THE COGNITIVE STRUCTURE OF PROFESSIONAL IDENTITY

Dr YingFei Gao, Professor Michael Riley, and Professor Eugene Sadler-Smith

School of Management, University of Surrey, United Kingdom

Email: y.gao@surrey.ac.uk

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ABSTRACT

The paper reports an exploratory study of the professional identity of 'engineer' and addresses the question as to whether there is a common identity that represents the individual's sense of self in a way that gives meaning to the concept of 'being an engineer'. The empirical study based on UK engineers and was carried out in three stages: qualitative approaches (Study One); quantitative stage (Study Two); confirmatory factor analysis and post-hoc analysis (Study Three).

We argue that, the way in which knowledge is used by the individual to place themselves within their environment involves the identification with a professional group. This leads directly to the issue of knowledge ownership and to the process by which such knowledge is evaluated.

Keywords: Values, Perception, Managerial thinking and cognition, Socialisation

In this paper we report an exploratory study of the professional identity of the occupation of engineer. The question which guided the research was; is there a common identity that represents the individual's sense of self in a way that gives meaning to the concept of 'being an engineer'? We argue that issues of competence and image are conceptually linked to the notion of identity and as such can be reflected in the individual's self perception of their own competence and occupational identity. Our focus is on the individual within a knowledge-based professional group. This group orientation leads to the two founding assumptions of the study which are, firstly, that the individual will have an occupational identity that resides within their cognitive structure and which is meaningful to the self. And, secondly that that structure is shared by those within their group.

We argue that in the case of professional expertise, there is a platform that is wider and deeper than the social setting of a role. This platform is the body of knowledge on which claims to expertise is founded. Expert knowledge enables professional performance in different tasks, situations and roles, consequently the individual's self-evaluation of that enabling knowledge is so central to their functioning that it is 'part of me' and therefore becomes part of the process of the formation of self-identity. However, as the setting is the professional group, the study has to address the issue of dual ownership of professional knowledge. The issue is that the locus of knowledge is both the professional group and the individual with the possibility of tension between them affecting the structure of identity. Applied knowledge would appear to be a potential arena for such tension to occur.

The empirical study is based on UK engineers and has the aim of identifying the cognitive structure of engineering identity. The study was designed in three stages beginning with qualitative approaches (Study One) to explore what elements might be involved in the construction of professional identity. This work was developed into a second quantitative stage (Study Two) in which, an instrument was designed to measure the occupational identity of engineers and its factor structure was explored. In the third stage of the study confirmatory factor analysis and post-hoc analysis (Study Three) are used to verify the structure.

The rationale for using engineers as the subject of the study was that this group possess high levels of human capital, diversity within the generic nomenclature of 'engineer', and have knowledge which is both academic and practical. This occupational group work at diverse tasks in differentiated

organisations and have a segmented professional group structure, hence, differential knowledge structures. These conditions would, we believe, test the notion of a shared engineering identity.

THEORETICAL DEVELOPMENT

Identity is essentially about self-definition; how one defines oneself and hopes to be defined by others (Gecas 1982). From a social psychological perspective the theoretical foundation of identity construction and function lies in identity theory (Burke 1980; Burke & Reitzes 1981; Burke & Tully 1977; Stryker 1980; 1987) with its connotations of self-categorisation theory (Turner 1982; 1985;1987) and social identity theory (Tajfel 1978) with its concept of group affiliations. It is this latter theory which provides the theoretical context for relating knowledge to professional groups.

Group Affiliation

Social Identity Theory argues that people seek part of their self identity through affiliation to groups. The behavioural implication is that 'we favour our own group'. Knowledge, although held individually, has group connotations because it is developed and shared through association with others. If knowledge can be held by both the individual and the group who share the same identity, then, who owns the knowledge? However, subsuming identity within a group is unlikely to be total and the individual self remains active. The process by which the individual places and locates themselves is one of self-categorisation. Being an individual is one such category of self categorisation (Turner 1985; 1987; Turner, Hogg, Oakes, Reicher & Wetherell 1987). Self-categorisation guides individual behaviour. Haslam (2004) suggests that self-categorisation as personal categorisation would affect commitment to group participation. This represents the essential dichotomy of identity that it can be both personal (individualistic) and social (group orientated), hence regulates behaviour. We argue that the ownership of knowledge is embroiled in this process.

Knowledge, Self Categorisation and Social Identity

If we argue that knowledge is central to identity then we are saying that it is salient to self identity and consequently to the broader concept of self**.** This leads directly to the question of the place of knowledge within the concept of self-identity; however, given that the concept of self is derived from a process of self-categorisation, the important relationship is between knowledge and the self categorisation process. The self-categorisation process uses substantive matter, including own

knowledge, to guide the self into a set of categories (Turner, 1982, 1985). Following the argument of Tajfel (1969, 1978) that categories are evaluated entities, the way an individual categorises their knowledge resolves, into an evaluated set of categories. As the knowledge of concern to the study is expert knowledge derived from an area of academic study and professional development, we assume that such expert knowledge is highly valued knowledge and that therefore it is influential to the development of self identity? We argue that for knowledge to be part of an identity process it needs to be valued. Bernstein, (2000) suggests that knowledge that is in some way salient to identity is inner directed and associated with a form of belief. For him, knowledge was an outer expression of an inner relationship between knowledge and the self. He used the case of self ownership of knowledge through knowledge creation to make this argument. This makes the important point that it is the valuation of knowledge that connects it to the self.

The Dual Ownership of Expert Knowledge

Professional knowledge exists within the concept of group in the form of professional associations. The principal issue is that of ownership because the individual's knowledge was developed and shared through association with others. Here, we argue that ownership of expert knowledge may, within the individual, be contested terrain between 'my knowledge' and 'my group' in the sense of belonging to the professional group in which the knowledge was learnt and from which a certain prestige is reflected on to the individual. Furby (1991) and Pierce, Kostova, and Dirks (2003) offer the thesis that there is a 'psychology of mine' that attaches itself to objects. We argue that the relationship between knowledge and identity has two pathways. The first, from the perspective of the personal ownership of knowledge, contends that self-owned knowledge is a moderating factor in transforming professional behaviour into professional identity. This transformation is through the knowledge producing conduct, which, is demonstrably competent. This is knowledge 'in action' which automatically connects to group affiliation because the expectation of competence from end-users resides in the professional image of the group. The second pathway is from the perspective of group ownership of knowledge, in this relationship professional identity is built through the ethnocentric properties of group attachment. In this scenario identity is constructed using knowledge as a valued attribute of a group to which the individual favours (Tajfel, 1978). The implication of this is that a set of professionals may use

knowledge as a salient attribute of their group attachment which creates the possibility of the group having common elements within their cognitive structure.

Common group affiliation implies a degree of commonality in the cognitive structure of members because of the social identity process. However, cognitive categorises can have individual meaning (Deaux, 2000) with the implication that individual and social identities have to coexist**.** How are they related as a process? Worchel, Iuzzini, Countant, and Manuela (2000) support the argument that self-categorisation and social identity theory co-exist simultaneously allowing the personal and social identities to be seen as a continuum. However, they argue against the notion that behaviour is determined by a single point on that continuum. Instead, they argue that behaviour can be determined by several identity concerns acting simultaneously and that self-identity and social identity alternate in terms of their salience according to situations. This suggests some conscious interpretation that allows for the locus of influence between forms of identity to be resolved. This notion grants to 'a situation' two particular functions; that is, to activate the consciousness of identity and to arbitrate the relative primacy of individualism or group affiliation. It is the meeting between expert knowledge and situation that has knowledge embedded within it, which raises the issue of the 'activated identity'.

We argue that the individual becomes aware of their identity when confronted with a situation; a problem to solve, a decision to make. The situation activates the identity by bringing to the surface the relevance of the individual's knowledge to that situation. We argue that this activation, forces the individual to legitimise their knowledge boundaries, and thus brings a reassertion of personal competence. The fact that situational competence has to be deduced from a wider set of knowledge makes the corpus of knowledge, not just a background context, but an immediate player.

Practical Knowledge

The practical nature of engineering knowledge affects the way it is internalised. Following the line of Dewey (1986) that knowledge is context specific, practical knowledge can be seen both as the 'understanding' that emerges from direct engagement with the environment (Kondrat 1992) and from the applied prior knowledge based on theoretical and scientific knowledge. Through action the individual validates their existing beliefs and, as information is transformed into knowledge, simultaneously gains explanations that might constitute new knowledge (Morton 2003). This notion of

knowledge being validated by its own instrumental effectiveness grants primacy to the atomised individual as the agent of knowledge (Tourinho & Neno 2003). Polanyi's (1964, 1975) notion of all knowledge being 'personal knowledge', and Orlikowski's (2002) distinction between knowledge and knowing, emphasise the intrinsic nature of knowledge derived from outside external sources. We suggest that the notions of practice and effectiveness brings forms of knowledge together and enhances awareness and appreciation of the value of existing knowledge and this we see as a tentative connection with the idea of the expert or professional.

METHODOLOGY

The objectives of the research were to: (a) test whether there is a common shared identity to being an engineer; (b) test a nominated cognitive structure of engineering identity.

Study One: Inductive Phase Using Qualitative Approaches

The research began with a four-stage qualitative approach (interviews, pilot questionnaires, focus group and Q sort) which carried the broad aims of eliciting the nature and stability of engineering identities and developing an initial structure of identity. In the first stage semi-structured interviews were held with engineers working in industry at a senior level (N = 15) with the express intention of seeing how they defined themselves in work relationships. The interviews drew out the commercial and manipulative aspects of identity. A commercial engineer providing technical solutions commented 'I introduce myself as business consultant. I have two hats and I use it to gain a good first impression.' Here the engineering identity is placed second for commercial reasons. These interviews showed that engineering identity was moderated by the role which their knowledge was being used for; as advice or as a resource. The interviews also led us to believe that an instrumental orientation and a commercial attitude might be elements of engineering identity. Content analysis of these initial interviews suggested there were issues around whether membership of professional bodies conferred legitimacy, the importance of being useful, that engineering knowledge was essentially practical knowledge that has its utility and that it was a demanding profession. Five possible elements of identity structure emerged from this analysis. These were tentatively nominated as; work centrality, group affiliation, salience of knowledge, utility and instrumentalism. Around this structure a pilot questionnaire was constructed. In this pilot 40 questions were used to represent these structural

elements. This procedure was applied to a sample of postgraduate engineering students (N = 40) and the results confirmed the existence of the concepts with the exception of instrumentalism. In the third stage the results of the pilot were presented to a focus group of senior academic engineers (N = 10).

As a tactic to elicit discussion on the role of knowledge in identity the group were asked to concentrate on the issues surrounding knowledge transfer at the individual level. This discussion brought out the importance of trust, the insecurity of knowledge and the individual versus group conflicts that attend project work. Interestingly, with research academics, the aspects of trust and conflict were related to issues of ownership of knowledge. The focus group reduced the possible component structure of identity to four. At this juncture in the qualitative inquiry, the same group of academics (N = 10) were asked to perform a Q-sort in order to establish construct content validity. For each of the four concepts valid items from the pilot, plus additional statements generated by the researchers, were entered into a concept validation exercise using Q sort technique. In this exercise 64 item statements were combined with four descriptors of the possible factor structure concepts and were put into a free sort Q technique (Kerlinger 1986; McKeown & Thomas 1988; Thomas & Baas 1992). The group were asked to conjoin item statements with concept definitions with the option to reject both outright. This process created an initial nominated component structure for engineers' professional identity which would be handed to the next stage of the study. The factors were, work centrality, the salience of knowledge, utility and group affiliation. Each concept definition had to receive at least four valid statements. In this context the validity criteria were that an item statement must be placed with the same definition at the rate of 70 percent. This exercise resulted in 35 items giving each nominal component receiving between five and eight representative statements.

Study Two: Deductive Phase

The design of the instrument. The 35 items from Study One were placed in a seven point scale using a polar dimension. For each of the 35 items subjects were asked to respond to in a very personal way using 'this is very true of me' and 'this is not at all true of me' (Lerner & Keltner 2000). Rationale for using this approach is founded on the individual perspective of the study and the need to invite very personal responses. It is important to restate that the research instrument was not concerned with questions related to what the individual engineer actually did, or, for whom they worked.

Sampling structure. With the cooperation of six major professional associations within the UK an on-line survey of 2200 engineers was conducted. The survey produced 1050 responses from professional engineers working in the UK. Within the overall sample were engineers working in education (N = 338) and in industry (N = 680). Research activity (which could include commercial product development as well as academic research) was distributed as; engaged in research (N = 602); not engaged in research (N = 408). The sample was inclusive of the following engineering specialisations: chemical (N = 127), civil (N = 93), computer (N = 54), electronic (N = 166), mechanical (N = 103), process (N = 33), scientific (N = 78) and structural engineers (N = 349).

Finding of study two. Working from a sample of 1050 engineers the approach to the analysis was to split the sample into two sub-samples; Sample 1 (N = 500) for conducting exploratory factor analysis (EFA) and the remainder as a hold out sample (N = 550), for the purposes of random selection of two further sub-samples in order to conduct confirmatory factor analysis (CFA) (for a discussion of this approach see: Hodgkinson & Sadler-Smith 2003). The exploratory factor analysis was conducted using Principal Components Analysis (PCA) using the Varimax procedure (see below for justification of orthogonal rotation). The analysis was computed at the individual level of analysis in accordance with traditional approaches to item analysis and scale development. Items were examined for skewness, kurtosis, and inter-correlations at this level prior to running the exploratory factor analysis (Anderson & West 1996) The Kaiser-Meyer-Olkin(KMO) measure of sampling adequacy was 0.843**,** and the Bartlett test of sphericity was significant at p<0.001, indicating the suitability of this data for factor analytic procedures. We adopted the scree plot as a means of interpretation of the extracted principal components (referred to henceforth as factors). The scree test indicated that a five factor solution was appropriate (Cattell 1966; Kline 1991).

Table 1 displays the matrix of factor loadings. The adopted convention for item elimination was that the loadings must exceed 0.4 as a strict criterion when compared with guidelines for identifying significant factor loadings based on sample size (see Hair, Anderson, Tatham & Black, 1998: 112). Hence, the 24 items comprised the final solution.

[Insert Table 1 here]

The factor structure was comparatively clear with few cross-loadings, namely: 'I always describe myself to others in terms of my work' (Item 18); 'I am the sort of person who likes to visualise my work being used' (Item 3*).* A total of 18 items load at over 0.50 or above on the five extracted factors. The factors were labelled as follows; group affiliation (F1), individual competence (F2), work centrality (F3), utility (F4) and distinctiveness (F5).

The original four nominated factors (see Study One) have become five in Study Two necessitating some degree of re-interpretation and re-appraisal. This was guided by three criteria; the degree of conformity to the nominal descriptions; degree of coherence of the items that loaded onto a factor making a plausible interpretation possible; degree to which the factor components told a logically and theoretically coherent story. Although work centrality (F3) is the clearest factor meeting the requirements of the first two criteria it is the configuration of the remaining factors that tells an interesting story. Table 2 shows the items which loaded on to the five factors. The right hand column shows where they were nominally placed by the Q-sort test.

[Insert Table 2 here]

In respect of group affiliation the most notable feature is that it contains the one item that most directly expresses the assumption of the study (Item19). This and two other items concerning knowledge have been drawn into group affiliation based on what we interpret as cooperativeness (Item 8) the rejection of the singleton (Item 20). Here knowledge security is seen firmly as part of group affiliation; the professional body as keeper of the knowledge (Item 10, and Item 13). However, Factor 2, individual competence is a new factor formed from salience of knowledge items that were not drawn towards group affiliation have come together in an individual guise based on personal competence (Item 2, Item 32, and Item 3). What gives this factor its appellation is the emphasis on 'my work' on personal responsibility to communicate.

The most straightforward transition was work centrality represented by four items (Item 1, Item 7, Item 11, and Item 18). By contrast, Factor 4 (utility) was difficult to interpret because the subjects appear to have reinterpreted the notion of utility as a rejection of pure theory (Item 4, and Item 5) and the preference for a useful output. Factor 5 (distinctiveness) represents a clear contrast to Factor 1 (group affiliation). Despite the presence in the structure of a desire to belong to a group, this factor we

interpreted as an awareness that their knowledge makes them both distinctive in the sense of being special (Item 27) and in the sense of being isolated (Item 28 and Item 33).

Salience of knowledge did not emerge as a distinct factor. However, crucially, this concept was not lost altogether but are 'dispersed' into new factors. Salience of knowledge when interpreted as knowledge security, becomes part of group affiliation but when interpreted as competence takes on an individuality. We see the resulting structure as conceptually clear and moreover providing additional insights by revealing the 'tensions' that sit beneath the concept of identity that were suggested in the theoretical discussion. Accepting the interpretation of group affiliation, the way distinctiveness has emerged is as an expression of a contrary direction; wanting to belong but also to be special. Similarly, the way knowledge salience has fragmented into professional competence underlines the tension between group and individual knowledge ownership. Table 3 shows the reliabilities (Cronbach alpha) for each of the five factors together with means standard deviations, inter-correlations (Pearson Product Moment) for the five factors expressed as composite scales.

[Insert Table 3 here]

The factor reliabilities are over for F1 (group affiliation) and F3 (work centrality) are over 0.7 whilst F2 (individual competence), F4 (utility) and F5 (distinctiveness) are over 0.6 which is an acceptable level of reliability for an exploratory study of this nature (Robinson, 1991). All but one of the scales are positively inter-correlated ($p<0.01$). Scale correlations range between 0.16 (utility with distinctiveness; work centrality with distinctiveness) and 0.44 (group affiliation with utility).

The exploratory factor analysis produced a clear five factor solution describing the cognitive identity structure of engineers. The structure displayed characteristics which align well with the theoretical notions of group affiliation contrasted with distinctiveness and competence and practicality. In the third stage of the study we set out to test the factor structure revealed by exploratory analysis by examine the degree of fit between a model consisting of a five factor solution and the data.

Study Three: Confirmatory Factor Analysis (CFA)

The results of the EFA were submitted to confirmatory factor analysis using structural equation modelling on three random samples of $N = 183$ drawn from the $N = 550$ hold-out sample which was not used in the EFA. Parameter estimates were calculated in turn for each of the three sample models

using the AMOS program. Table 4 shows CFA results and reports absolute and relative indices of fit to comprehensively evaluate the fit of the different models computed.

[Insert Table 4 here]

The change in chi-square illustrates the incremental improvement achieved by each successive model (Bentler & Bonnett, 1980; Bollen, 1989). The ratio of chi-square to degrees of freedom (χ^2/df) is also given, with ratios of less than 2.0 indicating a good fit. However, since absolute indices can be adversely affected by sample size (Byrne 1989; Loehlin 1992), three relative indices were computed and provide a more robust evaluation of model fit (e.g. Tucker & Lewis 1973; Byrne 1989). These three indices, as shown in Table 4, are the Tucker-Lewis Index (TLI) (Tucker & Lewis 1973), the Comparative Fit Index (CFI) (Bentler 1990), and the Normed Fit Index (NFI) (Bentler & Bonnet 1980). For the TLI, CFI and NFI, coefficients close to unity indicate a good fit, with acceptable levels of fit being above 0.90 (Marsh, Balla & MacDonald 1988). Furthermore, Root Mean Square Error of Approximation (RMSEA) is calculated by taking an estimate of the population discrepancy and dividing it by the degrees of freedom and taking the square root of the resulting ratio (Hodgkinson & Sadler-Smith 2003). Values ranging from .05 to .08 are deemed acceptable (Hair et al., 1998). In all cases, the relative fit indices for Sample 2 are marginally better than for Samples 2 and 3. Sample 2 data show a better fit to the data. The TLI suggests that this model accounts for 75 per cent of the variance (TLI = 0.75; χ^2/df = 1.80). TLIs of the three sample models shown ranging between 0.67 and 0.75, indicate higher levels of variance are accounted for by Sample 2 Model. Further, the χ^2 to degrees of freedom ratios are all below 2.0 suggesting acceptable fit across all three samples. The CFIs and the IFIs imply that between 79 and 80 percent of the variance is accounted for by this model. In all cases, the RMSEA vary from .06 to .07 is clearly within the acceptable range for concluding that all three samples adequately represents the data.

In summary, on the basis of the findings reported in Table 4 is that the fit of the five factor solution across all three sub-samples, in our view, it is acceptable and supports the five factor model.

Post-hoc analysis. The final stage of the analysis was to test the five factor model further by examining any sub group differences that the instrument was able to discern. The subgroups which were used for comparison were type of engineer (chemical, civil, structural,

electrical, process, computing, mechanical and scientist), level of research activity (pure research, applied research, product development and no research), age (20-30 years, 31-40 years, 41-50 years, 51+ years) and educational background (bachelor degree, master degree, PhD, and postdoctoral). Each sub-group comparison was tested using one way analysis of variance (ANOVA) and post hoc differences were examined using the Schéffe test. Table 5 shows the means and SDs and it highlights statistically significant differences for each of the factors by subgroup.

[Insert Table 5 here]

Five sub-group differences are worth highlighting. As expected there was variation in group affiliation by age; the younger group differed from both senior categories. No significant difference on individual competence expect by applied versus no research. This implies that doing research is essentially a very different level of competence from other forms of engineering. There is a suggestion in the data that work centrality is influenced by research activity which could possibly be interpreted as in terms of dedication particularly as pure research activity separates out from the others. If distinctiveness is interpreted as a propensity to stand out from a group then age seems to be the strongest influence. This mirrors the influence on group affiliation. In the case of utility, it could be suggested that the variation by type of engineer, by research activity and by age represents different interpretations of what being practical and doing something useful actually mean. This returns the debate back towards the valuation of knowledge.

Initial ideas derived from qualitative approaches were turned into a research instrument which has been validated by the findings. The results highlight the tensions between group affiliation and being a distinct individual as well as reaffirming the central position of professional competence in being a professional. It is the way knowledge is valued within identity that matters. Consequently there are issues to be debated as to the various functions which knowledge plays in identity.

DISCUSSION

The study establishes the idea of a professional identity founded on knowledge, but which is independent of situations, roles and organisations. However, the actual meanings and functions of knowledge within identity where found to be more complex that originally envisaged. The original supposition placed knowledge, as a singular concept, but this did not prove to be the case. A more

interesting picture emerged in which professional knowledge attached itself to other parts of the cognitive structure. One plausible explanation is that to the engineer, their knowledge is secular and does not involve inner valuation and personal belief beyond the pragmatic belief that 'I know it will work' (Tourinho & Neno 2003). In other words, knowledge in everyday use is not directly connected to the self. If this explanation is valid it makes it harder to argue that what connects professional conduct to group membership is identity. Consequently, it is possible to argue that task performance derived from professional knowledge can be detached from any form of sentiment about training and group affiliation. If professional knowledge is not internalised by any meaning to the individual, they will not identify themselves with such professional knowledge; such secular knowledge does not involve inner valuation and belief. However, this pragmatic stance is itself hard to sustain in the light of the individual's need to generalise their knowledge into forms that are portable across situations, to benefit from the fact that knowledge is continuously growing and to recognise their own knowledge limitations. The complexity of the relationship between knowledge and identity centres on how knowledge is valued and the tension between being an individual and affiliating to a group.

This complexity raises a question about the relationship of cognitive structure to knowledge formation processes rooted in tasks, roles and organisations. The fact that three of the dimensions of the structure, work centrality, competence and practicality, are drawn towards task orientation suggest that these may form the link between forms of identity adaptation and construction at the level of the specific role and the 'brought in' cognitive structure of identity. It is also plausible to suggest that the cognitive structure and role identity are conjoined by the social recognition of individual competence. At the centre of the questions which the research raises is the range of meanings and functions which are attached to the self-evaluation of knowledge. One possible conclusion is that questions, such as, how identity relates to knowledge transfer and how professional conduct related to professional image all involve the self-evaluation of knowledge.

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TABLE 1
Results of Exploratory Factor Analysis (Varimax Rotation)

	F1 Group affiliation	F2 Individual competence	F3 Work centrality	4 Utility	F5 Distinctiveness
I believe questions today are too big for individuals: cooperative effort is the only way forward (8)	**0.40**	0.07	0.07	0.25	0.23
I really think that to get professional recognition you need to achieve something useful (9)	**0.53**	0.14	0.00	0.26	-0.11
I feel my level of knowledge gives me a sense of security (10)	**0.41**	0.33	-0.08	0.26	-0.02
I believe knowledge has to be protected and sustained by professional authority (13)	**0.44**	0.12	-0.03	0.13	0.17
I am the sort of person who believes that intellectual achievement and career success go hand in hand (14)	**0.65**	0.04	0.08	0.09	-0.01
I always describe myself to others in terms of my work (18)	**0.44**	-0.05	**0.53**	0.12	0.10
As a professional, I believe my knowledge represents who I am (19)	**0.49**	0.12	0.33	0.17	0.16
I believe there is no room for the Lone Ranger (20)	**0.47**	-0.07	-0.03	0.22	0.19
I am the sort of person who gets a sense of belonging through association with other professionals (24)	**0.62**	0.22	0.19	-0.02	0.05
If I join an association I will want to play an active part in keeping it Professional (25)	**0.54**	0.32	0.29	-0.03	0.06
I am the sort of person who when I do not know something I do not let go until I do (2)	-0.06	**0.53**	0.36	0.25	0.12
I am the sort of person who likes to visualise my work being used (3)	0.13	**0.47**	0.18	**0.46**	-0.12
I am the sort of person who believes not everyone who calls themselves a professional is actually professional (1	-0.03	**0.40**	0.05	0.23	-0.01
I am the sort of person who thinks a lot about how to explain my work to those who might use it (23)	0.28	**0.53**	0.12	0.01	-0.13
I am the sort of person who believes that competency is only a starting point (29)	-0.11	**0.60**	-0.02	0.01	0.15
I am the sort of person who believes I have a responsibility to inform the general public about my work (31)	0.24	**0.42**	0.16	-0.14	0.05
I believe that progress is as much a function of organisation as it is of innovation (32)	0.14	**0.51**	0.01	0.05	0.04
I am the sort of person who thinks about work wherever I am (7)	0.10	0.14	**0.79**	0.08	0.08
I am the sort of person who takes work home with them (11)	-0.05	0.10	**0.78**	-0.08	-0.01
I am the sort of person who puts work before everything (1)	0.12	0.16	**0.72**	0.11	0.11
I do not like to start the job unless I can see the practical application (4)	0.21	0.15	-0.01	**0.66**	0.02
I am the sort of person who believes that theory is pointless without practical application (5)	0.09	-0.12	0.03	**0.75**	0.01
I believe there is no point in doing research unless there is an output (15)	0.27	-0.15	0.14	**0.54**	0.00
I need to feel that I can trust people I professionally associate with (16)	0.26	0.21	0.00	**0.41**	0.06
I take on researchers only with the recommendation of people I know (35)	-0.06	0.10	-0.01	**0.43**	0.37
I am the sort of person who when confronted with a mundane task, has the discipline to do it professionally (6)	0.13	0.24	0.21	0.02	-0.11
I am the sort of person who likes to think it is easy to dismiss prestige but have to admit that it matters (17)	0.33	0.10	0.11	0.31	0.09
I am the sort of person who feels uncertain about the effect of commercialism on academic standards (21)	0.30	0.15	0.02	0.07	0.35
I am the sort of person who believes that conflict between people with the same values is productive (22)	0.23	0.39	0.03	-0.11	0.00
I am the sort of person who has to feel on top of my job otherwise I have self-doubt (26)	0.24	0.35	0.26	0.13	0.21
I am the sort of person who feels uncomfortable working in an interdisciplinary environment (27)	0.09	-0.08	0.05	0.12	**0.66**
For me it is awkward when non-scientific people ask me about my work (28)	0.10	-0.04	-0.01	-0.09	**0.72**
I feel my professional knowledge makes me isolated (33)	0.03	0.06	0.12	-0.02	**0.63**
It is important to me to be an acknowledged expert (30)	0.33	0.38	0.17	-0.05	0.27
I believe the worst thing is to fall behind (34)	0.19	0.25	0.12	0.23	0.34
Variance	9..83%	8.04%	7.65%	7.26%	6.12%
Total variance accounted for					38.9%

Note: figures in parentheses indicate order on the questionnaire form (see also Table 2). Factor loadings greater than 0.39 are in bold

TABLE 2
Q-Sort

Factors and items	Nominated Factors
Group affiliation	
I am the sort of person who believes that intellectual achievement and career success go hand in hand (14)	Work centrality
I believe there is no room for the lone ranger (20)	Group affiliation
I am the sort of person who gets a sense of belonging through association with other professionals (24)	Group affiliation
If I join an association I will want to play an active part in keeping it professional (25)	Group affiliation
I really think that to get professional recognition you need to achieve something useful (9)	Utility
As a professional I believe my knowledge represents who I am (19)	Salience of knowledge
I feel my level of knowledge gives me a sense of security (10)	Salience of knowledge
I believe questions today are too big for individuals: cooperative effort is the only way forward (8)	Group affiliation
Individual competence	
I am the sort of person who believes that competence is only a starting point (29)	Salience of knowledge
I am the sort of person who when they do not know something I do not let it go until I do (2)	Salience of knowledge
I am the sort of person who thinks a lot about how to explain my work to those who might use it (23)	Utility
I believe progress is as much a function of organization as it is of innovation (32)	Salience of knowledge
I am the sort of person who likes to visualise my work being used (3)	Salience of knowledge
I am the sort of person who believes I have a responsibility to inform the general public about my work (31)	Utility
I am the sort of person who believes that not everyone who calls themselves a professional is actually professional (12)	Group affiliation
Work centrality	
I am the sort of person who puts work before everything (1)	Work centrality
I am the sort of person who thinks about work wherever I am (7)	Work centrality
I am the sort of person who takes work home with them (11)	Work centrality
I always describe myself to others in terms of my work (18)	Work centrality
Utility	
I am the sort of person who believes that theory is pointless without practical application (5)	Utility
I do not like to start a job unless I can see the practical application (4)	Utility
I believe there is no point in doing research unless there is an output (15)	Utility
I take on researchers only with the recommendation of people I know (35)	Utility
I need to feel I can trust people I professionally associate with (16)	Group affiliation
Distinctiveness	
For me it is awkward when non scientific people ask me about my work (28)	Salience of knowledge
I am the sort of person who feels uncomfortable working in a multi-disciplinary environment (27)	Group affiliation
I feel my professional knowledge makes me isolated (33)	Salience of knowledge

TABLE 3
Reliabilities (Cronbach α) , Scale Means, Standard Deviations and Intercorrelations

	F1	F2	F3	F4	F5	Mean	SD
Factor1 Group affiliation	**0.75**	0.43**	0.37**	0.44**	0.21**	3.52	0.92
Factor2 Individual competence		**0.63**	0.36**	0.25**	0.07	2.79	0.73
Factor3 Work centrality			**0.74**	0.17**	0.16**	3.52	1.25
Factor4 Utility				**0.63**	0.16**	3.49	1.03
Factor5 Distinctiveness					**0.60**	5.71	1.13

**correlation is significant at the 0.01 level, and ranges from 0.16-0.44

TABLE 4
Results of Confirmatory Factor Analysis

	Absolute fit index				Relative fit indices		
Sample	χ^2	df	χ^2/df	RMSEA	TLI	CFI	IFI
1 (*N*=183)	603	338	1.79	0.07	0.67	0.72	0.74
2 (*N*=183)	607	338	1.80	0.07	0.75	0.79	0.80
3 (*N*=183)	555	338	1.64	0.06	0.69	0.74	0.76

TABLE 5

Sub-group Comparisons

Sub-group	Category	Group affiliation		Individual competence		Work centrality		Utility		Distinctiveness	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Type of Engineer	Chemical engineer	4.06	1.04	2.86	0.60	2.23[bc]	0.75	2.45[d]	0.64	2.49	0.49
	Civil engineer	4.20	1.02	2.78	0.66	1.97	0.66	2.58[e]	0.71	2.44	0.46
	Structural engineer	4.17	0.93	2.79	0.63	2.01	0.68	2.27[e f g h i]	0.63	2.50[j]	0.44
	Electrical engineer	3.93[a]	1.05	2.70	0.75	1.91[b]	0.72	2.60[f i]	0.74	2.41	0.48
	Process engineer	4.14	0.96	2.72	0.66	2.18	0.66	2.50	0.68	2.51	0.49
	Computing engineer	4.01	1.14	2.70	0.69	2.02	0.76	2.63	0.66	2.23[j k]	0.55
	Mechanical engineer	4.11	1.11	2.64	0.69	1.86[c]	0.64	2.64[g]	0.73	2.52[k]	0.42
	Scientist	4.53[a]	1.08	2.88	0.65	1.91	0.66	2.89[d h]	0.78	2.43	0.43
Research/Non-research	Pure research	4.19	1.22	2.70	0.78	1.68[m n o]	0.56	2.85[q r]	0.86	2.38	0.54
	Applied research	4.11	1.01	2.67[l]	0.64	1.94[m p]	0.70	2.55[q s]	0.71	2.47	0.46
	Product development (research)	4.23	1.07	2.87	0.68	2.13[n]	0.79	2.62[t]	0.67	2.52	0.45
	No research	4.13	0.97	2.85[t]	0.65	2.1[o p]	0.66	2.32[r s t]	0.63	2.47	0.45
Age	20-30 years	3.85[u v]	1.11	2.63	0.85	2.18	0.80	2.63	0.74	2.27[w x]	0.58
	31-40 years	4.05	1.07	2.79	0.66	2.03	0.72	2.41	0.71	2.43	0.51
	41-50 years	4.24[u]	1.01	2.81	0.65	1.99	0.70	2.50	0.73	2.49[w]	0.43
	51+ years	4.23[v]	1.01	2.77	0.72	1.95	0.67	2.55	0.63	2.53[x]	0.42
Education background	Bachelor degree	4.17	1.01	2.82	0.66	2.13[i ii]	0.71	2.35[iv v]	0.66	2.49	0.47
	Master/equivalent degree	4.05	0.98	2.74	0.65	2.03[iii]	0.70	2.46[vi]	0.66	2.46	0.48
	PhD	4.30	1.09	2.80	0.75	1.86[i]	0.66	2.75[iv vi]	0.77	2.44	0.46
	Post-doctoral	3.98	1.12	2.64	0.78	1.75[ii iii]	0.68	2.64[v]	0.79	2.43	0.46

Notes: superscripts a-k refer to statistically significant differences (Scheffé test) for 'type'; superscripts l-t refer to statistically significant differences for 'research';superscripts u-x refer to statistically significant differences for 'age'; superscripts i-vi refer to statistically significant differences for 'education'.