Balanced Decision Making:
A New Argument for More Women in Engineering

Toner M.C.
Toner & Associates
PO Box 407
Elsternwick
Victoria 3185
Australia

Email: mctoner@toner-assoc.com.au

Bio:
Dr Mark Toner is a former Chief Executive of Kvaerner E&C Australia. He is a company director, an Adjunct Professor in the Engineering Faculty at Monash University, a member of the Victorian CELM Committee and a management consultant. He is a Fellow of Engineers Australia (EngExec) and an accredited Myers Briggs administrator.

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Abstract

Research has clearly shown that people who prefer to be "Analytical" (ie. those who make judgements and decisions using logical, objective and impersonal analyses of situations), and who comprise half the general population, overwhelmingly self-select into technical careers such as science and engineering. The other half of the population comprises those who prefer to use personal and human values to make judgements and decisions, and they are known as "Values-Based" types.

Australian male engineers typically have an overall Analytical/Values-Based mix of 88%/12%, and female engineers, with a greater preference for Analytical decision-making than females in the general population, are more balanced with an estimated 58%/42% mix of types.

The current male-dominated engineering profession in Australia is very unbalanced for rigorous decision-making, with a highly skewed Analytical/Values-Based ratio of approximately 85%/15% amongst its members. There is evidence that the strong Analytical culture of engineering faculties and the profession causes Values-Based male and female undergraduate and practising engineers to leave engineering. This paper argues that the profession acutely needs more Values-Based types to give balance and to bring a more people-oriented approach to decision-making. It is unwise and extremely impractical to recruit engineers solely by personality type, so direct recruitment of only Values-Based types to the profession is not a solution.

There are at least five strong reasons (*viz.* equity, excellence, efficacy, efficiency and culture change) for a more equal gender distribution in engineering. Significantly more women in engineering would bring greater balance to the Analytical/Values-Based ratio of Australia's engineers. This would increase the consideration of personal values and human and social issues in all types of engineering work, would give the profession more people and communication skills, and hence would make it significantly stronger and more effective. It would also change the profession's culture, which would reduce the high level of discrimination and harassment experienced by Australia's women in engineering.

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1. Introduction

It is not widely understood in many professions, including engineering, that approximately half the general population makes judgements and decisions using logical, objective and impersonal analyses of situations, while the other half uses processes based on personal and individual values. Both approaches, identified by the eminent Swiss psychologist Carl Jung, are rational and valid ways to make decisions. Jung called people who preferred logical, analytical thought "Thinking" types, and those who prefer to use human values "Feeling" types. Although Jung used these terms in a defined way, they are capable of being misunderstood and confused with their everyday meanings. So in this paper, the terms "Analytical" and "Values-Based" will be used instead of the terms "Thinking" and "Feeling" respectively.

2. The Analytical/Values-Based Dichotomy

2.1 The Work of Jung, Briggs and Myers

The psychologist Carl Jung published his seminal work "Psychological Types" in 1921 and it was translated into English two years later. It described the results of years of his extensive research into personality types. He classified people's personalities into eight categories after he discovered that "people are different in similar ways".

A mother-daughter team of psychologists, Katharine Briggs and Isobel Myers, extended Jung's work over the next two decades and expanded Jung's eight personality categories to sixteen. Their work resulted in the *Myers Briggs Type Indicator (MBTI)*, which is used today by about three million people annually and is the best-known and most useful personality-typing instrument in the world.

The MBTI is readily available and widely used to help people understand their own orientation to the external world, and how they make decisions. In particular, the theory covers people's preferences as to:

- how much energy they get from themselves or others (the introvert/extrovert scale)
- how much they experience the current world through details and facts, or think about opportunities and principles in a more abstract way (sensing and facts versus ideas and opportunities)
- whether they make decisions objectively or from personal values (logical analysis versus values), and
- how they plan and organise their own and others' lives (planning versus flexibility).

Furthermore, Myers Briggs theory directly impacts almost all areas of emotional intelligence, *viz.* self-awareness, self-regulation, empathy and social skills, and so is useful in a number of different ways.

The four scales above are dichotomies because an individual can have a preference for one of only two choices on each scale. The third dichotomy, the Analytical/Values-Based preference, is the subject of this paper. Unfortunately, in many individuals it is the most difficult dichotomy to analyse.

Jung postulated, from many years of observations, that some people prefer to make judgements and decisions using logical, objective, analytical and impersonal analyses of situations, while others use processes based on subjective personal and human values. Both approaches are rational in that they require mental reasoning powers and both are valid ways to make decisions. People who prefer logical, analytical, objective thought are "Analytical" (A) types, and those who prefer to use more subjective human values are "Values-Based" (V) types. It should be noted that preferences are being described here; an individual can make decisions in either way, but will feel more comfortable with, and will have more trust in, either an A or V approach over the course of a lifetime. These preferences are mutually exclusive at any particular time, ie. both can't be used simultaneously to make a judgement or a decision. It must also be noted that each process is no better or worse than the other, or right or wrong; they have advantages and disadvantages and may be more appropriate or less appropriate in any particular situation.

As an illustration of the difference between an A and V approach, consider the example of a manager of a large team who is ordered to reduce the size of the team for cost reasons, but is given a free hand as to how this will be done. An A-type will tend to accept the order from above and be concerned in general about the health of the organisation, and in particular about the effectiveness of the reduced team, not their morale or distress about colleagues leaving. He/she will consider how to develop a fair process for deciding which roles are to be made redundant and will be keen to be seen as able to make tough decisions while being fair and just through implementation. A V type, on the other hand, will tend to question the original decision on the basis that people's jobs are more important than a small improvement in an organisation's profit or ability to meet budget, and if the costs have to be saved, will explore others ways to lower the organisation's costs. He/she will be most concerned about the welfare of those who will lose their jobs, and how the organisation plans to look after them. Both the A and V approaches are rational and valid, but are very different. Importantly, they often produce very different outcomes.

Because of the difference in approaches to any situation by A and V types, any organisational unit, eg. a team, a department or a company, will be stronger if there are both A and V types in it. This way, the best solutions to problems are far more likely to be found, as long as one type does not dominate the other.

2.2 Correlation with Gender

The only one of the four Myers Briggs dichotomies to exhibit a correlation with gender is the A-V scale. General populations in Western countries (where most of the available data has been collected) typically comprise equal numbers of A and V types overall, but generally men are assumed to have an A/V ratio of 60/40 and women 40/60. Samples in recent years from 17,288 members of the Australian workforce however (covering both professions and some trades) give men an A/V ratio of 79/21 and women 42/58 (Ball 2002), but this is probably not typical of the Australian population, for which unfortunately no adequate data are available.

A/V ratios from various studies of sample populations (where n = sample size) are listed in Table 1.

Table 1: A/V Ratios for males and females from available studies.

n	% Female	A/V % Overall	A/V % Males	A/V % Females	Comment	Reference
N America:						
4,033	0		61/39		US high-school students	Myers (1980)
4,039	100			32/68	US high-school students	Myers (1980)
3,009	51	41/59	57/43	25/75	US general population	Myers (1998)
Australia:						
9,255	0		79/21		Australian workforce	Ball (2002)
8,033	100			42/58	Australian workforce	Ball (2002)

With 17,288 people analysed, the magnitude of this Australian sample is such that the error in the A and V values for males and females can be calculated as 1% at the 95% confidence level if the samples were unbiased. If there were bias, e.g. people sampled were not representative of the general workforce or the MBTI instrument was not administered or interpreted correctly, the A/V ratio might vary slightly. But a bias large enough to materially affect the main argument presented in this paper is highly unlikely.

2.3 Career Self-Selection

It should not be surprising that different personality types favour different types of careers. A types are attracted to professions where logic, argument, analysis and structure are required, such as the "hard" sciences (maths, physics and chemistry), engineering, accounting and law. V types, on the other hand, favour professions directly helping people, such as aid work, nursing, health care, counselling, religion and primary teaching (Myers 1998). In the corporate world, V types are typically found more in the HR and training functions, and in industries such as retail and hospitality.

The preference of different personality types to select particular careers can be measured by the Self-Selection Ratio (SSR), which is defined as:

$$\text{SSR} = \frac{\text{no. of people of a certain type choosing a career}}{\text{no. of people of that type in the base population}}$$

and has a value of 1 if there is no career preference. The SSRs for particular Myers Briggs types can be high, e.g. 2.94 for introverted, abstract, logical, organised (INTJ) types choosing engineering (Myers 1980), meaning that this type chooses engineering almost 3 times more than would occur if there were no preferences. Equally, some types choose to avoid engineering, e.g. from the same data: extroverted, detailed, values-based, flexible (ESFP) types had a SSR for engineering of 0.21.

The MBTI is used extensively for career counselling, and detailed SSR data on the preferences of every personality type for various career paths have been collected over many years.

3. The Engineering Profession

3.1 A/V Ratios

Unfortunately, A/V ratios for the worldwide engineering profession are rare. Table 2 lists published data, with even less information available for each gender. Most studies cover only engineers in Canada and the USA. Unfortunately there is only one small set of data on Australian male engineers, but it is large enough to give a estimated mean A value of 88% ± 8% at the 95% confidence level if the sample is unbiased.

Table 2: A/V Ratios for male and female engineers from available studies.

n	% Female	A/V % Overall	A/V % Males	A/V % Females	Comment	Reference
N America:						
2,188		67/33			US undergrads	Myers (1980)
1,865	14	73/27			Canadian undergrads	Rosati (1998)
1,252		75/25			Canadian undergrads	Capretz (2002)
83		75/25			US undergrads	O'Brien (1998)
3,718	18	74/26	77/23	61/39	US undergrads	McCaulley (1983)
116	29	69/31	74/26	56/44	US undergrads	Felder (2002)
146	100			43/57	US undergrad majors	Persaud (2005)
Aggregate						
9,368		**71/29**	**77/23**	**58/42**	A/V weighted means	
Australia:						
88			**88/12**		Workforce sample	Ball (2006)

The data of Myers (1980) show that, from an all-male group of high-school students in the US, a group who have chosen engineering would demonstrate an approximate overall increase in A value by a factor of 67/61 = 1.10.

The weighted aggregate A/V ratios for the North American data presented in Table 2 were calculated for comparison with the Australian data. These data show the significant differences between:

- male and female engineers overall in North America, with males having considerably higher A values, *viz.* 77% compared with 58%
- female engineers and females in the general population, with the latter having considerably higher V values (Table 1)
- male engineers in North America and Australia. The North American data set covers engineering undergraduates only while the Australian data set covers engineers in the local workforce. It could be expected that in any country, the A/V ratio for the engineering profession is slightly higher than for its engineering undergraduates, because some V types leave the profession for a variety of reasons, including discomfort with an A-dominated culture (Felder 2002).

Although there are no meaningful data on A/V ratios for female engineers in Australia, it is reasonable to assume that they will have significantly lower A/V ratios then their male colleagues, but higher than females in the general workforce. And given that the Australian engineering profession comprises only about 10% females (Engineers Australia 2006a), it can be calculated from data on the general Australian workforce (with an A/V ratio of 79/21) using a typical SSR type increase of 10% in the A value that the A/V ratio for the

Australian engineering profession is approximately 85/15. This is consistent with the A/V ratio of 88/12 for male engineers in Australia (Table 2) and 10% of the profession being female with a lower A/V ratio.

3.2 The Importance of People

The engineering profession in Australia is regarded highly for its technical skills and abilities. Its mission is to improve the safety, health, living standards and comfort of particular communities and of society in general. But engineers, because of their impersonal approach as individuals, are often poor communicators with inferior inter-personal and social skills, and poor delegaters (Batley 1998). Hence they are often poor managers of staff. The President of the Australian Council of Engineering Deans, Professor A. Johnston, was quoted in *The Australian* on 8 May 2006 as saying "engineers had to understand the workings of inter-personal relations, culture, management and ethics to get their job done, rise high in the corporate world and compete globally". The profession as a whole is not seen by society as people-oriented, two likely reasons being that engineers themselves generally have low inter-personal skills and they do not deal directly with members of the public, unlike the medical, legal and accounting professions.

For an engineer, dealing with people is essential and unavoidable. Many engineers work in project teams where they work with other people every day. At a time when the quality of engineers' relationships with their managers, subordinates, colleagues, team members, customers and suppliers, not to mention families and friends, is at an increasingly high level of relevancy for their careers and for their personal satisfaction and happiness, it is essential to change the profession to be more people-oriented and people-skilled.

4. A More Balanced Profession

4.1 The Need for More Values-Based Engineers

With the Australian engineering profession having an A/V ratio of approximately 85/15, it is very unbalanced and severely lacks V types who are more people-oriented. Other major professions don't have this problem because they have a much better A-V balance with far more female members. For example, in the medical profession in Australia in 2002, females represented 32% of practitioners, this proportion having increased in recent years due to higher numbers of female medical students, who comprised more than 55% of all medical students in 2005 (Australian Medical Association 2005). Similarly, more than half of all law graduates have been female (Branson 1997). By contrast, the number of female engineering students peaked in 2001 at just under 16% and has decreased every year since (Engineers Australia 2006b).

A profession such as engineering will probably always have a majority of A types because of the technical nature of much of the work. One of the major problems for the engineering profession in Australia however is that, because it is dominated by A types, it does not recognise or understand the significance of the A-V imbalance amongst its members. Through ignorance or arrogance, or both, it has done little to address this imbalance in the past. Yet there is evidence that V types, male and female, are not adequately catered for in undergraduate engineering courses (Felder 2002) or in engineering practice. Female engineers feel uncomfortable in a male-dominated culture and some leave the profession solely for this reason. This, as well as discrimination and harassment of women in engineering, has been documented by the national institution Engineers Australia (2002).

There are other issues to consider, like sustainability and the environment. Those individuals whose personalities dispose them to have strong interpersonal skills and who by their nature consider the human and societal aspects of any situation need to be recruited to the engineering profession and retained by it. These people are usually strong communicators, team players, outgoing and creative (Rosati 1998), but unfortunately, it is generally true that the typical A type engineer does not have these combined characteristics.

It is difficult for A types to understand and accept the benefits of having more V types in their profession, and to see the disadvantages of having only an A type approach to decision-making and problem-solving. Some examples might help:

- the Australian public's poor understanding of the breadth and depth of engineering and its contribution to society, and the profession's impersonal image, both of these due to the poor people and communications skills of the profession's leaders over past decades. The ability to communicate for an individual depends to a degree on that person's preference for introversion or extraversion, but a more personal, people-focussed V type approach also helps.
- the widespread belief of A type engineers that their real work is the "hard" technical work they must do, whereas people and HR issues are "soft" and of low priority.
- the consistently high working hours of many A types (doing technical work) and their failure to delegate, to the detriment of their relationships with their families and perhaps colleagues.
- the poor communication and people skills of many A type engineers in managerial roles, who do not support regular performance appraisals of their staff because they are uncomfortable with a process requiring close personal inter-action. If company policy requires them to do appraisals, they are reluctant to give honest feedback to individuals if it is negative.
- the example of a staff member who died at work in an Australian engineering company. The Directors and line managers (A types) avoided any involvement in the traumatic events of that day. The HR Department (V types) managed the distressed family and the many staff members who were in shock.
- in 1993, a severe downturn in workload caused John Brown E&C in Portsmouth, UK to make many people's positions redundant. The senior management (largely A types) considered a proposal from the HR Department (V types) that salary reductions would save jobs. Everyone in the company, including Directors, took a salary cut of 15% for about a year, saving approximately 50 jobs. As it turned out, this was later agreed to have been the best solution, as the company retained a capability it otherwise would have lost. How many organisations run by A types have done that in Australia?

Australia's engineering profession therefore needs to become more oriented towards people and away from equipment, machines and structures. This would happen naturally with a higher proportion of V type engineers. A more people-oriented approach to decisions would result and the profession and society would benefit.

4.2 The Solution

If it is accepted that Australia's engineering profession would be stronger with a more balanced mix of A and V types to make decisions, how can this be achieved? It is not regarded as ethical for an MBTI administrator in Australia to recruit V types (male or female) by type alone, and in any event, it would be an extremely impractical and unwise practice. But if the profession had more female members, its A/V ratio would be improved,

even though female engineers overall may comprise slightly more A types than V types. Making the profession more attractive to, and comfortable for, V types and getting A types to value the different decision-making approach of V types is clearly the solution, but recognising that the lack of women in engineering is a major weakness of the profession is the first step. How to rebalance the profession's A/V ratio by attracting and retaining more V types is then the challenge.

4.3 Learning Styles

A lower A/V ratio in the profession and a shift in culture towards a greater understanding of people issues might eventually reduce the "chilly classroom" effect which has been identified in the USA (Persaud and Salter 2005) whereby female engineers are uncomfortable in predominantly A type learning environments. Research continues on the mis-match between engineering faculty staff and students because of their different personality types (McCaulley 1983; Felder 2002), caused by self-selection of certain types into academic careers in engineering.

5. More Women in Engineering: The Way Ahead

5.1 Traditional Arguments

Burrowes (2001) has documented the history of women in Australian engineering and the lack of progress of the many programs initiated (by women) to change the male-dominated culture of the profession. In fact, there are excellent arguments for more women in engineering. Four strong arguments (ETAN 2000) are:

- **equity:** gender discrimination is a violation of human rights, or more positively, women should have the same employment opportunities as men;
- **excellence:** organisations flourish if they have a diverse mix of staff;
- **efficacy:** to improve the country's pool of highly skilled engineers it is essential to target both genders (especially in times of a shortage of resources as is now occurring in Australia); and
- **efficiency:** it is wasteful to educate and train female engineers and then lose their skills because they leave the profession.

These arguments are discussed further by Engineers Australia (2002) and make a very solid case for more women in engineering. Unfortunately, this report also documented the high levels of discrimination experienced by female engineers (36% of the 767 surveyed) and sexual harassment (27%), which have occurred in a highly male-dominated profession. It is not evident that the profession took any action over this disturbing and disappointing evidence. The fact that these immoral or illegal practices occur is a fifth reason for having more women in engineering to change the sexist male culture of parts of the profession.

5.2 A New Argument

The thesis of this paper is that Australia's engineering profession needs to become more people-oriented, which will happen naturally with a higher proportion of engineers who make judgements and decisions based on their own personal and human values. This argument is a subset of the "excellence" argument that a profession with a mix of members with different backgrounds, attitudes and skills will enhance the profession's capability level, will improve the culture of the profession and will reduce discriminatory practices. With a more balanced mix of A and V types, the profession will benefit strongly in ways that are not always predictable because the culture will change over time.

In summary, if there were more women in Australia's engineering profession, the high A-V imbalance would be ameliorated. Hence this is a new argument for more women in engineering. A technical profession such as engineering will probably always have a majority of A types. The profession should recognise however the benefits of more Values-Based practitioners who will focus more on the relevant people issues to generate a diversity of approaches for tackling problems and finding new solutions. The masculine culture, and the impersonal and closed image of the profession would then be improved.

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