

Canaries in the mineshaft: engineers in the global workplace

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Abstract

We need to get beyond the overheated rhetoric about the offshoring of jobs and look seriously at how engineers and the engineering profession want to live and act in society. This article outlines the current debate about the migration of jobs overseas and the dismemberment of engineering and technology jobs into commodifiable pieces. It is written so as to provide a cross-section of information sources for the reader interested in pursuing the topics further, but may also be read without attention to the footnotes.

Introduction

A few years ago when concerns were being raised about the impact of the global marketplace on the employment of US engineers, the authors drafted a paper entitled “Are current engineering graduates being treated as commodities by employers?”¹ We questioned whether engineering in the United States was still an attractive profession offering productive and satisfying careers and lifestyles. One of the important problems we noted was the churning in engineering employment, with more experienced engineers living under the constant threat of being replaced by younger, more recent graduates, and with little consideration being given to acquired knowledge, mature judgment, proven dedication to the larger enterprise, and such.²

Since that paper was first drafted many factors have rapidly converged and conspired to change both the world and the discussion about the dynamics of engineering employment:

- the world economy remains fragile and volatile, but increasingly integrated across national borders;³
- cheap, instantaneous global communication has made international markets and an international workforce a functioning reality;⁴
- huge pressure for profits has resulted in US industry engaging in out-sourcing by off-shoring significant numbers of technical jobs, while at the same time demanding increased innovation and creativity in engineering work and services at home;⁵
- the media have made “off-shoring” the crisis *du jour*, and politicians are embracing it in their campaign rhetoric;⁶
- threats of terrorism are world-wide and are cited as a reason for more restrictive US immigration practices which have affected the international student population and the intake of highly-skilled technical personnel;⁷
- applications to US universities from international students, long a mainstay of engineering enrollments at both undergraduate and graduate levels, are deteriorating while at the same

time overseas universities are stepping up their recruiting efforts abroad and are seeing positive results;⁸

- the much-awaited economic rebound in the US has been characterized as a “jobless recovery”;⁹
- enrollment in engineering programs peaked in 1986 in the US and has only recently begun to rebound;¹⁰
- enrollment profiles in engineering programs suggest that gender and race remain problematic in the profession.¹¹
- morale among mid-career professional engineers is sinking, what with salary compression and employment instability;¹²

Each of the above factors has added to the complexity of the issues surrounding workforce dynamics for engineers, and provoked intense interest in those concerned with the overall economic future of the US. The question is no longer just whether engineers are being treated as commodities, but how engineers and other highly educated technical people shape and are shaped by the emerging realities of a truly global workforce. Engineers as a professional group are thus the canaries in the mineshaft of the new world economy. Whether engineers manage the transition from local to international workplace environments will determine if the profession remains attractive. The ways in which engineers weather the transition will be significant indicators of the viability of the globalized workplace of the future and the quality of life it offers everyone. Who participates in shaping the transition will be critical to the success of the transitions. What results from the transition will have an enduring impact on the economic and moral strength of the US and the world.

Off-shoring

A pressure for profit has always characterized business, but it was in the decade of the 1990s that we witnessed enormous expectations placed on every business to make spectacular returns on a quarterly basis. The waves of mergers, IPOs, acquisitions, high entry salaries and Hollywood-style CEOs made continued profits seem the norm. And the pressures found ready targets in well-placed decision makers who acquired a taste for high living and risky, sometimes outright illegal, strategies. Despite a couple of hundred years of accumulated legislation and regulatory codes, US business and industry were open to foolish expectations and greed. The world-wide economic fallout of the new millennium, when it occurred, brought calls for punishment of the perpetrators, legislation designed to prevent a repeat, and a quick return to prosperity, three not always compatible goals.

Now as the US slowly pulls out of recession, the same urgency to ensure profitability is in the hands of a new generation of business leaders who seen as eager as their predecessors to see a rise in stock prices and return to the paradise of the 90s. Since the biggest investment of most companies is in personnel, this has meant turning more aggressively to outsourcing and off-shoring to reduce production and service costs. Profiting from several of generations of students graduated from excellent engineering programs in the US and, increasingly, in countries abroad as well, nations such as India are now offering attractive alternatives to US salary scales, with well-educated, lower-paid engineers and technical people who are capable of taking over parts or all of the jobs of some higher-paid US employees. Significantly improved communications and

information systems now make a global workforce in knowledge and information based areas a reality to a degree not possible even a few years ago. Whatever bonds of trust which used to link US employers and employees have been quickly lost; employers are reduced to looking for the lowest cost and employees for the highest salary, or more disturbingly, for a job. Leaders of industry will continue to seek the right skills at the right cost wherever the right combination can be located.

If the globally interconnected workforce is a reality from now forward, what should engineers, who are among the first professionals to be so deeply affected, do to shape that workplace to their needs? And what should be the engineering profession's reaction to the deconstruction of engineering work?

Rather than summarizing the flood of pieces that have been published in the past year on the phenomenon known as "off-shoring," in this section we will step back and articulate threads that have been running through the discussion. We will keep in mind that our readers are primarily engineering educators: in return, we ask that our readers keep in mind that the subject of off-shoring has been disproportionately shaped by the media and by political rhetoric, all playing against the background of the up-coming US presidential elections. For that reason, we will point to a few serious studies and thoughtful pieces which go beyond the hype and raise important questions, including whether such a phenomenon as "off-shoring" is worthy of attention.

(1) Engineering is arguably the first profession in the US to be significantly affected by globalization at the level of access to employment. While US doctors, lawyers and other front-line professionals have early on been forced to adopt practices to accommodate the shrinking and more integrated world, engineers and technical people are so far the only ones whose jobs are being publicly deconstructed and redistributed or entirely displaced offshore. This is one reason that the subject has attracted so much interest, despite the familiarity of the off-shore migration of manufacturing jobs.¹³

(2) The numbers of US high-tech jobs that have to date been sent off-shore still remain elusive,¹⁴ but they may ultimately be less interesting than the prospect that segmentation of functions and dislocation of work sites are the waves of the future for engineers.

(3) The optimistic view of offshoring is that it actually generates economic benefits in the US. This assessment was articulated by the McKinsey Global Institute in a report "Offshoring: Is It a Win-Win Game?" released in August 2003.¹⁵ If this and other more positive assessments of the results of globalization are true, there still remains the problem of getting from here to there, aiding highly educated professionals make employment transitions in a world where the pace of change outstrips the anticipated working lifetime. These are changes that move so rapidly that benign neglect is not an option.

(4) The US is not the only developed country that is being affected by off-shoring.¹⁶ But up to now, international dialogue between countries such as the US, the UK, Canada and Australia, all of which are experiencing the effects, has been absent.

(5) Since the off-shoring phenomenon is relatively recent in its present guise, there is a lack of information about the locations where the off-shored jobs are being placed. This includes issues are diverse as the quality of the infrastructure supporting employment centers, reciprocal trade agreements, skills training, worker safety, continuing education, all of which can help us understand the nature of the off-shoring dynamic, better predict its future and consequences, and map out strategies in response.

(6) Even while admitting that off-shoring is likely to become a permanent feature of the globalized economy, there is room to believe that very special conditions – not easily or quickly replicated – permitted India to become a prominent world-center for a number of IT related activities.¹⁷ So a thoughtful approach to how to respond – but one with prompt deadlines for decision-making – would make sense.

(7) Engineering educators should not be surprised by the emergence and growth of off-shoring. For decades US colleges of engineering have been graduating excellent students from India, as well as other lesser-developed countries around the world. While recent focus has been on the number of such graduates who have remain in the United States,¹⁸ significant numbers have always returned to their homeland, presumably in search of ways to put their education to good and profitable use. Seen in this light, tapping the growing cadre of well-educated engineers and technical people in their homelands is a natural outcome.

(8) Calls for internationalizing the engineering curriculum, including providing all students with structured experience in managing both electronic and face-to-face cross-cultural contacts, now become even more compelling in light of these developments.¹⁹

(9) Many people are now calling for managing the globalized economy, realizing that it will not manage itself. Management instruments can range from passage of protective trade legislation²⁰ to name calling (e.g. “Benedict Arnold CEOs”)²¹. The burden of managing the new engineering workforce dynamics that are emerging from globalization is not the sole responsibility of higher education. Engineering educators, however, are experienced professionals who have a realistic understanding of the place of engineering in world development and important things to say about the nature of the engineering enterprise and how engineers can best be utilized.

(10) The “jobless recovery” may actually be “down-sizing” or “right-sizing” wearing a politicized label. Increased productivity is desirable but the process also requires skilled management, as we learned in the 1980s, so as to smooth out the bumps and provide needed safety nets.

(11) When education and re-training are quickly thrown out as a solution for jobs lost through off-shoring, we need to remember that many of the people who have lost these particular jobs are already highly educated. There is a vast difference between providing retraining for those with no high school degrees, and fashioning productive ways to reintegrated into the employment market someone who has a master’s degree in engineering. Even the Brookings Institution has admitted that this is a challenge which for now is beyond their radar screen.²²

(12) “Today, most employees are seen as units to be stockpiled or shed as business warrants. Technology not only allows fewer people to do the jobs of many; it also allows their skills to be taught to almost anyone, quickly, anywhere around the world.” Robert Reich’s statement is a preamble to an argument against protectionist legislation, but it describes an unattractive work environment, and issues a challenge to educators to examine the balance in the current curriculum between skills and education.²³

Immigration matters:

Engineering employment issues cannot be discussed today without serious consideration of the world political scene, which has deeply affected immigration policies in the US in the aftermath of September 11. For years various groups have been tracking the increasing numbers of foreign-born engineering students and the relatively low numbers of US-born engineering students in US universities. The implications of these changing demographics have been read as positive, negative or neutral, depending on who is doing the analysis of the figures, but every US engineering school and engineering association has already been involved in attempts to increase the numbers of US students in engineering programs by scholarships, fellowships, pre-college programs, PR campaigns, supplemental teacher training, etc. These efforts, however, have only stabilized the already low enrollment in engineering at levels below those seen in the glory days of the 1980s.²⁴ And the welcome mat has remained out for foreign-born students eager to enroll in the best US universities, especially because many of those best and brightest aspired to remain in the US as citizens after graduation.

Today, however, immigration issues which deeply affect engineers and engineering education in the US are inextricably tied to issues of national security. The razor-thin tolerance that many US citizens and some of their elected representatives have had for students and workers from non-Western countries has diminished to a hairline, capable of fracture under the least provocation. Questions or concerns about H-1B or L-1 visa policies these days seem too often to provoke arguments about homeland security, international *quid pro quos*, and the national origins of terrorists.

For US engineering educators, immigration issues have moved from being an annual annoyance to being an important factor in enrollment and faculty employment. With almost 30% of US doctoral degrees in science and engineering going to foreign-born people²⁵, monitoring immigration laws, policies and systems needs constant attention because of potential negative effects on the entire engineering education enterprise in the US. International students have been a means for responding to the need for diversifying the enrollment in many US universities: if immigration is limited, the numbers start to read uncomfortably low. Finally, with technically-minded international students now having good universities and improved work opportunities at home, they can take their US education and return home, leaving behind a US engineering workforce which will gray more rapidly with their departure, or else never leave home for their education, leaving US universities without their talents.

It is in the interests of the engineering educators, as public leaders to participate actively in a sustained and informed discussion of the composition and characteristics of the technical workforce needed to sustain national and international productivity, progress and welfare.

Because immigration is a fundamental piece of the global workplace and the global economy, it deserves considerable attention under conditions where a fair exchange of ideas can take place. Engineers and technical professionals are more expert than most in this area and should lend their expertise to establishing the dialogue and defining the key issues. It appears unlikely that the US can continue to ratchet up its level of creativity and innovation at the same time that it is shutting the door to some of the best and brightest people who happen not to have been born without our borders.

What is the truth?

It is often frustrating to try to understand the employment dynamics affecting engineers. Information is frequently incomplete, and even when relatively complete, is too often contradictory or subject to widely differing interpretation. Added to this is the fact that within the past couple of decades there have been times when the subject of workforce dynamics has been tainted by suspicions of bias. In the 1980s a hue and cry was raised about the impending shortage of engineers in the US, and the sound carried even to the US Congress where laws were examined and policies changed to permit greater numbers of international students and professionals to come to the US to prevent the predicted long-term shortages. When the shortages failed to materialize, finger pointing began and accusations made aimed at individuals and institutions who might have profited from beefing up the numbers of engineers and technical people available for hire. There was a small-scale repeat of this situation in 2000 when H-1B and L-1 visa quotas were changed to increase the flow of highly trained technical people into the US, some say in order to depress the salaries of US workers through competition. These events should not deter us from attempting to shape the workforce of the future, but should serve as a cautionary tale. At the very least, we should steel ourselves against media-induced panic, carefully analyze long-range predictions, and admit that the engineering profession might find allies in other professions similarly challenged by change.²⁶

Here are some of the many questions which have not been adequately answered:

1. How many engineering jobs have been off-shored in the last five years? How big a percentage of such jobs in the US does that number represent? What industries have been most affected? Has greater efficiency and productivity made up for those job losses?
2. What job categories have been off-shored? Are they mostly graduate engineering and IT positions? How many were all high skills jobs?
3. What portion of the newly-exported US jobs were created from deconstructing and commodifying specific engineering skills? What do we know about the impact of this deconstruction on the over-all creativity and productivity of individual engineers?
4. What are the figures on reverse off-shoring? How many jobs have already migrated back to the US after having been sent overseas? What do we know about connections between product and service quality and off-shoring?²⁷
5. What is the real cost to companies of off-shoring or outsourcing abroad?²⁸
6. How are other developed countries affected by job migration?²⁹

It is difficult to understand the situation without a much better grasp on the facts and more attempt at synthesis of what we do know. Policy makers in education, government, professional societies, funding agencies, industry, think tanks and the media, are largely talking past each

other. The dialogue which does make place is not sustained: at best one or two sectors gather together intermittently to compare notes, but there has been no comprehensive look at the multiplicity of the issues, the influencing factors and the perceived future, and where interested parties can help shape the future of the technical workforce and their work.

Dialogue

In our original article about engineers being treated as commodities the authors put the burden on the professional associations to take action to improve the work situation for engineers. We proposed to use carrots, not sticks, asking the professional associations to give positive reinforcement to companies offering engineers a stable and productive work environment:

It appears that the issue of ‘engineer as commodity’ must be addressed directly, and soon, but who should lead the effort? Corporations and government agencies are unlikely to address it, given pressures for accountability and profit. Individual engineers or small groups of them are not able to make any impact. So it is up to the engineering professional societies – individually or as a group – to provide leadership. ^{30 31}

Today we see the problem as more nuanced and complex and deserving of a richer examination by a wider, interdisciplinary field of professionals, policy makers and thinkers. For that reason Engineering Conferences International has agreed to sponsor a major meeting on Engineering Workforce Dynamics in early 2005, under the direction of the authors of this paper. The conference will bring together the CEOs, professional engineers, professional societies, engineering educators, elected representatives, government officials, funding agencies, members of the media, statisticians and scholars, and create a structure for productive presentations and dialogue. The goal will be to define the current challenges to the employment of engineers, to begin to formulate policies to improve the dynamics of engineering employment, to draw policy makers into a coordinated action agenda, and to determine the role of engineering education in best attracting and preparing a new generation of engineers for the future we see on the horizon.

Here are a few of the themes to be explored in the forthcoming conference:

What new paradigms are being offered for the increasingly globalized workplace and workforce, and how do engineers and engineering stand to fare under each?

- What truth is there to the claim that the US can keep its competitive edge by concentrating on innovation and not troubling itself with loss of routine jobs overseas? Should lower-paying technical jobs be off-shored, while the US concentrates on high-end innovation?
- Should protective trade, immigration and monetary policies be crafted to stem the tides of change?
- Should Sputnik II-type incentives be used to induce more US students to undertake engineering as a profession?
- What would be the benefits of a government funded program aimed at re-training fully-credentialed engineers, and facilitating their re-integration into the most active and productive tiers of employment?

Is it possible to converge on a unified paradigm for better utilizing engineering capacity in a globalized economy?

- Who are the stakeholders in the creation of such a paradigm?

- What is the role of other developed nations, themselves undergoing similar strains, in the formation of a unified paradigm?

What needs to change in order to realize a new employment paradigm? How can the transitions be managed?

- What role do the professional associations have to play in shaping the engineering workforce?
- How should engineers be educated in the future, for initial practice and for continuing professional development?
- Where does ABET fit into managing a transition, both in the US and abroad?
- What role might unions, traditional players in negotiating workplace and workforce issues, have in the discussion of solutions?
- Is there a future for global accreditation and licensure?
- What are the responsibilities of industry to address workforce dynamics, including quality of life issues?
- Should engineering be re-defined to reflect the more extensive involvement of engineers outside of technical specialties, in policy formulation, executive management, elected positions?

Given that what happens to engineers and the technical workforce may well set the tone for the work environment of future generations of many professions, who are the best trusted and most credible advocates for the engineering profession?

- What useful alliances might be forged between the engineering profession and other professions challenged by applications of technology and rapidly changing working conditions, for example, medicine?
- What are the best ways of making the debate heard at policy making levels?

Conclusion

All these plans for the future are posited on the belief that engineers are key players in the continuing economic, social, and political progress of the world and in the stability and growth of the US economy. If immigration continues to undermine the participation of international students in US engineering programs, and if there is no foreseeable turn around of the negative attitude of so many US students toward engineering as a profession, and if the news continues to be saturated by stories about disappearing and disjointed jobs, with no mitigating steps taken to buffer the changes, the prospects for engineering in the US are bleak, and the implications for the economic strength of our country are serious.

Just as the medical profession moved doctors away from being blood-letters, distributors of patent medicines and bone-setters, one of the goals of engineering educators should be to see engineers placed more centrally in decision-making circles about the central issues of the profession. It might not be bad to aim at replacing jokes about the number of attorneys in the US Congress with similar jokes about the over-abundance of engineers who took their places.

If engineers and their profession are today threatened, history tells us that it will take more than a change of CEOs, the erection of trade barriers, or a closing of national borders to correct that. Globalization has its positive and negative elements: one of those negative elements is its

tendency to be demonized as an all powerful force poised to take over every aspect of our lives starting with our jobs. Of course it will, if we let it happen. Our challenge is to see globalization as just the business environment of the 21st century, and not to abdicate to it control over the social, educational, legal, political, economic, ethical and cultural structures that govern the way we want to live and work. For those, we must take individual and collective professional responsibility and action.

¹ Jones, Russel C., and Oberst, Bethany S. *European Journal of Engineering Education*, Vol. 28, No. 3, 2003, pp. 395-402.

² See George Mason University President Alan Merten's comment: "For the most part, companies are now unwilling to make serious, long-term investment in their employees." Quoted by Steven Pearlstein, "Still Short of the Offshoring Ideal," *Washington Post*, March 12, 2004, p. E01.

³ Bhagwati, Jagdish H., *In Defense of Globalization*. Oxford Press, 2004.

⁴ "Offshoring promises huge benefits to consumers." *The Economist*. December 11, 2003.

<http://ebusinessforum.com>

⁵ Thibodeau, Patrick, and Lemon, Sumner. "R & D Starts to Move Offshore," *Computerworld*, March 1, 2004. <http://www.computerworld.com>, Quicklink 45069.

⁶ Gongloff, Mark. "Outsourcing: what to do?" *CNN Money* (March 1, 2004). The article begins: "If you haven't turned on a TV or read a magazine or a newspaper recently, you probably haven't heard that your job is moving overseas." http://money.cnn.com/2004/03/01/news/economy/outsourcing_solutions/

⁷ Association of American Universities, letter from higher education organizations to the Honorable Sherwood Boehlert and the Honorable Bart Gordon, US House Committee on Science, February 25, 2004, available at <http://www.aau.edu/resources/Ltr2.25.04.pdf>.

⁸ Bollag, Burton. "Australia Sees Strong Gains in Enrollment of Foreign Students," *Chronicle of Higher Education*, March 9, 2004, <http://chronicle.com/daily/2004/03/2004030903n.htm>.

⁹ See for example, this report from Mark Schweitzer, an economist with the Federal Reserve Bank of Cleveland. "Another Jobless Recovery?" *Economic Commentary*. March 1, 2003, available at <http://www.clevelandfed.org/Research/Com2003/0301.pdf>

¹⁰ Davis, Lance A., and Gibbins, Robin D, eds. "Raising Public Awareness of Engineering," National Academy of Engineering. Washington, D.C.: The National Academies Press. 2002. <http://books.nap.edu/books/0309086248/html/index.html>

¹¹ "Raising Public Awareness," NAE.

¹² See Merten quote above, and Reich quote in note 22.

¹³ The Brookings Institution, "Preparing America to Compete Globally: A Forum on Offshoring, March 3, 2004, Washington, D.C., (transcript available on-line at <http://www.brookings.edu/comm/events/20040303.pdf>

¹⁴ The IEEE-USA is calling for the US government to begin collecting data on offshoring. See <http://www.eetimes.com>.

¹⁵ See <http://www.mckinsey.com/knowledge/mgi/offshore/>.

¹⁶ "Holyhood commissions inquiry into call centre jobs offshoring," Karl West, city editor, *The Herald*, March 1, 2004. (one example, from Scotland, among many).

¹⁷ Friedman, Thomas. "The Great Indian Dream." *The New York Times*. March 11, 2004. Available at <http://www.nytimes.com/2004/03/11/opinion/11FRIE.html>

¹⁸ Bartlett, Thomas. « Fewer Foreigners Go Home After Earning U.S. Doctorates." *Chronicle of Higher Education*, Vol. 50, No. 19. January 16, 2004.

¹⁹ McGraw, Dan. "My Job Lives Over the Ocean," and "Putting it into Perspective," *Prism*. December 2003, Vol. 13, No. 4, and January 2004, Vol. 13, No. 5.

²⁰ Schneider, Greg. "Anxious About Outsourcing: States Try to Stop U.S. Firms from Sending High-Tech Work Overseas" *Washington Post*. January 31, 2004, p. E01. Also Robert, Dan, and Alden, Edward. "Senate passes measure to restrict offshoring." *Financial Times*. March 9, 2004.

²¹ Mehlman, Bruce P. "Offshore Outsourcing and the Future of American Competitiveness." This report was presented in several locations in 2003 by Mr. Mehlman, Assistant Secretary of Technology Policy at the US Department of Commerce. See http://www.technology.gov/Speeches/BPM_2003-Outsourcing.pdf.

²² “Preparing America to Compete Globally.” Senior economist Jared Bernstein of the Brookings Institution is quoted as saying, “. . . I do think that there is a strange kind of dissonance around this education and training comments in this discussion . . . I don’t know if people are really wrapping their heads around how high the education and training bar has to be in what we’re talking about. . . . Now, that’s a very different kind of training debate than what we’ve typically talked about in these very walls at Brookings, which is let’s figure out how we can give people coming off the welfare rolls the soft skills they need to make it into the labor market. And we’ve had a pretty time, really pushing that agenda very far and have had some success but questionable. So you’re talking about a training agenda that is so far beyond anything we’ve contemplated.”

²³ Reich, Robert. “Jobless in America.” *CIO Magazine*. Fall/Winter 2003.

<http://www.cio.com/archive/092203/index.html>

²⁴ “The Science and Engineering Workforce: Realizing America’s Potential,” National Science Board. National Science Foundation, August 14, 2003. Available at <http://www.nsf.gov/nsb/documents/2003/nsb0369/start.htm>.

²⁵ Tilghman, Shirley M. “Testimony before the US House of Representative Committee on Science,” March 26, 2003. Available at <http://www.house.gov/science/hearings/full03/mar26/tilghman.htm>.

²⁶ See the work in progress at the National Bureau of Economic Research, Science and Engineering Workforce Project, <http://www.nber.org/~sewp/papers.html>

²⁷ Two examples, one well-known (Dell), one lesser-known (SafeHarbor Technology). Brewin, Bob. “Dell Sends PC Support to the States.” *PCWorld*, December 1, 2003. Available at

<http://www.pcworld.com/news/article/O.aid.113681.00.asp>. Cook, John. “Venture Capital: Weighing pluses and pitfalls of offshoring.” *Seattle Post-Intelligencer*. March 5, 2004. Available at

http://seattlepi.nwsourc.com/venture/163347_vc05.html.

²⁸ One of the most often quoted reports on this subject is a study done by Hewitt Associates and released in March 2004. In it the authors point out that many companies are not reaping the savings they thought they would through offshoring. See <http://was4.hewitt.com/hewitt/resource/newsroom/pressrel/2004/03-02-04.htm>.

²⁹ “Most Siemens Software Jobs Moving East,” *The New York Times*, February 16, 2004; Siemens, UK,

³⁰ “Are current engineering graduates being treated as commodities by employers?”

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