Motivational drivers affecting career choices in the resource sector:
The Science Career Inventory (SCI)

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Abstract

At a time when more and more mineral and energy resources are needed to fuel the world's growing economy, less and less young people choose career paths that will supply the leadership and technical support roles essential to assuring a sustainable future in the resource sector. This twenty-first century paradox is amplified by a developing worldwide shortage of young people with strong physical science and mathematics backgrounds who are interested in pursuing Higher Degree by Research (HDR) work in metallurgy, mining and chemical engineering. This dwindling pool of qualified students is of particular concern to the Australian economy in that nearly 50% of all the export income earned per year is directly attributable to the natural resources sector. In order to acquire a better understanding of the motivating forces that induce prospective employees with science and technical backgrounds to choose careers in the resource sector, the authors have developed a new investigative tool, the Science Career Inventory (SCI). The SCI comprises six scales (financial, academic, relationship, lifestyle, altruistic and personal esteem) with six items in each scale. There are three forms of the SCI that have been developed and trialled to date: the Professional Form, the Graduate Form and the Undergraduate Form. This paper describes a study trialling the SCI in order to present validation and reliability data for this new instrument. Qualitative and quantitative results concerning the reliability and validity of the instrument are reported. Conclusions are drawn concerning the motivational factors influencing the career choices of the participants reported on in this study and it is hoped that these findings will eventually be used to practically inform the resource sector and improve opportunities for science graduates and others interested in practical applications of science education.

Australia's Problem is a World Problem

Nearly a third of Australia's export income is earned by the country's mining and extractive metallurgy* industry. Yet at the same time the share of national wealth earned by this industry is on the increase, the supply of young science graduates gaining the academic credentials and experiences in the technical areas needed to maintain a qualified workforce continues to dwindle. The problem is well-documented, but no easy solution has become apparent.

The contention that the mining and extractive metallurgy industry in Australia supplies a great deal of the country's wealth is beyond reproach: during the 2003-2004 financial year, income from the overseas sale of metallic minerals and metals totalled $AU32.3 billion and that represented 27.5% of all the money Australian earned through merchandise exports (Australian Commodities, 2005). In Western Australia alone, over $18 billion of revenue was produced during the 2004 calendar year (Western Australia Department of Industry and Resources, 2005). If one includes the energy sector in this mix, over $50 billion dollars

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* *Extractive metallurgy* is the academic discipline that specialises in refining valuable metals from their native ores. There is another discipline called *Metallurgy* that studies the applications and engineering of metals and their alloys. This paper refers exclusively to extractive metallurgy.

of export income is created for Australia per year, $28.4 billon of which is produced in Western Australia alone. The trend of fewer and fewer students with a strong physical science background who are interested in pursuing a Higher Degree by Research (HDR) in areas relevant to the industry is equally apparent. The dilemma presented by a shortage of this type of research and the decreasing number of science students that feed the industry becomes apparent when one considers the value that even a small breakthrough in technology can contribute to the national good:

> *At the same time that the minerals industry contributes greatly to the economic wellbeing of Australia, the industry has generally spent a small percentage of its income on research. Part of the rationale for this is that in most cases, extractive metallurgy requires massive plants that are capital intensive and few look to any sweeping changes in the processes at hand. Consequently improvements based on research tend to be incremental, though often these incremental changes can be of great value. When one considers that the gold industry alone produced about $5 billon of gold in the last financial year, then an "incremental" improvement allowing only 0.1% more gold to be recovered from an ore body could result in a net gain of $5 million (e. g., 0.1% of $5,000,000,000)!* (Churach, 2003)

For the purposes of this study, the array of energy, mining, minerals and extractive metallurgy disciplines are clustered together as one industry (i.e., energy and mineral resources). The educational foundation of this energy and mineral resources industry rests upon three academic areas of interest, namely the earth sciences, mining engineering and extractive metallurgists. The specialties of geophysics and earth sciences supply the personnel needed to locate and describe these natural resources that are abundant in Australia. The field of mining engineering concerns itself with the techniques and processes needed to remove these resources from the earth. Finally, the extractive metallurgists use physical and chemical means (either pyrometallurgy or hydrometallurgy) to process and concentrate the ores. Considering the Australian data concerning student numbers studying these core technical areas, the diminishing tendency does not bode well for the country's economic well-being.

Bartier, Tuckwell & Way (2003) have compiled data showing the Australia-wide Honours Degree cohort in Earth Sciences during 2002 was lower than the previous 2 years. At the MSc level, students studying in this area remained fairly constant during 2001-2002, but they anticipated significant declines in 2003-2004. It was also noted that similar declines in PhD completion were expected for the Earth Sciences over the same time period. They go on to report that in the area of Mining Engineering, students working towards Bachelors and MSc Degrees have remained fairly level over the past few years, but there are significant drops estimated in PhD completions. Even with the recent minerals "boom" into 2005, there has only been a modest "rebound" in undergraduate numbers in Australia with many young people opting to enter the tight job market rather than to choose more study. In Western Australia in particular, the Northwest Shelf gas and oil projects are expanding, Pilbara iron ore facilities and the Wagerup alumina refinery are due for enlargement and a new nickel and cobalt processing plant is being developed in Ravensthorpe. The abundance of jobs in these projects no doubt contributes to the decline in the postgraduate numbers due to the very lucrative financial incentives available to young people just beginning their careers.

The outlook for student numbers in the areas of energy and minerals could even get worse! It can be argued that of the three "academic legs" that make up the energy and mineral resources industry, the one in greatest danger of dying would have to be the extractive metallurgists. Ian Ritchie (2002) goes so far as to speak of extractive metallurgy as being an endangered science and that it is becoming precariously close to extinction. The path to advanced study in the general field of extractive metallurgy is quite convoluted given that few students actually earn a Bachelors Degree in Extractive Metallurgy. Feeder bachelor degrees generally come from bachelor majors in Metallurgy, Chemistry and Chemical Engineering. Occasionally a qualified student will choose postgraduate work in Metallurgy coming from a background in Physics, Mathematics and Computing. In some special cases (e. g., bio heap leaching) even students with strong biology backgrounds can excel as PhD researchers studying in this area. Nicol and Woffenden (2002) paint an equally sombre picture on the undergraduate level, noting that Australia-wide there were in excess of 150 Bachelor Degrees in Metallurgy awarded in 1996, but that had declined to just over 50 completions in 2001. Where nearly a dozen Australian universities offered bachelors in metallurgy a decade or more ago, only two (Murdoch University and Curtin University Western Australian School of Mines) currently accept Extractive Metallurgy students. Moreover, the problem appears to be deeper and has earlier origins than simply at the university level:

> *"However, of potentially greater concern to the minerals industry as well as most other technology-based industries, is the significant decline in the quality of sciences education and learning within the secondary school system of Australia. Fewer and fewer school leavers are sufficiently qualified to study science and engineering at university. Many of those who are, choose not to do so…*
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> *The problem for all Science, Engineering & Technology (SET) Industries is between five and 10 years out from now, when the current cohort of secondary school students seek to join the workforce as professional engineers and scientists. It is likely there will not be enough to satisfy the demand."* (Bartier, Tuckwell, & Way, 2003, p 34)

Furthermore, this problem is not confined to Australia. There is ample evidence indicating a worldwide shortage of young people with strong physical science backgrounds who are interested in pursuing research in extractive metallurgy in particular and in Science, Engineering & Technology in general. As an example in the United Kingdom students enrolled in chemistry courses peaked at 4100 in 1993 and dropped steadily (save for one increase in 1997) to under 2900 in 2001. Even more, the absolute student numbers can be very misleading. When one looks on a percentage basis of the entire age group, the numbers are even worse. In 1989 some 2.7% of all UK university students studied chemistry, but by 2001 this number had dropped to about 1% (Breuer, 2002). The United States has seen a similar decline in chemistry bachelors degrees that have steadily declined from a high of 10,873 in 1997-98 (Long, 2002). Similarly, the total number of science and engineering doctorates slipped 1.7% in 2001 to the lowest level that have been awarded since 1993. Chemistry PhDs had dropped 10.6% since (1992 Chemical & Engineering News, 2003).

This lack of students threatens continued research throughout the energy and mineral resources industry and bodes of a shortage of replacement research and management personnel as the generation of staff nears retirement. In the final analysis, this shortage of student researchers choosing to enter the energy and mineral resources sector as a career led the authors of this paper to ask what motivational forces might be involved in this decline.

Career Development Theory

Certainly the modern world is based on the simple rule that we humans work in order to earn a living. That of course leads to the age-old question of 'What do you want to be when you grow up?' Surely there can be as many answers to that as there are people, but the question of why an individual chooses one occupation over another has interested researchers throughout the past century.

Parsons (1909) conducted the pioneering work in the area of career choice by classifying people as either career-decided (i.e., certain) and career-undecided (i.e., uncertain). Several decades later, Williamson's (1937) work offered evidence contradicting the then prevailing belief that one's career choice predicted academic achievement. His research went beyond Parsons' work by categorising peoples' vocational choices as very certain, certain, or uncertain. Still, this rather simplistic, either-or dichotomous model of career choice fitting all respondents into decided and undecided categories produced mixed and inconsistent results (Slaney, 1988). The human decision making mechanism seemed to be much more intricate and involved than that described by merely either-or forced choices.

It was not until the 1950s that Ginzberg, Ginsburg, Axelrad and Herma (1951) looked at career choices as being a much more dynamic process. These researchers interviewed a wide array of people from varying backgrounds and concluded that most people do not make a once-only decision concerning career choices. They argue that people generally tend to experience a developmental process that over a period of time progresses through six stages beginning with fantasy (as pre-adolescence) through interest, capacity, values, tentative choices and finally to a final, realistic stage (crystallisation).

At about the same time, Super (1953) presented his developmental theory that manifested itself in five stages: growth (childhood), exploration (adolescence), establishment (early adulthood), maintenance (middle adulthood) and decline (later adulthood). Additionally he put forward the view that "career" encompasses the sum total of all the roles one plays during a lifetime and presented the concept as the Life Career Rainbow. It was here that some might argue Super made his greatest contribution – the idea that one's self-concept has a great deal of impact on career choices and that this self concept constantly is shaped by and in turn shapes the individual's life experiences. At the end of the day, the work of Ginzberg, et al., and Super have been challenged, modified, refined and adopted by dozens of researchers, but the main contribution they all made was to put forth the idea that careers involved a great deal more than just what occupation one chose in order to earn a living.

More, they all supported the notion that career selection was an ongoing process that was continually affected by the dynamics of one's life experience and constantly changing as one progressed through life.

A decade later, Holland (1959, 1995) introduced his hexagonal model that proposed one's workplace milieu consisted of six distinct environments and that individuals fell into one of six corresponding personality types. Both the personality types and the environments he labelled as realistic, investigative, artistic, social, enterprising and conventional. In his model, there is an ongoing interaction between the individual and the environment in which certain personality types are attracted to certain environments while at the same time each environment is created to specifically attract the proper personality type.

In recent years, much of the research into career choice has gone into designing tools to better assess the direction in which the individual's vocational preference develops. In light of this, Hartung (1995) suggests that there have been two great movements in this area of measurement and refers to them as first-generation and second-generation measures. He describes the first-generation measures of career choice status as those that produce total indecision scores. By design, these instruments are not multi-dimensional and for that reason have engendered a great deal of controversy. As an example of this type of questionnaire, Hartung points to the "Career Decision Scale" (Osipow, Carney, Winer, Yanico, & Koschier, 1976), which was used to identifying a variety of subtypes of undecided people and postulated differing forms of interventions for each type of person. Hartung describes a second-generation of measures that characterises vocational indecision as a multidimensional construct. A representative example of a second-generation measure can be found in the work of Jones (1989) whose revision of the Vocational Decision Scale, the Career Decision Profile takes into account the complexity of career choices and assesses respondents along three different dimensions. The CDP attempts to measure the individual along the dimensions of (1) decidedness, or how certain one is concerning their choice, (2) comfort, or how comfortable one is concerning the status of her or his decision and, (3) reasons, or the underlying factors for being decided or undecided about the career choice.

Based on these foundations, the authors of this paper hypothesise that a retrospective study of *why* (the reasons) people have already chosen an occupation path (e.g., a career as a researcher in the energy and mineral resources industry) could offer insight that could be valuable in assessing the problem of declining enrolments in these areas. Tapping the collective knowledge of hundreds of years of experience is something that could be worth a lot of money to the industry Enticing new members of the profession into the careers in Energy and Minerals will perhaps help stem this loss as one generation retires and gives way to a succession plan for intellectual property as well as experience in the industry. This paper reports on the progress of a pilot study trialling a career choice inventory, though at the time of this writing, more data are being collected from both professional and student respondents. It is hoped that one result of this pioneering work exploring the motivational factors leading to these career choices will be a wealth of data useful to educators, industrialists and the community at large.

Methodology

The development of the Science Career Inventory (SCI)

In order to develop a meaningful tool that could be used to assess the motivational factors affecting career choices that lead an individual to become a scientific researcher in general and into the energy and mineral resources industry in particular, the researchers conducted numerous interviews and conversations with professionals who have already made the career choice in question, namely a science based career in mining/metallurgy. After thorough analysis and consideration, six broad areas were identified that could offer strong motivation to someone making a career choice within the energy and mineral resources industry. Briefly, these six areas are: Financial, Academic, Relationship, Lifestyle, Altruistic and Personal Esteem and are described in Table 1.

Table 1
Description of Scales and Sample Items for each Scale of the SCI

Scale Name	Description of Scale The extent to which the respondent perceives that their career is motivated by…	Sample Item
Financial	…financial rewards and the amount of economic security the career offers.	My career assures me of a more sound financial position in the future
Academic	…having a outlet for lifelong teaching and learning within their scientific field of interest	I enjoy finding answers to questions that no one else has found before.
Relationship	…the relationships formed within their place of work and with colleagues of similar background and interests.	My work allows me to feel as though I am a valued member of a team.
Lifestyle	…the general working conditions, geographical location and day-to-day demands of the workplace.	I believe my career allows me to live the kind of lifestyle that I want to live.
Altruistic	…the desire to use their abilities and talents for the betterment of the general community.	The best way I can help others is through the work I am now doing.
Personal Esteem	…a need to be recognised and respected among their peers as well as the community at large.	My career/industrial position entitles me to respect within the general community.

The process of designing a questionnaire to assess the importance of each of these concept areas sought to develop clusters of summated questions ─ a series of questions aimed to tap a particular motivational concept. Each item is designed as a statement which the respondent is asked to answer on a 5-point Likert Scale ("strongly disagree" to strongly agree"; see Appendix). Summated questions allowed for a numerical score to be computed for each participant by totalling all the responses within a given cluster (scale). According to Spector (1992), this methodology adheres to the key characteristics required to devise a scale for which statistical measurement of confidence can be determined. Spector identified four characteristics all summated rating scales must have:

- the scale must include multiple items that may be combined or added together
- each individual item must be able measure to be rated on a quantitative continuum (e.g., along a construct such as a Likert scale)
- the items can not have a “right” or “wrong” answer (i.e., it can not be a “multiple choice test” testing knowledge or abilities)
- every item is on the form of a statement and respondents rate each statement in terms of which response most closely reflects their point of view

The primary questionnaire consists of 36 questions with each of the six motivational areas comprising six different items. An additional 14 Likert Scale questions were included along with three open-ended questions in an attempt to learn more about specific issues relating to career selection. Background and demographic data was collected at the beginning of the instrument.

Development of the three forms of the SCI

When considering the sample for this study, it was noted that there are differences in the motivations for people to enter the career of their choice and that these may be different at various stages of their life. In a pilot study conducted by the authors (Churach & Rickards, 2003) three different versions of the SCI were developed: a Professional SCI form, an Undergraduate Student SCI form and a Post-Graduate Student SCI form. The purpose of the three versions of the SCI was simply to attempt to accommodate differences that may be evident in each sample. This paper reports exclusively on the Professional SCI form administered to a sample of 118 professionals from Australia, North America, Europe and Africa.

Data collection

Quantitative data were collected using the SCI and qualitative data were gathered using a combination of the SCI form and through semi-structured interviews. Data were collected over a limited time so that responses were not influenced by any changes in the workplace environment.

Results

This paper reports on the preliminary findings of a sample of 118 respondents, all of whom were professional staff within the energy and mineral resource sector. Of those completing the SCI, 51 reported their highest level of education was a bachelor degree, 21 had earned masters degree and 45 had completed their PhDs. Only one respondent reported no post-secondary credential.

Though the researchers have designed an instrument (the SCI), on-going work is aimed at refining the tool based firstly on participant feedback and later on focus group sessions.

One of the difficulties encountered is that there were no other studies of this sort (e.g., energy and mineral resource career motivators) with which to compare this work. It is hoped that the SCI will become a benchmark study in the area. To that end, the instrument is available to prospective participants at the CSRP website and the authors of this paper encourage professionals within the industry to participate in the on-going work (http://www.csrp.com.au/education/sciproform.html). The researchers aim to collect a larger base that will be used to better validate study with a broader perspective from the industries targeted.

Quantitative

Though the sample size is relatively small in this pilot study using the SCI, it is likely that the data may give some insight to the findings to date. It must be remembered that there is a small pool of people in the industry as a total population from which to draw. The Scale

Table 2
Scale Mean Scores for the Science Career Inventory

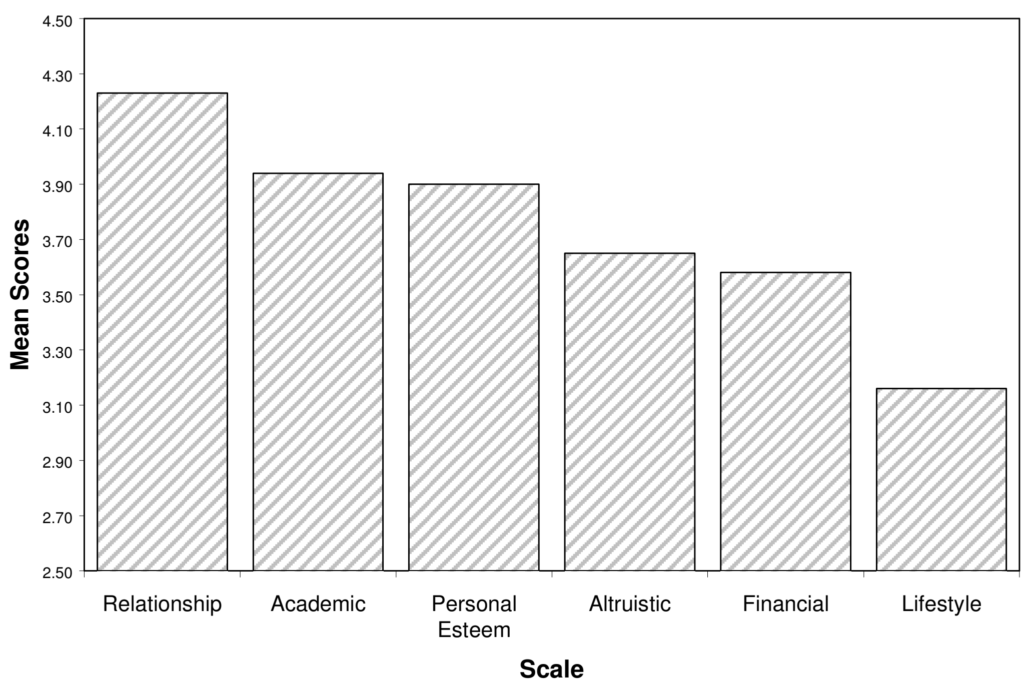
Scales	Mean for Scale	Standard Deviation	Alpha Reliability
Financial	3.58	0.73	0.864
Academic	3.94	0.54	0.733
Relationship	4.23	0.58	0.809
Lifestyle	3.16	0.61	0.564
Altruistic	3.65	0.59	0.732
Personal Esteem	3.90	0.87	0.727

n= 118

Mean Scores (see Table 2) are indicative of participant responses to the items. These are important as they serve as an indication of what were the motivating factors for professionals to choose the field as a career. Standard deviations are also listed for each scale indicating the spread of responses. This spread signals the level to which participants responded in a like manner to the items presented. At this stage of the research the sample is smaller than desired, but the data are encouraging to date, as the standard deviations are relatively small. This supports the notion that the respondents were tending to answer the questions being asked in a similar manner, though inter item analysis was needed to give greater insight to the reliability of this assertion.

After limiting the questionnaire to six questions for each of the six scales, a quantitative analysis of the reliability of the instrument was carried out using SPSS. Reliability refers to just how likely it is that an individual would obtain the same score responding to the scales on two separate occasions. Because having respondents complete the questionnaire is impossible, an alternative, statistical approach is used. This method looks at the consistency of a respondent's answers to one item compared to all other items in that scale. This is done by calculating Cronbach's alpha reliability coefficient, a number that generally ranges between 0 and 1. The closer the Cronbach's alpha coefficient is to 1, the greater the internal consistency of the items in the scale. As a rule of thumb (George & Mallery, 2003), Cronbach's alpha coefficient "> .9 – Excellent, > .8 – Good, > .7 – Acceptable, > .6 – Questionable, > .5 – Poor, and < .5 – Unacceptable" (p. 231). To a degree, an increase of the value of the Cronbach's alpha coefficient is somewhat dependent on the number of

Figure 1:
Scale Mean Scores for the SCI.



items in a scale, though this quickly reaches a point of diminishing returns. In the end, a high Cronbach's alpha points to a good internal consistency within a scale, but does not indicate that it is unidimensional. Like a good golf swing, there are always factors that can not be fully accounted for.

The Initial Validation information for the SCI is also shown in Table 2. The Cronbach's alpha for five of the six scales of the SCI indicates good or acceptable internal consistency of the items. The sixth scale (Lifestyle, $\alpha = 0.564$) shows poor internal consistency. In retrospect, a review of the six items included in this scale gives insight to this inconsistency and in fact, may be a reflection of the central concept of lifestyle within this industry. For example, consider the following two items:

> "I enjoy working in the laboratory and my career allows for enough laboratory work"

"I enjoy working outdoors and my career allows for enough outdoor work"

The questions seem contradictory and tend to elicit polarised responses (e.g., those who like indoor work will score these items 5 and 1 and those who like outdoor work tend to score them 1 and 5). Though the authors intend to revise this scale in the next stages of this research, it is hypothesized that useful information is still gleaned from these data in that lifestyle motives do not seem to be strong drivers in motivating people to choose careers within the energy and mineral resources sector. It is anticipated that this will be a valuable area for discussion within the focus group interviews.

Table 3:
Raw data for Driving Career Forces for Professionals.

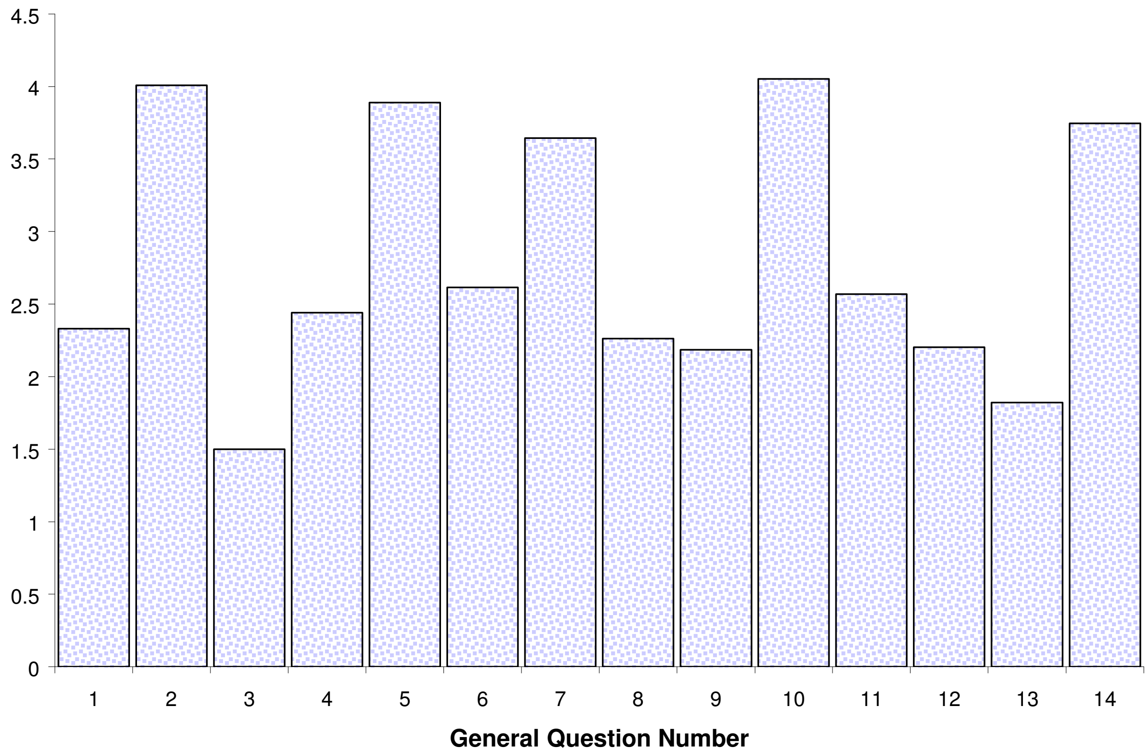
	General questions as they appeared in the survey	Mean Response	Standard Deviation
1	A former high school teacher of mine caused me to consider scientific research as a career.	2.33	1.25
2	I will in some way be in the minerals/energy sector five years from now.	4.01	0.87
3	I did *not* enjoy science classes in high school.	1.50	0.87
4	A friend of mine had a career in the metals/minerals industry.	2.44	1.30
5	A favourite class of mine in high school was Chemistry	3.89	1.20
6	Upon completion of my degree, I will probably seek work in an industry other than metals/minerals.	2.62	1.14
7	A favourite class of mine in high school was Physics.	3.64	1.15
8	I always knew my career would be in the minerals/energy sector.	2.26	1.17
9	I enjoy solving mathematical-type problems.	3.81	1.08
10	I wanted to be a scientist when I was in high school.	4.05	1.03
11	A former university instructor/professor caused me to consider scientific research as a career.	2.57	1.28
12	A family member of mine had a career in the metals/minerals industry.	2.20	1.39
13	My career ambition in high school had nothing to do with science or engineering.	1.82	1.03
14	A favourite class of mine in high school was Mathematics.	3.75	1.12

n = 118

Figure 1 is a graphical representation of the mean scale scores calculated for the 117 respondents to the Professional Form of the SCI. It becomes immediately clear that in this sample, the largest motivational driver in career selection amongst the professionals has been relationship factors. Here items included contentment and shared value of working with colleagues, team approaches to solving problems and friendships with others in the industry.

Both the Academic and Personal Esteem scales rated high within the sample. When one considers that nearly every respondent to this survey has minimally earned a bachelors degree, it becomes easily understandable why the academic side of the industry is viewed in a positive light. Similarly, receiving personal satisfaction from carrying out one's "job" would be expected in nearly any profession. In that sense, the career path chosen by an individual would become self-selecting in that if one did not experience personal esteem from job related activities, there is a high chance that person would have left the industry

Figure 2:
Raw data for Driving Career Forces for Professionals.



n = 118

and not have been included within the sample population.

The questionnaire also included 14 general questions concerning the driving forces affecting career selection as identified by professionals. Table 3 and Figure 2 report on responses to these questions. Certainly those answering this survey had a strong interest in the sciences and related disciplines long before a career choice was made. This is a valuable finding and is indicated by the overwhelmingly positive response to the item "I wanted to be scientists when I was in high school" (4.05). Additionally, strong positive scores were calculated for favourite high school subjects of chemistry (3.89), mathematics (3.75) and physics (3.64). Reviewing the other responses to these questions offers greater support to similar themes. It is also noted that the second strongest positive response was to the item concerning remaining within the energy and mineral resources sector in the future. One needs to have a reasonably high level of career satisfaction to be so confident of remaining within the industry into the future.

Qualitative: Snapshots from the workplace

Qualitative data was obtained from both written (open-ended) responses on the questionnaires. The results from the qualitative data collection supported the findings from the quantitative data collection.

For example, when asked for an opinion about what had been the greatest effect on the decision to pursue your chosen career, participants responded most strongly to positive school experiences, stemming from both primary and secondary experiences as well as early exposure to the industry via excursions as a child, or through parental career exposure to science. In addition, a significant positive response was evident where professionals had been mentored by an effective teacher or had established a positive teacher-student relationship with an effective secondary or tertiary teacher. The least supported reasons were financial reward and autonomy.

Concerning teachers, nearly two-thirds of the respondents took the time to answer open-ended questions concerning the effect a teacher had on their decision to continue on a career path into the energy and mineral resources sector. One wrote, "My high school science teacher had a profound effect on my career choice… [he] made the subject very hands on, and always kept the material interesting." Another said, "Mrs X was my chemistry and physics teacher. She saw my liking of chemistry and put forward the idea of metallurgy to me." Still another commented, "My math teacher in high school. He gave us many practical applications and was always challenging us with new problems."

Though the majority of these were positive responses, there were some teacher-related comments regarding a negative influence to career prospects. For example, participants were asked about why any one teacher stands out in your mind at any level of school from primary through tertiary as a negative influence on your decision to follow a career in the energy and mineral resources industry? A typical response was, "Yes. My Year 11 and 12 Chemistry teacher said I would not be likely to study chemistry at Uni. I proved him quite wrong. He wasn't a good teacher," or "My chemistry teacher was not very dedicated. However, he did tell me I had the ability, 'but I didn't seem motivated."

In summary, qualitative data suggests that teachers had the greatest influence on the career choices of those included in this sample population. Of these teachers, the overwhelming majority were high school science teachers, though quite a few mathematics people were mentioned. The value of informing secondary school science teachers about the energy and mineral resources sector is heightened by their direct contact with students who may want to consider these areas as a career choice. School teacher professional development programs and experiential workshops are a positive way to enhance teacher comfort with the knowledge required to understand these careers better so that they are able to confidently inform students.

There were also many university-level lecturers and professors mentioned as sources of inspiration. Interestingly enough, only one participant made a mention of a high school career counsellor as having any impact on career decisions.

Discussion

Certainly human interaction can be seen to have the greatest effect on career choice decisions and much work has been done in science education and teacher-student relationships. It is apparent that the “Relationship” scale is seen to be the biggest driving force in career selection in this study. It is equally clear that participants had a strong interest in the general area of sciences and mathematics at least as early as high school. Additionally, it can be concluded that this sample population generally has a strong aptitude in these disciplines for the simple reason that of the 118 people in the sample, 117 had at least a university degree.

Putting these finding together indicates that, at least in this sample population, career choice was greatly affected by the inter-workings of three key components:

1. People choosing professional careers in the energy and mineral resources sector had a strong enough aptitude to gain entrance to and complete a technical degree in a tertiary institution
2. People choosing professional careers in the energy and mineral resources sector had an initial interest in the academic areas of science and mathematics
3. People choosing professional careers in the energy and mineral resources sector report a strong influence by relationship factors within their professional lives and that being involved with a team working towards a common goal and having personal friendships within the industry are important components of career satisfaction.

Based on this interaction of forces, is there any way one could have a positive impact on trying to influence more careers within the science and mathematics area in general and the energy and mineral resources sector specifically? Of the three components mentioned above, certainly little can be done to affect the innate scientific and mathematical aptitude possessed by the target population. However, the authors hypothesise that the participants in this study were open to inputs concerning a general interest for and liking of technical areas during formative, adolescent years and continue to be influenced by these interpersonal relationships throughout their careers. In context of the findings concerning the large impact that school teachers (particularly school science and mathematics teachers) have had on the career choices of those involved in this study, it seems likely that any initiative aimed at influencing these teachers would likely have a positive impact on the career aspirations of their students.

Conclusion

The indications are that the Science Career Inventory can be a useful tool in identifying the motivational forces that contribute to career choices of the respondents in this pilot study. The authors recognise the limitations of the small sample size reported here and data collection will continue. Nonetheless, it is hoped that this paper has in a small way provided early indications, by way of feedback to the participants, that there is at least one team looking at how to enhance this economically “human resource” aspect of the energy and mineral resources sector, both here in Australia and internationally

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Appendix 1: Professional Form of the SCI

Science Career Inventory (SCI): Professional Short Form

Contact researchers at:

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1. Name (optional): ________________________________ 2. ☐ Male ☐ Female
3. E-mail Address (optional) ________________________________
4. Years you have been employed in the minerals / energy sector? ____________________
5. Highest degree completed and in what discipline? ____________________
6. From what university or institution was this qualification earned? ____________________
7. Does any one subject teacher stand out in your mind at any level of school from primary through tertiary as a **POSITIVE** influence on your decision to follow a career in the mineral resource and energy sector? If so, briefly describe why he or she stands out in your memory?
____
____
____
8. Does any one subject teacher stand out in your mind at any level of school from primary through tertiary as a **NEGATIVE** influence on you? If so, why does he or she stand out in your memory?
____
____
9. In your opinion, what had the greatest effect on your decision to pursue your chosen career?
____
____
____

Directions

The following questionnaire asks for your views concerning mineral resource and energy sector as a career and the motivational forces that have influenced your decision to work in this area. Please think about how and why you have chosen this career as you respond to these statements. Consider each statement in context of your own experiences, personal motivations, opinions and attitudes and mark them accordingly.

Mark 1 if you *strongly disagree* with the statement.
Mark 2 if you *disagree* with the statement.
Mark 3 if you have *no opinion* concerning the statement.
Mark 4 if you *agree* with the statement.
Mark 5 if you *strongly agree* with the statement.

		Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree	
1.	This career allows me to earn a high income.	1	2	3	4	5	Financial
2.	My career assures me of a more sound financial position in the future.	1	2	3	4	5	
3.	I am able to earn enough income to afford a lifestyle with which I am comfortable.	1	2	3	4	5	
4.	This career enables me to save towards my retirement.	1	2	3	4	5	
5.	In this industry, I am likely have a job that pays well throughout my career.	1	2	3	4	5	
6.	The financial rewards associated with this field career make all the work worthwhile.	1	2	3	4	5	

Please turn to side two

	SD	D	NO	A	SA	
7. I am able to get to know and to work with world-renowned experts within my field.	1	2	3	4	5	Relationship
8. I enjoy the type of people I meet in this career/industry.	1	2	3	4	5	
9. My work allows me to feel as though I am a valued member of a team.	1	2	3	4	5	
10. I find it easy to develop friendships with other professionals and researchers in this career/industry.	1	2	3	4	5	
11. Working with other people is an excellent way to go about solving a problem.	1	2	3	4	5	
12. Some of my best friends are also interested/involved in this career/industry.	1	2	3	4	5	
13. I am intellectually stimulated and challenged by the work that I am doing.	1	2	3	4	5	Academic
14. I enjoy writing professional material (eg. reports, presentations, etc.).	1	2	3	4	5	
15. I look forward to learning even more about this industry during my career.	1	2	3	4	5	
16. I enjoy finding answers to questions that no one else has found before.	1	2	3	4	5	
17. I look at myself as a lifelong learner.	1	2	3	4	5	
18. I look forward to teaching others about what I have learned in this career/industry.	1	2	3	4	5	
19. I enjoy working in a laboratory and my career allows for enough laboratory work.	1	2	3	4	5	Lifestyle
20. Much of what I do in this career/industry does not really seem like work to me.	1	2	3	4	5	
21. I believe my career allows me to live the kind of lifestyle that I want to live.	1	2	3	4	5	
22. My career choice allows me to live in the geographic location of my choosing.	1	2	3	4	5	
23. Generally, my career allows me to work the schedule of hours I prefer to work.	1	2	3	4	5	
24. I enjoy working outdoors and my career allows for enough outdoors work.	1	2	3	4	5	
25. I am better able to benefit my community/country by the work I do in this area.	1	2	3	4	5	Altruistic
26. My work contributes in some way to a better standard of living for all people.	1	2	3	4	5	
27. In part, what I do in my career results in a cleaner environment.	1	2	3	4	5	
28. Eventually, my contribution to the more efficient use of resources will be of benefit to all people.	1	2	3	4	5	
29. The best way I can help others is through the work I am now doing.	1	2	3	4	5	
30. A better world tomorrow must be based on the scientific research done today.	1	2	3	4	5	
31. One result of my work is that other professionals value my opinions.	1	2	3	4	5	Personal Esteem
32. I would be pleased to find my work referenced in another professional's study.	1	2	3	4	5	
33. The work I do has allowed me to take on greater career responsibility.	1	2	3	4	5	
34. My work in this area allows me to better work towards a personal advancement in the future.	1	2	3	4	5	
35. I would get satisfaction in seeing my name on a professional paper I have published.	1	2	3	4	5	
36. My career/industrial position entitles me to respect within the general community.	1	2	3	4	5	
37. A former high school teacher of mine caused me to pursue this career.	1	2	3	4	5	General Questions
38. I will in some way be in the minerals / energy sector five years from now.	1	2	3	4	5	
39. I did *not* enjoy science classes in high school.	1	2	3	4	5	
40. A friend of mine had a career in the minerals / energy sector.	1	2	3	4	5	
41. A favourite class of mine in high school was Chemistry.	1	2	3	4	5	
42. In the future, I will probably seek work in an industry other than mineral resource and energy sector.	1	2	3	4	5	
43. A favourite class of mine in high school was Physics.	1	2	3	4	5	
44. I always knew my career would be in the minerals / energy sector.	1	2	3	4	5	
45. I enjoy solving mathematics-type problems.	1	2	3	4	5	
46. I wanted to be a scientist or engineer when I was in high school.	1	2	3	4	5	
47. A university instructor/professor caused me to pursue this career.	1	2	3	4	5	
48. A family member of mine had a career in the minerals / energy sector.	1	2	3	4	5	
49. My career ambition in high school had nothing to do with science or engineering.	1	2	3	4	5	
50. A favourite class of mine in high school was Mathematics.	1	2	3	4	5	

Thank you for answering each item…