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Research paper

An insight into the Professional Culture of Indian Engineering Students: to Face Challenges of Industry 4.0

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Abstract

To leverage the best that technology has to offer us, India must embrace Industry 4.0. Implementing Smart manufacturing will usher in a new phase of industrialisation in India. However one of the major problems that India will face is lack of skilled labour. To manage this short coming higher education department should make changes to the engineering education scenario. While making changes they should keep in mind their occupational culture. For this a thorough understanding of the professional culture is of primary importance. This article examines the occupational culture of the Indian engineering students by studying their communicative performances. Students have been interviewed. Bantz's Organizational Communication Culture (OCC) methodology has been used to analyze the messages to find traces of this culture. The findings derived from a study adopting such method can have important implications for practitioners as it will help them provide the Indian engineering students proper guidance and make them ready to meet the challenges of industry 4.0.The various characteristics of this culture that these students possess if harnessed properly by upgraded educational system can help India leverage the best of Industry 4.0.

Keywords: *Communication Performance Perspective; Industry 4.0, Organizational Communication Culture (OCC) Method; Communication Performance Perspective*

1. Introduction

The industrial revolution of the 18th and the 19th century ushered in a new world by giving rise to factories. Industrialisation started when the manual work done by the people in ancient times was replaced with machines or their work was mechanised. Gradually electricity was introduced, then there was the beginning of mass production and then came the third industrial revolution with the advent of computers and the beginning of automation. Now we are about to enter into a new era ,a new world of Industry 4.0, where computers and automation will in tandem, with robot connected remotely to computer systems can control the manufacturing with minimum human support. In this phase the machines talk to other machines and products. Information is processed and distributed very fast thereby bringing about significant changes to the entire industrial ecosystem.

Engineers have played significant roles in bringing about industrial revolution through the ages. At present, engineering ecosystem is again heading towards a phenomenal change with rapid advancements in technology. In other words we are heading towards the fourth industrial revolution or Industry 4.0 being greatly discussed at different levels. The role of Engineers in bringing about this pivotal change is significant. In this scenario, Indian engineering sector is also eager at adopting the sophistication of technology. At such times there is a dire need to be at par with it and implement the techniques in every sector. Industrial sectors are looking towards using latest technology, so that they can be key contributors to attain this objective. In this endeavour they are planning to set a framework towards introducing 'Industry 4.0'. Indian Engineering sectors need to gear themselves towards the use of latest technology thereby creating smart factories. In smart factories, complex works, information exchange and instructions are done by computers involving minimum human involvement. Knowledge and timely adoption of upcoming trends is the key for success in this ever changing world of technology. Karl Marx in his book 'The Communist Manifesto' beautifully said that human beings were at the mercy of machines in the 19th century; this can be held true at the present times too.

1.2 Challenges for India

However there are certain factors that act as a huddle in India's way of making the most out of Industry 4.0, one being the Indian engineering education scenario. While Indian engineering sector is greatly enthusiastic about adopting the new industrial revolution educationists need to invest heavily in the country's engineering educational system. It is only then that the fourth industrial revolution would bring about a meaningful change in the Indian engineering scenario. According to consulting firm KPMG, India has a shortage of skilled engineers. In South Korea the percentage of skilled work force is 96 per cent, while in India, it is a meagre 4.7 per cent. China's skilled workforce is 24 per cent of its population, which is six times more than that of India. Hence the biggest challenge before India is lack of a skilled workforce. So it evident that the number of trained engineers that can understand the sophistication of technology is mediocre compared to some other developing and developed countries. Under such scenario it is important to analyze whether India can reap the benefits of the new industrial revolution. Its developed counterparts in South Korea, Singa-

pore, and Japan already have a good number of skilled engineers that would help them to realise the full potential of the fourth industrial revolution. In fact China has also made a name for itself on the world forum. Latest data shows that India is way behind the three developed nations and its neighbour in terms of industrial automation.

To leverage the finest of the technology, India must gear itself towards Industry 4.0. Using the cutting edge technology, will give a new lease of life to industrialisation in India. Apart from policy implementation hurdles, one major bottleneck that India will face is lack of skilled engineers. A smart strategy to counter this is to up skill engineers in these fields.

The overall development of the nation can be achieved with a good engineering education system. So the system of engineering education needs major reforms. A critical examination of the engineering education sector in India is required to face the challenges of industry 4.0. The significant changes implemented will play a key role in India's future as it can help produce some of the best engineers. India requires skilled engineers who can help propel our economy forward.

India's ranks third globally in higher education system, coming behind China and the United States. After Independence, there has been an enormous rise in Technical Education in our country providing training in many disciplines at certificate, diploma, degree, postgraduate degree and doctoral levels in institutions throughout India. However it is a sordid state that the higher education in India is does not match with the global Quality standards. A report by NASSCOM states that only 26% graduates are employable others need rigorous training.

1.3 Challenges in Teaching and Learning Process

Effective instructional materials as well as innovative teaching techniques are required for a good engineering education. This requires a change in the traditional method of teaching. Pedagogical challenges exist in both teaching and learning. Often student learning is not as good as expected, rendering it difficult to ensure all students master the material presented. Sometimes, the students need varied approaches tailored to their type of learning. So India needs a robust engineering education system. The increase in industrial output is directly related to Education levels in a country which helps in raising the GDP of a country.

Some of the best students get an opportunity to study in India's renowned Institutes of Technology. However these comprises to only 1 percent. Rest 99 percent of technical education students in India also need quality to be able to perform. India needs to make significant changes in its technical and engineering education sector to generate the pool of highly skilled professionals and creative thinkers to be a part of industry 4.0. An insight into their professional culture would help trainers to design effective modules, so as to make them ready to face the challenges of cutting edge technology of industry 4.0.

There is much literature in western contexts which points to this fact that engineering curricula needs reforms. However such studies are rare in Indian contexts. (Buch,2015) in his work argues about the feasibility of making modifications to engineering education in order to bring about a more holistic engineering work practices. (Carliner, 2012) argues that trainers should focus on recognizing distinction in work processes and values while developing and delivering training materials. In a study by (Graaf & Ravesteijn, 2010) on the skills and knowledge an engineer should possess have pointed to the fact that there is a need for modern training methods and he argues that a new set of educational tools are required. (Trevelyan, 2010) argues that engineering needs to be understood as a much broader human social performance than traditional narratives that focus just on design and technical problem-solving. (Bucciarelli,2008) is of the view that expansive reading of the codes of ethics are what it might mean to be responsible, but a substantial reform of undergraduate engineering education across the board is needed. (Lucena,2006),argues that the demands for flexible engineers presents significant challenges to engineering education, he stressed for a curriculum that prepares students for the complex experiences of engineering work in ever changing organizations.

1.4 Reasons for Insight into their Professional Culture

Every human being belongs to various groups and categories simultaneously hence carry layers of mental programming, corresponding to the culture. For example: it can be a social class level, which is associated with educational opportunities and with a person's occupation or profession; and for those who are employed, to an organizational or corporate level to the way employees have been socialized by their work organization (Hofstede 1991: 10). Culture can not only be found in national, geographical, political, and racial level but also at occupational level. Occupational cultures also have their own cultures as countries and organizations (Van mannen & Barley, 1984). Members of a particular occupation exhibit more or less the same type of behaviour. So occupational theorists point to the fact that a person is largely affected by the existing social, moral, physical, and intellectual character of the work itself. All types of occupational communities are characterized by distinctive work cultures which shapes the behaviour of the members. Engineers are more attached to their occupation rather than to their organizational communities (Whalley & Barley, 1997). Cultural assumptions in organizations are unique as they are drawn from a particular occupation (Schein, 1981). Engineering Culture is an occupational as well as organizational Culture as it has some unique aspects based on the technical and rational thinking backgrounds of engineers, and this can be found in organizations where engineers are involved. Technical sophistication is a major attribute of an engineer without which they have no value. Creativity is also the essence of this culture. This creativity is possible as they are fascinated with technology and its aesthetics. In order to know their culture in details one needs to focus on their communicative interaction. An interpretive method for studying culture helps in uncovering the underlying assumptions. For this efforts of both the insider i.e. one who makes the unconscious assumptions as well as and an outsider who helps uncover the assumptions has to be made by asking the right kind of questions (Schein 1984: 3–4).

Communication performance perspective by (Pacanowsky & O'Donnel-Trujillo, 1983) is also an interpretive approach which helps in understanding the cultural practices. Certain specific and repetitive communication practices by members of an organization create and maintain culture which becomes a feature of organizational life. Primarily (Bantz's, 1993b) organizational communication culture (OCC) method is used to analyze messages of Indian engineering students. The findings derived from a study adopting such method can have important implications for practitioners as it will help them provide the Indian engineering students proper guidance and make them ready to meet the challenges of industry 4.0, by implementing a better curriculum.

1.5 Communication Performance Perspective

The theoretical perspective adopted for this study is communication performance perspective by **(**Pacanowsky **&** O'Donnel-Trujillo**,** 1983**)**.This approach tries to understand the practices that comprise culture. (Pacanowsky & O'Donnel-Trujillo, 1983**)** were the first to write on communicative performance. This performance perspective allows one to probe further and get a better understanding of communication as a process and culture as a social construction that is continually reconstructed.In setting out the boundaries of cultural communicative performance perspective (Pacanowsky & O'Donnel-Trujillo,1983) observe that if culture consists of, as Geertz suggests, 'webs of significance that man himself has spun' (1973, p.5) and if as we have suggested else-

where, spun webs imply some act of spinning (Pacanowsky & O'Donnel-Trujillo,1982, p.123),then we need to concern ourselves not only, with the structure of cultural webs, but with the process of their spinning as well (Pacanowsky & O'Donnel-Trujillo,1982, p.128). This perspective best suits this study which attempts to know how a known culture is communicatively performed and also learn how culture is manifested in the daily interaction of the engineers.

2. Methodology

2.1 Organizational Communication Culture Method (OCC Method)

This study employs the organizational communication culture (OCC) method, which was formulated by Charles R. Bantz (1993), with the basic objective of studying organizational cultures. Employing OCC as method researchers have tried to interpret organization cultures through an analysis of their communicative life.OCC as a method involves

i. Gathering of messages
ii. Analysing these messages for four major elements: vocabulary, themes, architecture and temporality
iii. Analysing the symbolic forms in these messages: metaphors, stories, fantasy, themes
iv. Inferring patterns of expectations from the elements, symbolic forms, expectations and messages
v. Inferring patterns of organizational meanings from these same elements, symbolic forms, expectations and messages
vi. Weaving the patterns of meanings and expectations into a tapestry that represents the organizational communication culture.

The present study uses interview transcripts as primary data source. As a result, the study will not make an analysis of temporality, architecture, or fantasy themes, as each of these are related to actual interaction, which cannot be examined from interview messages. The present study shall examine vocabulary, themes and stories and metaphors only.

Several studies have referred to engineering students as engineers (Bucciarelli &Kuhn, 1997; Lovgren & Racer, 2000, Leonardi, 2003). (Bucciarelli & Kuhn, 1997) have made the strongest argument for studying engineering students in order to understand engineering culture. For this study Engineering students from various engineering colleges in India were interviewed. Students ranged from undergraduate to masters level. Participants belonged to various branches of engineering. The decision to not to limit oneself to a specific branch of engineering was consciously made keeping in mind studies which show several commonalities among various sub disciplines of engineering (Bailey, 2000; Barley, 1996; Downey & Lucena, 1995; Florman, 1987; Kunda, 1992; McIlwee & Robinson, 1992; Whalley & Barley, 1997). All interviews used a semi structured interview protocol. The interview protocol was constructed by the researcher in consultation with her supervisor and other experts. It was cross-checked for applicability and cultural sensitivity. Some portions of the protocol evolved during the study.

Participants were asked many open ended questions in the following general categories: (1) On their education and work experience, (2) their experience working in groups with others (3) studying and preparation practices for their courses, and (4) opinions about the assignments given and teaching style of the discipline in which enrolled. After an analysis of their messages for vocabulary, themes and stories as per the OCC method, the following results are found.

3. Results

3.1 Vocabulary

(Bantz, 1993b, p.90) argued "words are the building blocks of verbal messages". Vocabulary here involves the words that engineers used in their common interaction. Words by themselves are not always self-evident as to the context of their use. As a result, this work has tried to make sense of how certain words are used and in what contexts they appear. In vocabulary analysis four main ideas were identified which was same across all of the interviews.

3.1.2. Self Confidence Related to Technical Competence

From a study of the vocabulary of the engineering students it was found that Engineers felt self confident when they were technically strong in their domain. . This ability instilled in them a sense of confidence with which they could face the challenges successfully. This was one of the most sought after quality in the engineers. Participants in this study clearly linked self confidence with technical competence.

3.1.3. More Inclined towards Practical's Than Theory

Another thing that emerged out of engineer's vocabulary analysis is their strong affinity towards practical's than theory. Engineers have a passion to use what they learn. They highly prefer hands on experience, as in their real work place they have to make use of technology for completing a task. This would further help them when they join industries. They learn better when they use a particular technology rather than from the theories and lectures. They are passionate about doing the various technical experiments. This practical experience is the life line of engineering as most of the engineering invention is the outcome of research which involves application of theory. We can find this practical orientation in engineer's vocabulary analysis. For engineers practically looking at things and experiencing it helps them in better understanding rather than learning it from a book.

3.1.4. Dislike Old Traditional Method of Teaching

From an analysis of engineer's vocabulary it was also found that they disliked traditional method of teaching. They emphasize on modern form of teaching where learning builds on the knowledge students already have allowing them to form concrete associations to new information, which helps in remembering and understanding concepts well. Traditional learning is based on repetition and memorization of facts that students dislike. Engineering students like modern methods of teaching, as they feel that the world has changed so must the education methods.

3.1.5. Get Frustrated Under Extreme Pressure but are Capable yo Overcome by Self Motivation and Relaxation Techniques

An analysis of their vocabulary also reveals another interesting facet that of engineers being capable of overcoming frustration by self motivation and relaxation techniques. Engineering works are known for their quality and service that they provide. In order to provide the best to society engineers have to work very hard. The nature of engineering works also reveals that they are the product of the hard work, dedication and concentration given by the engineers to it. These works are a product of long research. Their nature of works makes them work under extreme pressure. Despite of all these sometimes the research fails or they are not able to get their desired results or they fail to meet the deadlines. These make them extremely stressed and frustrated. Still they manage it and keep working. They are capable of overcoming these by motivat-

ing themselves as well as by adopting some relaxation techniques. They feel failures are a part of life, so they face it and try to solve it.

3.2. Themes

(Bantz, 1993b, p. 95) explained thematic analysis is a process of reduction requiring two criteria. Themes must occur frequently within the messages and they must represent "at minimum a simplex of ideas and at maximum a multiple complex of ideas". Thematic analysis is vital for a proper and thorough understanding of cultures as reveals issues that are important to members and displays their cultural practices and values. From an analysis of engineers' messages four common themes were identified. (Bantz, 1993) observes, that paying close attention to these can help researcher see features of a culture that members themselves may not aware of. Overall, four themes were identified which was quite consistent in all the interviews.

3.2.1 One should be Confident but not Over Confident

Engineers are confident about their ability but they strongly feel that one shouldn't be overconfident as this leads to failure and frustration. So they feel that it's very important to learn one's limits or go through a reality check of their skill set. To be confident one must be honest to oneself by considering their abilities and recognizing the limits so that they can work on the weak areas for improvement. They feel that while working they shouldn't be overconfident rather work cautiously so that they avoid facing failures. They are very much grounded and practical.

3.2.2. Greater Autonomy at Work is Desired

Another striking theme emerging from engineers talk is that of a desire for greater autonomy at work. They want to do their work with certain plans in their mind to make it perfect. Perfection in a work is something which they keep striving at. They feel that this can be possible if they are provided with greater autonomy at work. When they are subjected to certain control they feel that they can't give their best at times. For an engineer the need for autonomy has been emphasized. The same also hints at previous studies that point at engineers being poor at group work.

3.2.3. Learning is a Solo Activity

Engineers like to learn things alone when it comes to understanding the fundamental concepts. They don't like any sort of disturbance while trying to learn the things. Any sort of distractions they get while doing it affects their learning process. They feel that if fundamental concepts are clear then only they will be able to implement it in group works. So to learn engineering concepts and fundamentals they prefer to work alone. Further working alone makes them aware of their strengths and weakness knowing which they can work on to improving their skills. They prefer to be in quiet settings when trying to learn some basic concepts which are vital. Most of the engineers in this study were of the view that, to adequately learn fundamental engineering concepts and skills, they need to study alone. The above hints at the acquisition of engineering knowledge being a solo activity. The same may later result in development of individualistic tendencies among engineers.

3.2.4. A Good Engineer should be Able to Apply what they Learnt

Application of engineering knowledge is the essence of creativity which engineers value the most. According to engineers a good engineer is one who can make use of what they have learnt successfully. Right from the college days they are indoctrinated with the value that to be successful they have to use these scientific principles properly in their work for the creation of goods and services which benefits society. They are keen to learn the various scientific principles and at the same time are even more interested to learn the fields in which it can be applied. They have a strong fascination to make use of their engineering knowledge to their figment of imagination and make it a reality. Their definitive purpose is to make an application of their skills to make things that makes life easier for humanity.

3.3. Stories

In the interviews participants told many stories about the way they worked alone and worked with other engineers. Although each participant shared a variety of personal stories, the diversity of story types across all of the interviews was actually quite small. I identified five categories of stories that participants told consistently across all of the interviews.

3.3.1. Challenges Call for Hard Work

One of the major themes that emerged from the analysis of engineers' message was that when engineers face a challenging task they march ahead with vigour. A difficult task creates a great interest in their mind which helps them propel fast to do it well. They are fond of taking challenges as it helps them to be more creative. Challenging works enable them to use all their tools of knowledge which they always desire to make use of. A difficult task is something which they always keep looking for so that their skill can be used best. Engineers give their best while working in some areas that are new and challenging. Hard work, exploring multiple options in one's pursuit for the right answer and never giving up was one of the stories found among engineering students across all branches. This is a ritual performance.

3.3.2. Working under Deadlines

Engineering is a time-bound course. The number of papers a student has to clear before obtaining the final degree is substantial. Competing with time remains one of the constant features of an engineering student. Handling time pressures are a part and parcel of an engineering student's life. The same was also a story during conversations. Internet often comes as a saviour for an engineering student while the latter grapples with time pressures. This is also a Ritual performance.

3.3.3. Systematic and Methodical Approach as a Key to Success

A systematic or a methodical approach helps engineers to collaborate effectively, resolves issues at work and, be successful in their ventures. Another striking theme that emerged out of engineers talk is that they are very systematic. A systematic or a methodical approach helps engineers to collaborate effectively, resolves issues at work and, be successful in their ventures. Engineer's value being systematic and methodical as it ensures consistency as well as optimal performance at all levels of their work. This organised approach helps them in reducing overall confusion which further helps to be more effective. They approach work as a craft that could be done through methodical study. This is a ritual performance.

3.3.4. Target Oriented as Well as Marks Oriented

For engineers setting targets at work helps increase their efficiency which can be regarded as useful tools in their workplace. Performance targets are always considered as advantageous for them. Performance targets are goals for specific works that they do for achieving their aim. Meeting important targets for them is an indi-

cation of their current success and future growth. This requires identifying the vital indicators of the nature of their works which will help in establishing accurate performance targets. Making plans for setting targets through achievable goals is an aid in analyzing areas where an engineering work excels and where it can be improved. Marks and grades are important for an engineering student. First, they may have a bearing on a student's career graph. Next, the role of peer pressure may not be ignored. This is a political performance.

3.3.5. Passion to Give the Best Output Amidst Adversity

Adversity is not just one difficulty or setback rather it's a series of unforeseen events that acts as stumbling blocks in the path of one's achieving goals and finding happiness. Engineers will experience adversity at some point in their work place, but they are capable of overcoming it with the right attitude and hard work and with a passion to give the best. Facing an adverse situation can make one easily distracted resulting in minor setbacks and disappointments, in such times engineers are capable of adjusting their perspective, hence even if they face obstacles they manage through it and come out with the best and achieve their goals. Engineers have an interest to give the best; this makes them work hard whatever the situation may be. This is a political performance.

4. Discussion

After a study and analysis of their vocabulary it is found that Indian engineers are very much practical and grounded. When they know the technology well they can march ahead to any positive extent and this fills them with self confidence. For this they desire more hands on experience with latest technology which only modern educational techniques can offer.

A study of the themes form their interaction reveals that to give the best they liked to master the subjects well by learning themselves alone without distractions. They also desired greater autonomy at work to do things well. This develops an individualistic attitude which hampers group work. So they should be trained to work well in groups. It is also observed that they don't like to be over confident as this may result in failure, so they are quiet logical and rational. Under such circumstances if they are highly skilled they can be relied on to give best of results. They also feel the mark of a good engineer lies on how well they use their skills. This means if provided with cutting edge technology they can master it well and make good use of it.

Some of the ritual performances that the engineers ritualistically engage in are that Challenges call for hard work. Another ritual performance that they engage in is to be Systematic and methodical to get success. This can best be used to get the best of output in challenging works. So if they come across an interesting syllabus of their choice they can master it well. Students also want to be accustomed to the corporate culture which requires to work under certain deadlines for which they prepare from their college days. The political performance that they engage in are that they are very much marks oriented and target oriented. This means that to show their superiority they can work very hard to get things done. Another political performance that they engage in is their passion to give the best amidst adversity.

5. Conclusion

The present study has made an attempt to study the Occupational culture of the Indian engineering students. The study has made use of the OCC method by Bantz to analyse the messages of the students. Nearly hundred students were interviewed. From a thorough study of their culture it is found that Indian engineering students have various positive traits which if harnessed properly by providing them with right education and training can make up for the shortcoming in terms of skilled engineers that acts as a stumbling block for India to embrace 4.0. They are ready to work hard when given a challenging task. They are interested to learn more of practical things. These aspects of their professional culture have a positive side, i.e. if any new challenging courses are introduced students will learn with great interest. They are capable to master any challenging changes in their courses. The various traits that they possess reveal that Indian engineering mindset is very creative and provided with the right tools they can prove to be the best. And India can harness this pool to the best use of Industry4.0.

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