# AC 2012-4681: SELECTION OF EFFECTIVE GROUPS IN ENGINEER-ING PROJECTS USING MANAGEMENT THEORY PRACTICE

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**Selection of Effective Groups in Engineering Projects using Management Theory Practice**

# A study that is a work in progress

## Introduction

Many engineering courses incorporate group projects as standard. The challenge for most academics is selecting groups that are well balanced and will produce a fair result for all group members, that measure their technical abilitie,s and their participation within the group.

Commonly group selection is made by balancing stronger and weaker members by academic ability, although random or self- selections are not unknown. Most have a common problem of "difficult" groups, and there is substantial writings on this which do not always either agree or come to a common conclusion and it is not the intention of this paper to review this work.

Instead this paper will report on work using a well-known management theory, that it is should be possible to select out unbalanced groups and give all students in the class a sense that they were in a "good group", and that is that is not possible then give the course leader an indicator of "difficult" group problems that might be ahead.

## Group Theory

The Belbin Team Role theory[1] was devised by Meredith Belbin to measure the performance of groups and identify common Team Roles; from studying over 200 teams at Henley Management College, UK, he observed individuals appeared to demonstrate a set of characteristics consistently in a group exercise.

Belbin asserts that the team roles are not equivalent to personality types, and that unlike psychometric tests used to sort people into personality traits, the Belbin Self Perception Inventory (SPI) scores people on how strongly they demonstrate behavioural traits commonly displayed in team roles. (See Table 1) A person may and often exhibits strong tendencies towards multiple roles and typically two of these roles will feature strongly, a "primary" and "secondary" role. Equally, there are roles in which individuals would be uncomfortable and unsuitable, which score low in the SPI assessment.

He then completed his argument by suggesting that the "ideal team" would have members with a balanced mix of roles and unsuccessful teams would have too many members in the same role. In order to create the best team possible from those available, members should share each other's' role to understand how they will act in the group, and if necessary be aware that be willing to act within their "secondary" role in order to assist group adhesion.

### Table 1: Description of Belbin team roles

The descriptions provided here are summaries only. Full descriptions are given in Belbin's text.

| CH – Chairman | Positive qualities: | Allowable weaknesses: |
|---|---|---|
| Typical features: Calm, self-confident, controlled. | A capacity for treating and welcoming all potential contributors on their merits and without prejudice. A strong sense of objectives. | No more than ordinary in terms of intellect or creative ability. |
| SH – Shaper | Positive qualities: | Allowable weaknesses: |
| Typical features: Highly strung, outgoing, dynamic | Drive and readiness to challenge inertia, ineffectiveness, complacency and self-deception. | Proneness to provocation, irritation and impatience. |
| PL – Plant | Positive qualities: | Allowable weaknesses: |
| Typical features: Individualistic, serious minded, unorthodox. | Genius, imagination, intellect, knowledge | Up in the clouds, inclined to disregard practical details or protocol. |
| RI – Resource Investigator | Positive qualities: | Allowable weaknesses: |
| Typical features: Extroverted, enthusiastic, curious, communicative | A capacity for contacting people and exploring anything new. An ability to respond to challenge. | Liable to lose interest once the initial fascination has passed. |
| CW – Company Worker | Positive qualities: | Allowable weaknesses: |
| Typical features: Conservative, dutiful, predictable. | Organizing ability, practical common sense, hardworking, self-discipline | Lack of flexibility, unresponsiveness to unproven ideas. |
| ME – Monitor Evaluator | Positive qualities: | Allowable weaknesses: |
| Typical features: Sober, unemotional, prudent | Judgment, discretion, hard-headedness. | Lacks inspiration or the ability to motivate others. |
| TW – Team Worker | Positive qualities: | Allowable weaknesses: |
| Typical features: Socially oriented, rather mild, sensitive | An ability to respond to people and to situations and to promote team spirit. | Indecisiveness at moments of crisis. |
| CF – Completer Finisher | Positive qualities: | Allowable weaknesses: |
| Typical features: Painstaking, orderly, conscientious, anxious | A capacity for follow-through, perfectionism | A tendency to worry about small things. A reluctance to 'let go'. |

**Note 1**: Originally Belbin developed eight roles, subsequently adding a ninth. This study refers to the original eight roles above, since the ninth is a "specialist" role, which in engineering project work is a characteristic shared by the entire group.

**Note2** : Belbin has subsequently created a major business, analysing activities in companies and offering consultancy on team work issues. His company retains copyright to the test and analysis of the test, and care must be taken in its re-use  (see Appendix 1). However he does allow individuals to use his book and complete the test for their own personal development. This is the safe option for its use in academia if an institution does not have an extensive copyright agreement

Typically, what could be defined as a "<u>good" group</u>, would have the correct balance of team members to meet the task involved. This may include in primary or secondary role:

> Chairperson, 1-2 Shapers, Completer Finisher, Resource Investigator, and the remainder Company/Team Workers.

## **Original Hypothesis**

The author's original thesis had been that if an ideal engineering group could be defined from Belbin's original management theory then the problem of "bad groups" could be eliminated and the following describes that initial work and conclusions drawn from it. There is deliberately an absence of numerical analysis in order for  a main message about engineering students to be brought to the fore.

Belbin Test use in Group Teaching Activities

The author teaches a class in Project Management at Masters Level, which includes an interactive simulation where a defined project is completed against standard parameters. The project has to be completed within a measureable project timescale, quality and cost – meeting the theoretical units of project success. In any one class, there will be 6-10 groups and class has been delivered on 12 occasions over the past six years. These groups are typically amorphous since they are mostly multi-disciplinary within engineering except for three occasions where they were solely chemical engineers.

The contention here is that the numbers and diversity of individuals is sufficient that lesson can be drawn and passed on to a wider community, and with the inclusion of discrete chemical engineering groups, an assumption that individual discipline activity is no different from the engineering student population.

Originally, the author began this approach on the basis that using the characteristics from the Belbin test would allow the formation of "good" groups and subsequently group dynamics could be eliminated from the technical challenge of the class, and since this simulation was consistent and re-producible, it provided a common measurement tool. The unit of success for any group across this class being the result from the project management simulation, which operates as follows:

All groups complete a project were the individual resource and task values have a defined monetary value and with good project planning a profit is achieved over the project. The group is charged for resources and make claims for tasks completed. Variability in individual groups is as a result of the efficiency of resources used including borrowing finances to fund the work. Therefore the measureable output will be the profit made in completing the project.
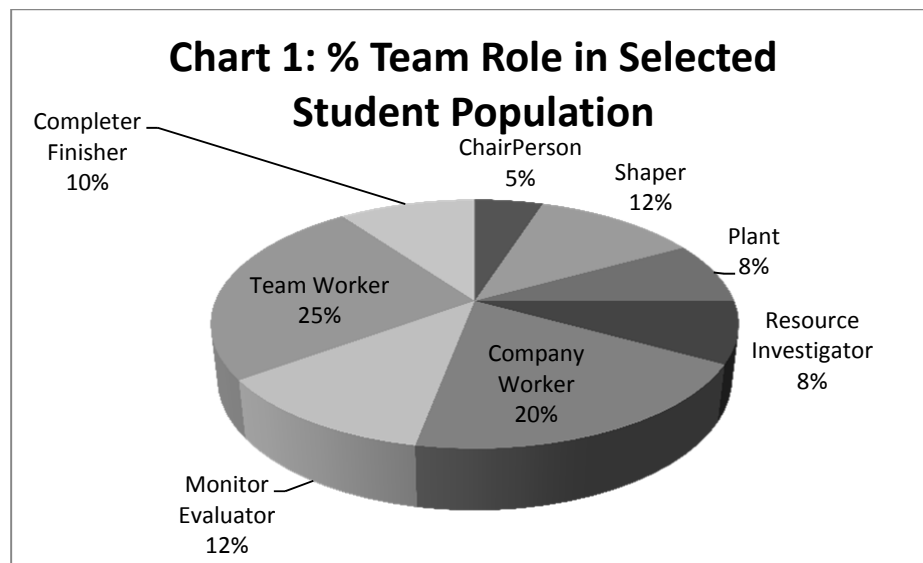
On a $3m value project, an $800k profit should be achievable and consistently from within a cohort of 8-10 groups, three groups will be "in profit" by $250-600k and 3 groups will be "in loss" by -$300-1000k, the "good" and "bad" group respectively.

Thus for this study, it is a uniform exercise across the complete cohort and comparisons can be made of "good" and "bad" groups based on the groups Belbin characteristics.

Therefore Belbin characteristics were measured prior to the project simulation commencing and groups were formed either randomly or planned along the Belbin "good" group profile.

There was clear evidence across all year cohorts that some groups did exceptionally well and some groups' poorly. In general, the trend would be that the better performing groups were Belbin balanced and the poorer groups had too many Company/Team Workers.

However, what is apparent across the total of 700+ engineering students that an ideal mix of Belbin characteristics available for there to be all "good" groups in the cohort doesn't exist. What was common across each annual cohort and across the total population is that engineers tend to the Company or Team worker role. (See Chart 1). In addition, when Belbin profiles were correlated to academic performance in the chemical engineer groups, high academic achievers were generally not Chairpersons or Shapers who are essential for group management and dynamics.



Chart 1: % Team Role in Selected Student Population

ChairPerson 5%
Shaper 12%
Plant 8%
Resource Investigator 8%
Company Worker 20%
Monitor Evaluator 12%
Team Worker 25%
Completer Finisher 10%

Therefore each group selection process had to be compromised because of the absence of primary role Chairperson or Shaper individuals that could be shared across all groups. Instead many groups had these roles filled by individuals where these roles were secondary and in addition groups would have three, sometimes for members in Company or Team worker roles.

During the analysis of each class's work it was clear that:

- Most groups were not perfect Belbin fits and performed "off the top end of the achievable profit scale".
- Where random selection achieved a perfect Belbin profile, performance was excellent
- If random selection produced a Team/Company worker dominant group, performance was extremely poor.

## Conclusion to Original Hypothesis

The original test had been to establish that management theory can apply to academic group work and a robust group selection method could be used. There is evidence in the work to suggest this may be possible by a recognisable good performance in well balanced groups, but the analysis of a large population of engineering students suggests that a skew in individual profiles makes its application difficult.

## Alternative Conclusion

However there is a lesson to be broadcast here albeit, it is of being unsuccessful in the first instance:

Firstly, the alternative Hypothesis to be tested is therefore when looking at student groups, where the marking is a combination of individual & group work and shows large divergences, then could that group have been classed as a "bad" Belbin group.

Secondly, that a review of Belbin roles at the early stage of group work would identify for the course leader, groups more likely to fail unless direction is reinforced because if these groups do not have a well-balanced the Belbin then they will lack direction and the ability to achieve common tasks.

This is the next stage of the work and the author is open to collaboration in order to achieve large student numbers more quickly than in an individual study.

References

Belbin, M. (1981). Management Teams. London; Heinemann.

Appendix 1:

Belbin Copyright

Quote from http://www.belbin.com/rte.asp?id=7 :

We frequently receive calls requesting information on the copyright of Belbin materials. In particular, the use of the self-scoring paper Self-Perception Inventory (SPI) originally published in Meredith Belbin's book, *Management Teams: Why They Succeed Or Fail* (1981). To clarify our position, we own the copyright and do not allow this questionnaire to be reproduced in any form. Individuals may purchase the book and complete the Self Perception Inventory (SPI) for their own personal development, but any copying or wider usage is an infringement of copyright