Understanding Globalization for the 21st Century Engineer

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Abstract

Globalization has been defined as a force of economic growth, prosperity and democratic freedom. However, it has simultaneously been defined as a force for environmental devastation and exploitation of the developing world – thus opening our eyes to the co-existence of both benefits and risks associated with globalization.

In today's competitive global business environment, the supply chain has changed dramatically in the last two decades for a lot of organizations. Hence engineers of the 21st century need to be aware of the global supply chain and understand that they are designing products and services for a global market place. Due to this, they need to be fully cognizant of the concept of globalization and understand how it affects their profession.

In this paper, the authors discuss the benefits and risks associated with globalization. Effects of globalization on various business functions are elucidated, and the case is presented for the need for engineers to understand these effects. Lastly, the authors discuss the global strategies of organizations in the 21st century including increased complexity in vendor qualification and standardization.

What is Globalization?

The word "Globalization" first surfaced in the English language in 1959 and entered a dictionary two years later [1]. Knowledge of the term globalization must include a dissection of the term and a careful, as well as critical, examination of all the aspects involved. A muddled or misguided core concept compromises our overall comprehension of the problem. In contrast, a sharp and revealing definition promotes insightful, interesting and empowering knowledge, an understanding that helps us to shape our destiny in positive directions [2], i.e, in order for the concept of globalization to maintain any analytical usefulness, it must be unpacked, carefully defined and examined for its impact on society, the economy and the world system[3].

Globalization has been varyingly used in academic literature to describe a process, a condition, a system, a force and an age [4]. Given these competing labels have very different meanings, their indiscriminate usage is often obscure and invites confusion related to the term "Globalization." This is also prevalent because Globalization is an uneven process; meaning that people living in various parts of the world are affected very differently by this gigantic transformation of social structures and cultural zones [4].

Hence, it is necessary to think of globalization from varying perspectives and also to realize that Globalization is a complex phenomenon that comprises several aspects. Some researchers say that economic processes lie at the core of globalization. Others say the political, cultural, environmental or ideological aspects are the essence of globalization [4]. However, the most appropriate understanding of globalization would state that each of the above researchers have correctly identified one important dimension of the phenomenon of globalization. However, the collective mistake lies in the researchers' dogmatic attempts to reduce a complex phenomenon like Globalization to a single domain that corresponds to their area of expertise. Fortunately, with increasing research being done in the field of Globalization, more and more researchers have started thinking along the lines that an understanding of globalization requires a multi-dimensional approach.

Table 1 gives us a few commonly sighted definitions of Globalization

Table 1: Commonly cited definitions of Globalization

Author & Affiliation	Definition
Anthony Giddens *(Former Director of London School of Economics)*	Globalization can be defined as the intensification of worldwide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa.
Fredric Jameson *(Professor of Literature, Duke University)*	The concept of globalization reflects the sense of an immense enlargement of world communication, as well as of the horizon of a world market, both of which seem far more tangible and immediate than in earlier stages of modernity.
David Held *(Professor of Political Science, London School of Economics)*	Globalization may be thought of as a process (or set of processes) which embodies a transformation in the spatial organization of social relations and transactions – assessed in terms of their extensity, intensity, velocity and impact – generating transcontinental or interregional flows and networks of activity, interaction and the exercise of power
Roland Robertson *(Professor of Sociology, University of Aberdeen, Scotland)*	Globalization as a concept refers both to the compression of the world and the intensification of consciousness of the world as a whole
James Mittelman *(Professor of International Relations, American University, Washington)*	Globalization compresses the time and space aspects of social relations

These definitions point to four qualities or characteristics at the core of the phenomenon. They are [4]:

(i) Globalization involves the creation of new, and the multiplication of existing social networks and activities that cut across traditional political, economic, cultural and geographical boundaries.

(ii) Globalization is reflected by the expansion and stretching of social relations, activities and interdependencies.

(iii) Globalization involves the intensification and acceleration of social exchanges and activities

(iv) Globalization processes do not occur merely on an objective, material level but also involve the subjective plane of human consciousness. The compression of the world into a single place increasingly makes global the frame of reference for human thought and action. Hence, globalization involves both the macro structures of community and the micro structures of personhood. It extends deep into the core of the self and its dispositions, facilitating the creation of new individual and collective identities nurtured by intensifying relations between the individual and the globe.

Everyday understanding of globalization in the engineering domain:

For the practicing engineer, an understanding of globalization is the increasing integration and interdependence among countries resulting from the modern flow of people, trade, finance and ideas from one nation to another. The World Bank, a strong supporter of globalization, defines the term as, "The growing integration of economies and societies around the world" [5, 6]. Globalization is also thought of as the "shrinking" of the world and also to the increased consciousness of the world as a whole. It is a term used to describe the changes in societies and the world economy that are the result of dramatically increased cross border trade, investment and cultural exchange. One of the primary changes is to think of an interconnected world and global mass culture, often referred to as a "global village" [7].

From an engineering perspective, globalization is about the monumental structural changes occurring in the processes of production and distribution in the global economy. These structural changes are responses by many global enterprises that confront tremendous pressures and fantastic opportunities presented by the increased application and integration of technologies. It is through this application of technologies that companies have been able to break apart business functions that were previously thought to be best collocated, and spread them across the globe in a globally disarticulated labor and production process. At a secondary level, globalization is affecting all of the social, political and economic structures and processes that emerge from this global restructuring, specially the central role that knowledge, education and learning have taken up. In fact some analysts argue that knowledge, education and learning are more important for globalization to succeed than land, labor and capital. This is why we are said to be living in a knowledge economy in the 21st century [8, 9]. To sum it all up in simple terms, globalization can be thought of as the array of impacts that arise from the increasing tendency for national borders to be crossed by people, goods, services and information [10].

Lastly, in certain situations, when engineers in the U.S. think of globalization, they also think of outsourcing and the fact that a lot of jobs in the U.S., particularly in manufacturing, have been lost to other countries [11-14]. This aspect of globalization has come about because of the existence and development of an advanced network of information and communications infrastructure, based on a network of telecommunications, broadcasting, computers and content providers.

As typifies complex phenomenon, globalization also has pros and cons associated with it. The pros and cons can be evaluated and would vary depending from which perspective they are evaluated. For the purpose of this paper, we will evaluate the pros and cons from the perspective of the US economy and from the perspective of the other economies that the US has increasingly started trading with since globalization took off in the late 80s and early 90s.

The advantages and disadvantages of globalization have been heavily scrutinized and debated in recent years. Proponents of globalization say that it helps developing nations "catch up" to industrialized countries much faster through increased employment and technological advances. Critics of globalization say that it weakens national sovereignty and allows rich nations to ship domestic jobs overseas where labor is much cheaper and as a result only increasing profits for multinational companies. The benefits and risks associated with globalization are discussed in the following sections of this paper.

Benefits of Globalization

We evaluate the benefits of globalization from two perspectives: (i) From the perspective of the US economy and (ii) From the perspective of the economies that the US has increasingly traded with since globalization has become more prominent in the last two decades.

(i) Benefits of globalization from the perspective of the U.S:

a. The U.S. has greater options to choose from when it comes to trading partners, which leads to greater competition, which in turn leads to lower prices and higher efficiency [15, 16].
b. U.S. companies are able to take advantage of cheaper labor in developing countries, leading to increased profits as well as lower costs of the end

deliverables to the user, which is the U.S consumer [7, 17, 18]. However, in the last 1-2 years, analysts speculate that some manufacturing jobs might return to the U.S. due to rising labor costs in China [19, 20].

c. Due to globalization, many U. S. firms have been able to focus on their core competencies as a way to gain a competitive advantage and add unique value to their stakeholders. It helps the organization not to squander valuable time worrying about support operations. Instead, organizations can devote their top talent to nurturing, building and leveraging core competencies which provide them more of a competitive edge as compared to concentrating on support activities [21] and thus help create more jobs that promote innovation, which is a primary factor that drives the U.S. economy.
d. By 2015 there will be a significant reduction in the U.S. workforce. Seventy million baby boomers are expected to be leaving the workforce and only 40 million workers entering to replace them. Thus, there could possibly be a large pool of unfilled jobs especially in the fields of science and technology. One of the possible benefits of globalization for U.S. companies is to give these organizations an opportunity to access talent from across the globe and prevent a labor crisis in the U.S. [22].
e. Because technology evolves so rapidly, by the time a firm invests in, trains its staff and implements a certain technology, it may already be obsolete. Under these circumstances, it does not make economic sense to maintain a permanent technical workforce. Instead, the organization can look for state-of-the-art technology from a wide variety of vendors, which is only possible due to globalization. Thus, U.S. organizations can continue to have access to state-of-the-art technology, as well as the professionals who are trained to use or implement the technology, for a much lower fixed cost [23].

(ii) Benefits from the perspective of the economies that the US has increased trade with:

a. Due to globalization, many jobs have been created in various developing countries or in "provider destinations" as they are called in globalization language. This has led to higher incomes for the populations of those countries, thus benefiting them with a better living standard due to increased disposable incomes.
b. Globalization has led to increased technology transfer to other countries from the developed world, leading to higher living standards resulting from advances in technology in the fields of health care and infrastructure.
c. Globalization has led to a significant increase in foreign direct investment (FDI) in the developing countries which has helped those governments provide better infrastructure.

Risks of Globalization

According to Taylor [24], the term "risk" refers to potential problems or issues that may arise and adversely impact the progress or outcome of a project. Risk is a part of every project and is usually associated with adverse or negative outcomes and is therefore perceived as a danger or hazard [25]. In a challenging global economy, it is progressively more difficult to put together a project which is both effective and cost efficient. This difficulty arises in part because a project's complexity continues to increase exponentially and the number of stakeholders involved in globally dispersed projects is expanding rapidly [26].

Consistent with the earlier section on the benefits of globalization, the risks of globalization are evaluated from the following two perspectives.

(i) Risks perceived due to globalization from the perspective of the U.S.:

a. One of the primary risks that the U.S constantly deals with as an outcome of globalization is dealing with global instabilities stemming from the interdependencies of economies on a worldwide basis.
b. Currency fluctuations also take place on a day to day basis due to increased foreign currency trading between various nations
c. High rate of unemployment in the U.S. because of a large number of jobs, particularly in the manufacturing sector, being shipped overseas. This high unemployment rate also puts political pressure on the government in Washington.
d. Increasing prices of oil due to heightening demand in developing countries which is an outcome of globalization, and directly the U.S as we are an oil dependent economy.
e. When selecting vendors or providers to work with overseas, U.S. organizations face the threat of choosing an inappropriate vendor who would not be able to meet project requirements. The organization could also face the threat of the vendor appropriating their ideas to produce a competing product or service [23, 27, 28]

(ii) *Risks perceived by the countries who the U.S. has increased trade with due to globalization:*

a. Slavery and child labor is a major issue that developing countries are dealing with as an outcome of globalization. U.S. companies such as Nike have been caught operating sweatshops to employ cheap labor and do not adhere to any sort of standards for their employees overseas due to lack of implementation of rules by the overseas governments.
b. Despite the fact that globalization has resulted in increased incomes in developing countries, there is still a huge disparity in the distribution of income across the globe. The global income is approximately $31 Trillion a year, but 1.2 billion people still earn less than $1/day. This results in 80% of the global population earning only 20% of the global income [29, 30] and this 80% of the global population primarily lives in the developing countries.
c. Due to expansion of U.S. fast food franchises overseas, the developing countries also have to deal with "McDonalization of Societies," which refers to the obesity rates increasing in those countries due to consumption of fast foods, that are high in fat content, but are becoming increasingly popular in those countries due to

strong branding and powerful marketing. This has led to increased health care costs in those countries due to health complications related to obesity.

d. The environments in the developing countries are being exploited for the financial gains of large corporations and this leads to various complications to the regional and in some cases even the global ecosystem.
e. Due to the time difference between the U.S and the "provider countries" and the "24/7 work culture" that has arisen as a result of globalization, the populations of these provider countries are experiencing increased health problems due to irregular working hours and are also noticing a spike in societal issues, which are hard to evaluate in dollar terms by the governments of the countries involved.

Importance of engineers understanding Globalization and the pros and cons associated with it:

Globalization is perhaps the central concept of our age. It is a highly complex interaction of forces producing integration and disintegration, cooperation and conflict, order and disorder. Accordingly, the complexities associated with globalization have increased exponentially as compared to a few decades ago. Hence, since in today's economy, engineers design products for a global marketplace, they need to understand the following aspects of globalization:

(i) They need to understand the risks associated with their product or service offerings and also the interconnections between those risks, i.e, they need to understand risks from a systemic perspective [31].
(ii) Engineers, particularly those who work for Transnational Corporations (TNCs), have to deal with inefficient performance of the departments located in different parts of the world and communication problems that arise as a result of that. A clear understanding of globalization would enable engineers to do a better job dealing with this issue.
(iii) Engineers need to understand the economics that are associated with their product or service. These economics could vary significantly, from time to time, for projects that are performed from different parts of the world. An understanding of globalization would enable engineers to better comprehend and resolve this complication associated with projects they work on.
(iv) In the U.S., the majority of the engineers, work on design problems and the production is outsourced to various vendors in countries where the labor is significantly cheaper.Accordingly, engineers need to understand the various types of contracts such as unit pricing, fixed pricing, variable pricing and performance based pricing [32].
(v) When U.S. engineers collaborate with other engineers in different parts of the world, they need to understand different cultures and how to deal with them so as to have a fruitful interaction with their peers in different countries [33].

Areas affected by globalization which engineers should be aware of [34]:

- World Trade & Investment – Engineers should be aware that world trade has experienced a 27 fold increase in the last 6 decades. This should make them aware that they are part of a global economy and hence should be aware of varying

globalization issues if they are to remain competitive. However, despite the extent of poverty having decreased, at the same time, 80% of the world's population lives on 20% of the world's income. Hence, engineers should realize that they have to design products that are extremely cost efficient and also sustainable over the long run. Foreign Direct Investment (FDI), which has increased drastically as a result of globalization, can alter methods of production and thereby initiate much more change than the simple trading of goods, which engineers need to be aware of.

- Technology – Engineers are aware that the IT revolution the world went through is reshaping economies and societies around the globe. It provides them with new ideas and increased access to information, which improves overall efficiency while producing products or providing a service. It also leads to significant drops in cost of technology making it more accessible to people and thus leading to increased connectivity and a knowledge based society. This makes the consumer more savvy, with a larger choice of products to choose from -- thus putting more pressure on the engineer to design products more efficiently.
- Intellectual Property – Engineers need to understand the varying intellectual property (IP) laws and their implementation that exists and vary from country to country. In today's globally connected economy, intellectual property is stolen on a regular basis and it costs the U.S $500 billion in lost revenue every year due to counterfeit goods. Due to this, engineers must understand the risks associated with IP being leaked to or being stolen by overseas colleagues and also the value of their IP must be understood.
- Energy – Due to globalization and outsourcing, there is a huge demand for energy in the developing countries, particularly in the BRIC nations, which comprise of Brazil, Russia, India and China. Due to this increasing demand, oil prices are at an all-time high and the pinch is being felt across various domains regarding the shortage of resources. Due to this engineers need to understand concepts such as sustainability – both environmental and social, when designing new products, which was practically non-existent before the concept of globalization, came into play. Engineers also need to be aware of issues such as the carbon footprint and water footprint of the entire supply chain associated with the product.

Global Strategies of Organizations

The reaction of organizations to changes in international competition is an important but under-explored aspect of adjustment to globalization [35]. The primary phases followed by U.S. organizations, in implementing global strategies, are as follows:

- Strategy Formulation
- Feasibility
- Preparation (Selecting Vendors)
- Evaluation of the foreign market
- Commitment/Investment
- Transition

- On-going management

One of the particularly tedious and tricky tasks that TNCs have to deal with is increased complexity in vendor selection. Since TNCs are global players, they have a huge pool from which they can select vendors. However, they need to understand intricate details associated with vendor qualification such as: Relationship Management, Vendor Capability, Breadth of services offered by the vendor as well as the experience and reputation of the vendor. According to a study done by IBM [17], the best practices which U.S organizations affected by globalization (TNCs) tend to implement are:

(i) The organizations become business partners with their vendors and are not mere buyers.

(ii) The organizations realize that it is not all about price but about obtaining the best value from having global relationships with partners across the world.

(iii) Organizations integrate their suppliers into their own supply chain to the extent of involving them in decision making and change initiatives in order to make the business relationship more of a partnership in which the risks are shared and both parties could be held accountable.

(iv) Organizations train employees to understand the differences in culture and thus enable their employees to more easily integrate into the global marketplace and product better value for their organization.

Engineers need to understand these aspects of global strategies that organizations implement, so they can be aware of the bigger picture and contribute more effectively to the organization's overall goal.

<u>Future outcomes due to continuing globalization which engineers need to be aware of:</u>

Over the past two decades globalization has completely transformed how nations are conducting business in the world. The increases in technology and liberalization of government policies have led to an increase in inequality among nations as well as between social classes in a single country [5]. Some of the future trends in globalization which engineers should be aware of are:

(i) Because of all the factors associated with globalization discussed in this paper, there will continue to be an increase in complexity, diversity and the number of stakeholders involved. Some of the stakeholders and their roles are listed below in Table 2 showing how different stakeholders have varying interests causing the complexity of projects involving globalization to be significantly greater than for domestic projects. It is also necessary for the engineers as well as managers to understand the stakeholders and how they interact.

Table 2: List of various stakeholders and their roles in globalization projects

Stakeholder	**Primary Role**
Client	Buying services of end product
Provider	Selling services or products
Advisory Firms	Providing quality advice to clients and providers
Government in provider country	Increase business and FDI
Government of client company country	Protectionism
Non-profit organizations	Serve as a watchdog
Professional Organization	Educate through events, certifications and standards
Academia	Research in the field of globalization

(ii) There will continue to be multiple providers for a single project as globalization continues to mature and organizations continue to look for the best value. As a result, engineers need to understand integration issues to much greater extent than when they dealt with a single provider.

(iii) Virtual teams will continue to operate and increase in numbers resulting in a greater number of engineers working remotely with other team members. Due to this engineers have to learn to be better communicators and also be aware of cultural issues that may arise while communicating with colleagues in different parts of the world.

(iv) Customers will take a greater role in driving and designing products requiring engineers to listen to the voice of the customer even more closely than they currently do.

(v) Rising prices of oil will force companies in high wage countries to continue to be involved in globally disbursed projects and thus in globalization. This will put more pressure on engineers to device ways to "design more using less".

(vi) Vendor focus will shift from basic skills and low costs to domain knowledge, transition challenges, change management and HR issues.

(vii) There will be an increase and shift in venture capital funding from West to East.

Conclusion

This paper provides an overview of the benefits and risks of globalization that engineers will need to understand in an increasingly dynamic and interconnected world. The era of globalization is pushing demand for a new type of engineer. In a previous age, an engineer worked with a black box mindset and might only need to understand the particular subsystem he was working on and not the entire system. Engineers evolved with the need to understand the entire system and think beyond just the engineering phase to consider the needs of other departments within the firm, such as designing for ease of assembly for the production department and ease of use for the marketing department. With globalization, engineers are required to think far beyond the firm walls, and require an understanding of various cultures and types of communication.

This new world will challenge engineers who like other professionals tend to dwell in silos. The silo approach is not suited to dealing with a dynamic environment characterized by complex issues such as rapid changes in information technologies, the explosion of globalization and outsourcing, and increased competition. A transdisciplinary and integrative and way of thinking is required. While engineers are not yet well-equipped and experienced to deal with the globalization issues raised in this paper, they are familiar with useful tools, such as the systems approach, which can be a springboard to adapting in this new era.

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