Cultural Relativism and Technology Transfer in Engineering Education

Dr. Jayanta K. Banerjee, University of Puerto Rico, Mayaguez Campus

Jayanta Banerjee is a Professor in the Department of Mechanical Engineering at University of Puerto Rico, Mayagüez campus. Dr. Banerjee received Ph.D. from the University of Waterloo and M.Ed. from Queen's University, both in Canada. He has worked in industries and taught at the universities in Germany, Canada, USA and Latin America. He has over hundred publications in refereed journals and conference proceedings and a few books to his credit. Jayanta is a member of ASEE, ASME and VDI (Germany).

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Jayanta Banerjee (ASEE Life Member)

Faculty of Engineering

University of Puerto Rico at Mayagüez (UPRM)

"Culture manages us far more than we ever manage it; and it happens largely outside our awareness."

Schein (Anthropologist)

Abstract

While we cannot govern our education only by our culture, culture still plays a very significant role in our academic and professional career. In engineering education, in particular, it is very important to understand a local culture while transplanting a new technology in a different country. In any technology transfer the giving end and the receiving end must understand each other's constraints, and the limitations of the technology that is going to be transferred and transplanted. Our class lectures and labs are not sufficient to make a student prepared for, nor at a minimum aware of, such nuances in different local cultures in global technology transfer. An engineering student has to live and work in a different cultural setting during one or two CO-OP training assignments or in other types of industrial internships in a different country and a different culture. In this short paper several examples are given to illustrate how cultural relativism plays a significant role in preparing an engineering student to work in varied cultures.

Key words: CO-OP internship, industry-university partnership. cross-cultural customs, high-tech.

Introduction

The term 'cultural relativism' has a subjective component, whereas the phrase 'technology transfer' is very objective. Very often the relationship between these two terms or expressions can be better explained and understood through examples around the world. Here is one: the difference between a typical Western kitchen knife and an Oriental *Bothi (*used extensively for cutting meat, fish, potato and vegetables in Eastern India, Bangladesh and the other Far East countries like Myanmar, Thailand, Cambodia, Vietnam, etc.). In the case of a standard kitchen knife, the piece of meat, potato or vegetable is held in one hand on a base plate - say, a table - and the to-and-fro motion of the knife, held with the other hand, cuts the item. Bothi, on the other hand, is a curved metallic blade, like a knife, but it is vertically bolted on a wooden base plate. The blade is kept fixed in position, by pressing the wooden base plate with one of the feet in a semi-sitting position on the floor, and the item to be cut is held with two hands and wedged into the blade with some force. Thus, in case of a knife, the workpiece to be cut is fixed in position and the tool (knife) moves; in case of a Bothi, the cutting tool (Bothi) is fixed in position by the foot, and the item is held with both hands, moves into the blade. In both the cases, the *relative* motion is the same. Each house spouse, American or Asian, is an expert in her/his own kitchen; but if the tools are reversed, it would be a nightmare!

In another example, both Japan and the United States of America (US) have stable structures in industrial organization, and both are very successful. However, the approaches are different. In Japanese industry, once a position is offered, it is almost for lifetime until retirement but the promotion is slow, whereas in the US, permanency in employment is not guaranteed but the process of evaluation and promotion is much faster. In Japanese industries, the technical career path is more generalized; one has to know a little bit of everything: Jack of all trades, (but also master of a few!), whereas in the US more specialization in one particular branch is required, at least, in certain fields. Japan is more used to collective decision making while in the US the decision is made by the individual managers. In Japan, the responsibility is carried collectively whereas in the US industries responsibility is more individualistic. By the same token, in Japanese industries the concern is holistic while in the US, concern it is more segmented.

The Change of Work Culture during the Three Scientific Revolutions

Any "*paradigm shift*" in science, using this favorite term of Thomas Kuhn [1], cannot change very quickly our habits and customs, in sum, our culture. When humankind shifted from fruit gathering nomadic tribes to food producing home owners, it took a long time to adjust socially and culturally to the first scientific revolution of our known history: the *Agricultural Revolution*. Adjusting with the transition from a world trotter to a home dweller was extremely difficult. Similarly, when our growing human family emerged from an essentially agricultural to an industrial society, at the onset of *Industrial Revolution*, our working habits had to be coordinated in a different daily timeframe, and our workspace had to undergo a drastic and tough transformation. Today's imminent socio-cultural metamorphosis, arising from the current *Information Revolution*, has been ongoing over several decades from the earlier Computer Numerical Control (CNC) to contemporary advanced Artificial Intelligence (AI). This changed will need even more time and tuning for a lasting and stable adjustment. The monumental changes during the last three scientific revolutions had produced enormous transformation in our habits and customs, and hence in our culture.

During each transition, the workers had to adjust themselves to the new working hours from sunrise to sunset. Nomadic tribes had more flexible time schedules. As we passed through agricultural and industrial revolutions, the working hours became progressively more rigid. However, with the current information revolution, time and space have become more flexible. Often we can work from home at our own pace, or go to work at our *flextime* as long as we document the number of hours worked per week. Similarly, for the university and college students, many courses are offered online and the students don't have to commute to the campus and sit in a classroom to participate in a lecture or a lab. This is, indeed, a very positive shift in higher education. According to Professor Rafael Reif [2], President of MIT, eventually the entire engineering education system is going to be offered online, which will be less expensive for the students and easier for the instructors. Whether it will be better is still under debate!

As a result of the current information revolution, today's media have become very conducive to technology transfer. The know-hows and their break-throughs are no longer great trade secrets. Thus, the hard work of an individual is no longer what facilitates technology transfer; rather it is the collective sharing of information by a group [3]. Once the waves and the counter waves of Artificial Intelligence (AI) slowly but surely dwindle by the middle of the twenty-first century, the human side of technology transfer, which is still somewhat ignored, will be the focal point at the local, national and global levels. As opposed to today's situation, once a technology becomes easily *'knowable'*, it is transferred from the *haves* to the *have-nots.* This process will become much easier and less expensive from the giver's side and easily accessible at the receiving end.

Technology Transfer through International Internship

The CO-OP and other internship programs have become very popular in USA and Canada. They expose students to real engineering environments in different countries far from their homeland where different cultures have survived over centuries and millennia. International internships teach engineering interns how products are envisioned and used differently in different cultures. Conversely, international internships expose students to how different tools are used for the same purpose in different countries, like an American kitchen knife and an Asian *Bothi*. Giving another example, again from Japan, in the area of New Production System (NPS), Noboru Kawasaki writes, "A company that has even a shred of doubt in NPS will not succeed. NPS is like a *Lotus Sutra,* a Buddhist mantra that teaches universal solution. If you believe in it, you will succeed."[4]. Faith is ingrained in Oriental cultures, even in the technical gadgets of manufacturing a product; this may sound naïve to a Western reader. In Japanese manufacturing industries, NPS is based on several philosophical codes. Here are some of them:

Problems beget wisdom. Think how to do it, not how to explain it. There is always room for improvement. Don't use money, use your brain. Try NPS for one year, before complaining about it.

An international intern or trainee has to live in Japan and work in a Japanese firm to understand and appreciate such philosophical codes. These codes are based on Japanese culture and are made for Japanese NPS. However, they can be adapted to a different country and applied to a different culture, in the same way that Jordan's and Deming's American manufacturing philosophies of total quality control were adapted to Japan. This adaptation is only possible when the giving end and the receiving end of such intercontinental technology transfer – between America and Asia, in this example - are aware of the cultural differences. For example, does this Lotus Sutra, *'there is always room for improvement'* imply that we'll never reach total perfection? Does this doctrine contradict the concept of Total Quality Control (TQC)? Does it contradict *Nirvana*: a supreme state of self-realization? In these apparent contradictions lie the crucial role of cultural relativism in Global Technology Transfer (GTT).

The Gap between the Giving End and the Receiving End in Technology Transfer

We need to differentiate *information* from *knowledge* and *wisdom*. Today's Information Technology (IT) is not a great secret anymore. Knowledge lies in the 'know how' of how to use information properly and efficiently. This is where the gap lies between the knowledge-rich giving end and the knowledge-poor receiving end in any international technology transfer [5]. Similarly, within the same country, rich or poor, this knowledge gap among the workers generates economic gaps, socio-cultural gaps, and eventually value gaps! For example, there is an increasingly widening knowledge gap between the workers on the same factory floor. Some are acquiring proper hands-on experience through training in the hardware and software of a particular computer technology, say, a CNC machine, while some "others" are doing the most tedious, routine work at a computer terminal or work station with absolutely no hope for self-improvement. This essentially creates the value gap between the *haves* and the *have nots*. Very often the lowest paid and the least educated workers are the have nots. While the haves enjoy secured financial positions, stable social status and elevated influence. The have nots are usually dumped into oblivion. Furthermore, this knowledge gap brings forth a significant power gap, since in a highly competitive market of today, *knowledge is power*. In technology transfer, internationally or within the boundaries of a nation, these gaps become extremely sensitive socio-economically as we move in the first quarter of the twenty-first century towards the unmanned systems, human-robot interface and artificial intelligence.

Wear of Human-ware

During the earlier decades of Information Technology (IT) and its application in engineering, mainly in Computer Integrated Manufacturing (CIM), there used to exist very good communication network among the design office, the manufacturing plant and the testing rig. Today, the machine programmer's job is a fulltime position, and the program controls the machine pretty much without any human interference. In a mass-scale production line, even the loading, unloading and storage of the raw materials and the final products are automatic with the use of Automated Guided Vehicle (AGV) and Automated Warehouse System (AWS). Thus, the *behavioral gap* among the designer, the manufacturing engineer and the testing supervisor expands. Furthermore, the machine operator ends up being a '*programmed person*' without having any role of intelligent intervention in the entire decision making process, and is eventually displaced from his/her idly sitting position by a robot arm. The operator's skill, hard-earned over many decades, analytical capacity and more importantly, the ability to participate in a human decision making process gets eroded due to the lack of active involvement. This is *human wear*!

Human wear can be avoided through technology transfer within the same workplace and also outside the work environment by retraining the worn-out workers, namely the elderly technicians in a factory, and thus retaining them. This is also a way of bridging the gap between human and machine, but most importantly between human and human, namely, the young and the elderly factory workers. This is, in essence, an application of the philosophy of flexible "manufacturing cells" in "worker's cells". A typical worker's cell, for example, would have a new generation of machine programmers who could teach the elderly machine operators a new programming language – say, G Codes - and at the same time, would learn from them the hands-on experience of grinding a cutting tool with manual precision. The CAD expert in the worker's cell would teach the draftsperson of the previous generation how to draw using a computer screen, and also learn from her/him the art and aesthetics of freehand sketching. This is a way to bridge the generation gap through technology transfer between the two adjacent generations in the same workplace.

Global Technology Transfer through International Internship (Student Exchange Programs)

Through CO-OP and similar internships or student exchange programs, the final year undergraduate students in engineering carry their technical know-how from the home universities to the host institutions, whether industries, universities or technical colleges. This is also a two-way process – a symbiosis! An undergraduate student in the final year can undergo the capstone design experience in the host institution, thereby contributing her/his technical expertise; and, at the same time, learn a new language, appreciate the habits and customs of the people of a different culture. In the past, numerous engineering students have benefitted from these very rewarding experiences in countries as far as China and India [6]. This is a significant contribution to *lifelong learning* that our ABET (Accreditation Board for Engineering and Technology) gurus are trying to implement!

Technology Transfer through Collaborative Interinstitutional Research & Development (R & D) Partnership

In emerging technologies, such as bio-medical engineering, micro-nano materials and manufacturing, bio-materials and bio-manufacturing, etc., there exists international cooperation among the research institutions worldwide, both in the industrially developed and in the developing countries. Not only the engineering students but also their professors/mentors can participate in such partnership programs. A university faculty member can take a Sabbatical leave for six months or a full academic year, and work in the host institution's R & D labs. The faculty member can also take along with her/him one or two students to work in the same area or in an allied field. Large companies such as Boeing, General Motors (GM), and General Electric (GE), have such facilities in a very organized fashion. Some companies have production plants in other countries in order to take advantage of their lower labor costs. In the past, students have gone to work in such overseas plants as CO-OP interns, Engineers in Training (EIT) and as regular employees. This is another way of technology transfer with a different culture and has been very rewarding in the lifelong learning for many undergraduate students in engineering [6].

Summary & Closing Remarks

One has to be very careful about the sensitivity of the local beliefs while importing and implanting something from outside. It is like our body that may receive or reject any foreign object recently transplanted: a heart, a lever or a kidney. This could be a new technology or a new commercial product from outside. Here is another example. The famous beer producing company of Denmark, *Carlsberg*, opened a plant in Thailand. On the labels of its beer bottles and beer cans Carlsberg put the figure of an elephant, since an elephant is a very happy symbol in Thai culture. The sales increased. So, after a while they put two elephants on the beer labels – a male and a female – a happy couple. And the sales doubled! During the entire year the sales kept increasing but then suddenly sales declined drastically. The Carlsberg bosses got annoyed; and after some socio-cultural research they found out that in the Thai family tradition a couple without a kid for a long time was not a very good sign. So they put on the beer bottle label a baby elephant in between the two adult elephants, and the beer sales rose back to normal again!

In my personal case, I was sent by my Canadian company to Bangladesh to do some negotiation with their government. Everything in the business trip was going as planned because, being a Bengali by birth, I knew the local language and the culture very well. On the last day of negotiation, I was supposed to travel to Dacca, the country's capital to sign some final documents. The meeting was scheduled during the early morning hours. So my chauffeur and I woke up very early, and started driving before daybreak. There were no traffic jams during those early hours and the drive was smooth without any problem. When we reached the outskirt of Dacca I felt very relaxed thinking that we had arrived just in time to sign those very important final papers of the negotiation. At that very moment my chauffeur slowed down the car and neatly parked it at a safe sidewalk. He got out of the car, opened its trunk, took out his prayer mat, put it properly in the direction of Mecca and started praying. This is his first prayer of the day, and he does it five times a day, no matter whether he is in Dacca or in Mecca. At that point of time it would be a cardinal crime for me, even to whisper very softly in his ear, "*Hurry up! Otherwise we'll be late!".* I would rather arrive late to the meeting to sign the very important negotiation documents instead of offending a universal religious ritual in a local setting. Similarly, I remember when the central government of Mexico came to negotiate with the Chiapas, the Amerindian tribal chief declared, "Don't come to help us. First, try to understand us; then and only then we can sit together and talk."

Unlike during the 1960s and 70s, words like ‘underdeveloped’ or ‘Third World’ were not used too frequently in academic conversations, even though they exist openly or insipiently in our societies. More often the old Mississippi folksong, “We are on the same boat, brothers!” vibrates in technology transfer. The wind has no more any directional preference: neither from North to South, nor from West to East. A professor of engineering materials would probably call it, “No anisotropy!”

In engineering education and in engineering practice, graduate students and senior undergraduate students can contribute enormously to technology transfer within a country or internationally. This precious source of technical and humanistic resources of the engineering student population has not yet been tapped efficiently. A student, graduate or senior undergraduate, can take a semester off from research or course work, go to an industry, a research lab., a university or a technical college in a different country, in a culture different from that of her/his home, and contribute in a specific field of study; and at the same time, start learning a new language, travel a bit and get the taste of a new food, local customs, religions; a new way of living in a different culture. In order to do this one doesn’t have to be a great adventurous world trotter like Marco Polo or Ibn Battuta. There are many international organizations that provide support in searching for and acquiring such short term overseas internships for one or two years. Some of them are Rotary International, UNESCO, Engineers without Borders (EWB), International Red Cross and Red Crescent, Peace Corps (USA), Canadian International Development Agency (CIDA), Canadian University Services Overseas (CUSO) and many others.

Technology transfer, apart from being globalized, can also occur within a country or nation from academia to industries, and *vice versa*. Not only the engineering students but also their professors and mentors can take off from lecturing and/or academic research, taking a Sabbatical leave for one semester or one full year and work in an industry, in its R & D department or in the actual production line. Conversely, the engineering practitioners from the industries can spend some time in the university laboratories, contribute their real-life industrial experience and also take some refresher courses. This is also another way of technology transfer within a country – between the industries and academia – where both gain value: a win-win situation!

In knowledge transfer from preceptor to disciple, from mentor to mentee (*Guru* to *Sishya*, in Sanskrit), the transmitting and the receiving ends of knowledge and the knowledge itself have to be in unison. The same is true in the domain of arts: the artist, the art work and the observer must be in unison. John Dewey emphasized this point particularly in the realm of art education [6]. In technology, the closest that comes to the arts is architecture. In engineering we are just one step behind.

In the transfer of any technology, whether it be high tech or low tech, nontraditional or conventional, between academia and industry within a country or internationally, or between the *haves* and the *have nots* on the same factory floor, there must be very good understanding and appreciation, not just some basic knowledge, about the constraints and limitations of both the giving and the receiving ends and of the technology itself that is to be transferred. In the past many ventures of global technology transfer failed, even though there were good intentions from the giving side. This happened due to the lack of information about the local conditions. When a research group of biologists, medical doctors and social workers from Harvard University went inside the tribal villages of Yanamami in the Amazon, with all good intentions and preparations, they just forgot to take a very simple precaution against the common *flu* virus; and the Amerindian tribes got infected and died in hundreds. Many decades ago a similar human cataclysm happened in Indonesia for the lack of taking proper precautions against the very common DDT powder.

In engineering itself, and only during the last century, Three Miles Island, Chernobyl, Exxon Valdez oil spill in Alaska, chemical poisoning of the Union Carbide's plant in Bhopal, India are just a few examples of such accidental disasters. Any technology transfer, especially in the fields of emerging technologies, like IT, AI, bio-medical engineering, etc., the transfer and the transplant need to be dealt with careful caution to avoid repeating our past mistakes in the realm of cultural relativism.

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