Building an aircraft' was simply a vehicle to facilitate group interaction and develop a sense of membership with the Department; future activities will build other items. The aim of providing the horizontal specialist activities was to give different (vertical) group members varying pieces of information, so that all members would have to contribute if a team was to have a chance of winning. Rather than focussing on allocating more time to the exercise, there will be an investigation into the efficiency of time expenditure.

The other common suggestion for improvement was to reduce group size. The original plan was to have approximately 8–9 students per group, although the most common size in the end was 10 students. This is because a large number of 'very part time' students wanted to join in the exercise, far more than was expected.

When asked how the activity could better serve students, the responses indicated that the students did not understand the desired thrust of the question, which was to better serve stimulation of organisational culture. However, the responses were still useful. The most common responses related to provision of more concrete guidelines for the building exercise and a clearer explanation of the expectations of the exercise to students. Some of this will improve in future years, as students gain experience in doing the exercise. However, it will be useful in future years to have a preliminary session with level 4 students, as these will be the captains and organisers of the groups.

EVIDENCE OF A CHANGE IN ORGANISATIONAL CULTURE

The aim of the exercise described above, in concert with other measures, is the development of an organisational culture appropriate for current teaching practices. At the end of the exercise the obvious question is: 'is there any evidence of a change in organisational culture?'

Realistically, it will take some time before quantifiable measures indicate a change. It is also questionable whether the usual measures of student satisfaction will show a change. Satisfaction is an indicator of the congruence between expectations and perceptions, and the activities being used to improve perceptions will also increase expectations.

There is, however, some anecdotal evidence to suggest a change has occurred. Once recent incident relates to a level 3 class taught to students by another department. Students based in Mechanical Engineering are only one of four degree groups that must take this particular subject. After one week of the subject the Mechanical students began to contact academics, and eventually the head of department, with concerns about the material. After consultation between the head, the lecturer, the head of the lecturer's department, and students, it became apparent that students were lacking some prerequisite knowledge due to problems with a class in the previous year. Once told of their existence, the lecturer was quite happy to address these concerns. At the end of this process, the lecturer asked why it was only the Mechanical students who had, almost as a group, raised the issue and instigated change. Students from the three other degrees were having the same

problems with the same root cause; however, not one student from the other three-quarters of the class, (who were from the lecturer's department) said anything. The answer appeared to be due to the difference between the organisational culture of the student groups. The response by the Mechanical Engineering students was the sort of response that the Department sought to cultivate.

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