Chinese Engineers – Threat or Opportunity?

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Summary ............................................................................................................................................. 3
Intro – At KFC with Rachel and Quing........................................................................................... 4
Objective, delimitation, and methodology ....................................................................................... 6
Chinese culture and tradition – as seen from Scandinavia ............................................................ 8
The Chinese educational system .....................................................................................................11
Engineering educations in China ......................................................................................................15
Who are the Chinese engineers and what do they know? ............................................................17
  The teacher is always right ...............................................................................................................20
Chinese engineers’ career opportunities ........................................................................................21
New competence profiles on the way? ............................................................................................24
Summing up: Strengths and Weaknesses, Opportunities and Threats ......................................26
  Strengths ............................................................................................................................................. 26
  Weaknesses........................................................................................................................................... 28
  Opportunities.......................................................................................................................................29
  Threats.................................................................................................................................................. 30
China – a station on the way. Destination: Global Engineering?................................................ 32
List of informants................................................................................................................................34
Literature.......................................................................................................................................... 35
Summary

The recent years have seen a great interest in China. An interest mingled with the fear that the Chinese will outcompete the Western economies on the global market. Especial great attention has been given to the many engineers that China is educating each year. However, great uncertainty also exists regarding just exactly how many engineers are concerned and which competences the Chinese engineers actually possess.

This report deals with illustrating the relations concerning the Chinese engineering educations, the Chinese engineers, and their competences. From a Scandinavian starting-point, the report takes a look at the Chinese engineer culture and the structure of the engineering educations in order to give a description of ‘What do the Chinese engineers know and not know’ – i.e. the Chinese engineers’ competences. The aim is to attract attention to a number of key relations concerning the Chinese engineering culture and the Chinese engineering educations.

As our point of departure, it is important to state that the Chinese engineers are just that: Chinese. The Chinese culture and the Chinese society differ in many ways from the Scandinavian ones, and Chinese engineers thus naturally have other ways to approach collaboration, authorities, values, etc. – also even though engineering cultures are mixed in the global melting pot.

China’s intensive focus on education has resulted in a marked increase in the number of graduates with higher educations. In 2011, 6.6 mill. highly educated graduates were educated in China – of which approx. 2.2 mill. were engineers. But although China thus produces many engineers, great differences exist between their level of competences and professional abilities. A minor flock of Chinese elite universities are educating highly qualified academics and engineers on an international level, whereas a major share of Chinese universities are combating extensive quality problems, out-dated forms of education and teaching, shortage of teachers, etc. The competence levels of the Chinese engineers thus present a varied picture indeed. Simultaneously, however, a clear awareness and will exist to work on improving the quality of the educations. This must be taken in conjunction with the rising degree in which China is opening up to interplaying with the West. The Chinese society and culture are under strong influence of the globalizing tendencies, and the young people are willing to change and open towards new forms of cultural education and teaching.

Through a SWOT analysis, the report will search out the strong and weak points of the Chinese engineering culture and of the Chinese engineering educations. Simultaneously, it will be assessed which opportunities and threats the Chinese engineers are facing in gaining access on the global engineering labour market.

In conclusion, we reflect if it is indeed opportune to give so much attention to the Chinese engineers in particular. Although the sheer number of Chinese engineers may seem to be overwhelming, this is perhaps not the most central point in relation to the possibility whether Scandinavian engineers can retain their position on the global engineering labour market. Here, the report points at the fact that more attention should be given to the globalizing tendencies of the university and engineering educations these years. In the global hunt for talent mass, this may have consequences for the Scandinavian engineers.
China has many faces. And the face of the Chinese youth is quite different from that of old China.

The young Chinese speak English and behave very confidently when we meet them. They readily guide our way, translate from Chinese into English, etc., so that when we are visiting the big cities in China it is far easier to communicate with the youth than with their mothers and fathers. Many of them even speak English quite well and have a decent vocabulary and a good pronunciation, although they never have been outside the country or spoken with that many foreigners. They start to learn English already in kindergarten, and they learn English with the aid of language programmes in which they hear the pronunciation. Additionally, they watch American television series, perhaps daily, just as young people in our part of the world. That pays off when meeting Westerners. They are familiar with other behaviours, ways of dressing, habits, etc., so that even series such as The Vampire Diaries is educational in this process, and the young Chinese women swoon over the handsome protagonist Paul Wesley in the series, just as young girls in the West.

We told some young Chinese people that we heard music from a park, went there and saw Chinese people dancing to the music, in pairs or by themselves according to their own patterns. In their opinions, that was old-fashioned and somewhat embarrassing, and certainly not something that the young people would do. When young people take time off, they prefer to go shopping. To promenade up and down the long shopping streets where the foreign designer shops are situated side by side – from the major brands such as Gucci and Rolex to the Swedish brands Zara and H&M. The prices are no cheaper than in the Scandinavian countries, nevertheless they can afford to buy a purse or a blouse now and again. Mostly, however, they go shopping in the innumerable cheaper markets that also sell plenty of fake copy products. Most young people in cities such as Beijing and Shanghai are dressed in the fashions of young Western people even down to hairdos and glasses. However, Chinese streets do not display as many of the more specific youth cultures as many a European metropolis.

The young people we meet would all like to go to the West, but it is difficult for them to obtain a visa to do so. Denmark, for instance, with its strict foreign policy does not render many opportunities for Chinese students to visit, apart from short tourist stays, unless an exchange deal or an educational programme exist or a work permit as part of the job.

We met the young people everywhere and were able to exchange a few words with them, but the only real possibility to talk with them was at the Chinese universities. We were invited by various professors within various scientific areas, all renowned within their fields, but they were compelled to invite one or more students to come along to the meeting to ensure an understandable dialogue. For far from all professors in China speak English, and by no means on a level that makes communication possible. If you are a student, however, English is a matter of course – and if you are a PhD student, you might even have been studying in Canada or USA.

The students live in large four-bed dormitories on Campus, where the only things they possess are a bed, a table, a chair, and a wardrobe. All meals are taken in the student dining halls, so there is great difference from Danish student halls of residence, in which students from different lines of study often reside together, the kitchen usually functioning as a social pivotal point in their everyday life with self-organized, shared cooking. Usually, the young people live with their parents until they are married. Until then they belong to that household, and not until their marriage do they become their own family. So usually, it is not possible for the young people to move away from home unless they marry. Student life at the dormitories at Campus being an exception. By far the most live here, also although they have family quite nearby. Possibly a relic left over from the Communist era, so as not to differentiate between rich and poor or between countryside and town dwellers. The students with whom we talked did also prefer to live together with the other students, have a pleasant time together, throw small parties, and that sort of thing.
The young people are quick to participate in the conversation and even take independent initiatives as well, although only if directly encouraged to do so. However, it were the students of one of the universities that would invite us out to lunch after our visit – at their favourite restaurant KFC (Kentucky Fried Chicken). Here, Rachel and Quing often dine when they have finished shopping in the supermarket. Rachel by the way has chosen her ‘Western name’ herself just like many other young Chinese students. Both McDonald’s and others of the major fast-food chains are quite popular with the young people, although the quality, as far as we could judge, was not up to the same standard as in the home country, USA.

When asked what she saw as the greatest challenge for the Chinese university students, Rachel replied, “The greatest challenge for us young people is to get a job that doesn’t follow the stereotypical frames, and find a fourth way to challenge ourselves”. First challenge being to get an academic education, second challenge to get the first job, third challenge to go abroad.
Objective, delimitation, and methodology

Our meeting with Rachel and Quing – and what insight they gave us into Chinese society – is kaleidoscopic. And that is just how it must be! For Chinese society is not just one thing, but on the other hand characterized by different tendencies, development patterns, and dynamics. Experts even like to say that China is the ‘country of opposites and paradoxes’ (Mitter 2008). In the nature of the case, this report cannot then answer the great question that forms the background for the enormous interest for China as seen in the West recently: Does China’s development constitute a threat or an opportunity for the West? During the past nearly 35 years, China has entered upon a course in which they have ‘opened up’, and capitalist principles of the market economy are beginning to take up more and more space. This has meant that new markets have been opened for the West in China, but also that Chinese interests have found a solid footing in the world economy. In this connection, Western public opinion has often raised the questions whether we in the West are competitive enough towards the new China, and on what we are to live in the future when our businesses move their production – and as a more recent tendency – research and development activities to lower-paid areas in the Far East. These are great – and important – questions to which, alas, no unequivocal answers are given. Neither in this little report.

In this report, we do not bite off more than we can chew. Although the great China interest is characterized by the above question, we must delimit and focus our presentation. As described earlier, in this report we are interested in the Chinese engineering educations, the Chinese engineers, and their competences. We shall take a look at the Chinese engineering culture and the structure of the engineering educations in order to give a description of ‘What the Chinese engineers know and do not know’ – i.e., the Chinese engineers’ competences. This description may perhaps indirectly contribute to answering the big question “on what are we then to live in the West?” But only very indirectly. Although engineering competences are an important part of the competitive power, a great number of other circumstances still play a part – and which are not dealt with here. Additionally, ‘competences’ are a relative concept as well. Thus, it is not possible to be ‘competent’ in oneself – one is always competent in relation to a context and to other people’s minds. Therefore, it is important to realize the standards and optics in which we view the competences. And in our case, they are Scandinavian. It is not our ambition to do a comparative study of Chinese and Scandinavian engineering competences; however, we shall discuss Chinese engineering competences in relation to the Scandinavian standards for what important engineering competences are.

The objective of our presentation is to point out a number of attention points to form the background for further exploration and reflection. The time spent and resources employed in working out this report do not allow a thorough scientific treatment of the subject-matter. The report is therefore to be taken as a preliminary and –in the nature of the case – interim suggestion hopefully to stimulate more thorough studies and analyses.

The background for our treatment is the desk research that we carried out during the autumn 2011 (see the literature list). A number of acknowledged, international scholars working with education research, engineering professionalism, engineering educations, and the Chinese engineering culture, have aided us by pointing to relevant literature that may contribute as answer to our problem. As is the case with desk research, you never finish pursuing new points and search new angles. In our case, however, we still believe that we have come as far as is possible in relation to our problem. Nevertheless, we cannot base our problem solely on desk research. Thus relatively soon did we discover that the available literature in this area is relatively sparse for those of us who do not read Chinese, and also soon did we realize that part of the literature thus is characterized by the ‘political correctness’ which the Chinese regime directly or indirectly forces upon research. Therefore, it was quite essential that we were given the opportunity to carry out a number of interviews with researchers in the engineer field both internationally and in China. When meeting the Chinese researchers in a more intimate interview situation, we were greeted with great hospitality and greater openness about the challenges characterizing Chinese engineering competences. Our
dialogue with international experts in this field also made a crucial contribution to the picture that we are trying to draw. (See the list of interviewees). Finally, the general impressions of modern Chinese society that we received when visiting Beijing and Shanghai to study (February 2012) have been of great importance to the report. Our interviews have primarily been carried out with researchers and practitioners in academia. We also planned to carry out several interviews with representatives of Chinese and Scandinavian engineering businesses in China, but from practical reasons, this was not possible.
Chinese culture and tradition – as seen from Scandinavia

When we ask the question what Chinese engineers know and do not know, it is of the utmost importance to understand the Chinese cultural background. For Chinese engineers were Chinese before, during, and after they became engineers. Furthermore, the Chinese culture is one of the oldest in the world, and Chinese society – with many and important changes on the way – has existed as a unity through millennia. This is a contributing factor to structuring, correcting, and orienting the way in which the Chinese meet the world. Although it may be problematic to talk of ‘national character’, neither will it do to undervalue the specific characterisations entailed by the socializing within national cultures (Nisbett 2004, Ames 2011, and Hofstede). What should also be borne in mind is that the engineering culture is a recent phenomenon in China. The first engineering schools and universities were founded approx. 100 years ago in China (Hayhoe 2011), and by far the majority of the leading engineering universities in China carries less than 50 years’ history.

Just as Western cultures are strongly influenced by their Judeo-Christian origin, it is without any doubt that the Chinese culture is strongly influenced by the teachings of Confucius (Mitter 2008, Fung 1997). Confucius (551–479 B.C.) was a philosopher whose ideas and teachings formed the basis of practically every Chinese imperial dynasty up to when China became a republic in 1911. Confucianism attaches importance to seeing the individual as an integrated part of society in which every single individual is to fill a space and play a part in order to create balance and harmony. Confucianism is thus a kind of moral and social philosophy that sets the norm for how a good society should be managed and what it means to function as a citizen. The virtues to which Confucianism attaches weight are:

- **Ren** – mercy and harmony
- **Yi** – honesty and sincerity
- **Zhong** – doing one’s best, conscientiousness, and loyalty
- **Shù** – altruism and care for others
- **Zhi** – knowledge
- **Xin** – fidelity and integrity
- **Li** – correct behaviour, good manners, politeness

The cultural virtues manifest themselves in relation to one’s orientations and actions – for instance in a professional context in an organisation. It can be difficult to say how the virtues manifest themselves in modern Chinese culture and in work relations, which is of interest to us in this case, but cultural theorists have come up with their suggestions.

Professor Geert Hofstede, an internationally acknowledged cultural researcher, has carried out extensive comparative intercultural empirical studies on how workplace values are influenced by national cultures. He divides the cultural orientations into 5 dimensions:
1. PDI – Power distance (to what extent hierarchies and inequality are accepted)

2. IDV – Individualism vs. collectivism (to what extent weight is attached to ‘I’ or ‘we’)

3. MAS – Masculinity vs. femininity (to what extent weight is attached to material reward, performances, prestige vs. cooperation, modesty, care)

4. UAI – Uncertainty avoidance (to what extent one feels insecure concerning ambiguity and risk)

5. LTO – Long term orientation (to what extent weight is attached to quick results and ‘truth’ here and now or patience in achieving results and recognizing that ‘truth’ depends on the context).

Through empirical studies, Hofstede has studied to what extent these values are prevalent in various cultures. The below diagram shows Hofstede’s study results of China, Denmark, Norway, and Sweden (http://geert-hofstede.com/countries.html).

Hofstede’s analysis points out a number of differences between the Chinese and Scandinavian cultures. His study thus points out that the Chinese accept a far greater power distance than the Scandinavians; Scandinavians are far more individually centred than the Chinese; Scandinavian cultures celebrate ‘feminine’ values to a far greater extent than the Chinese do; and Scandinavians are far more fixed on achieving quick results and finding solutions here and now than the Chinese with their greater patience and different horizons as when to find the ‘right solution’.

Although such generalizations always should be taken with a grain of salt, Hofstede’s research of the five dimensions yield a good platform for identifying some important differences between the values and norms prevalent in China and Scandinavia respectively. Our interviews certainly did confirm abundantly the major differences between what is expected of engineers in China and Scandinavia. In the Scandinavian culture, it is quite important that every individual common-or-garden co-worker is able to ‘think for him- or herself’, take an initiative, relate in a critical and reflective manner to solving problems, be oriented towards results,
etc. The Chinese culture to a greater extent has a tradition for respecting the agreed hierarchical and organizational divisions of labour, traditions and formalities, etc.

Naturally, these overall cultural preferences are by no means nature-given, but on the other hand a manifestation of long-term historical movements. Hofstede’s findings originate from the previous decade, and demonstrate great differences in a number of parameters. Among the researchers, great disagreement exists as to whether the different cultures will converge in the light of globalization, or whether, on the other hand, they will continue to display great difference and diversity. Francis Fukuyama (Fukuyama 1993) has spoken of “the end of history” in the sense that the world’s cultures increasingly will be harmonized and resemble the Western cultures; whereas a writer such as Samuel Huntington (Huntington 1996) predicts continuous and greater cultural differences in the future world. However, a third perspective could also be imagined, predicting increasing convergence between cultural values – but a convergence not solely based on Western values, but which also includes Eastern cultural values. Richard Nisbett (Nisbett 2004), for instance, points out that ‘bicultural’ patterns of orientation may arise among people who have lived in foreign cultures for a prolonged period of time. In relation to our concern, it will be an interesting – but also open – question, for instance, whether the expert culture found among groups working professionally with technological and commercial problems will be able to tie Scandinavian and Chinese engineers together despite great cultural differences and preferences. Is it possible to imagine, for instance, Chinese and Scandinavian engineers – by virtue of similarities and educational and professional backgrounds – finding a basis to facilitate meeting across the general cultural differences?

Pursuing this great question would carry too far, and our few interviews are not nearly sufficient to give us evidence for drawing sharp conclusions on general cultural barriers and opportunities, but on the other hand, it is just as clear that the significance of the culture should not be underestimated. Let us for the time being restrict ourselves to pointing out a few essential points for attention in relation to the cultural field.

Points for attention:

- What do cultural differences and preferences mean for the collaboration between Chinese and Scandinavian engineers?
- Can a common engineering culture – the joint interest for technology and the will to solve problems – compensate for cultural differences?
The Chinese educational system

Throughout the past 30 years, the Chinese educational system has gone through a number of great and radical reforms (in 1993, 1998, and most recently in 2009) the object of which has been to modernize the educations and increase the number of students – not least in relation to the further and higher educations. What we are dealing with is thus a massification of the higher educational system in China (Hayhoe 2011).

Since 1998, when the Chinese government passed an extensive reform of the educational system, the number of graduates to receive a high school degree or a university degree has multiplied. And the ambitions do not appear to grow any less in the future. In 2009, the Chinese government adopted a new strategy to set even greater objectives for the educations (Outline of China’s National Plan for Medium and Long-term Education Reform and Development 2010–2020). A basic premise for the Chinese modernization process has thus been – and indeed continues to be – to focus massively on education and research. The focus is partly supported by an economical subsidy of the educational sector, but in particular by restructuring the basic principles and mechanisms of the sector. The tremendous growth in the supply of study places and degrees has been supported by a decentralizing process in which the individual education institutions and universities have received increased autonomy and an opportunity to act on freer premises and more oriented towards the market economy. Also entirely private universities and foreign universities are by now well-established in China. Since 1999, public Chinese universities have been able to establish subsections that on a private basis can offer degrees at college level, and since 2003, these colleges are required to be run on entirely private and market-oriented premises.

In 1999, mere 37 private universities existed with a total of 46,000 students in China. By 2008, the number had grown into 640 universities with more than 5 mill. students (Hayhoe 2011). During the period from 1990 to 2010, the average yearly household expenses to education fees increased from 17.82 to 258.36 Yuan (China by Numbers 2012).

This average naturally covers the entire Chinese educational system, but the increase is even more marked if the university degrees are viewed alone. For in 1997, it became possible for the Chinese universities to charge study fees. The average yearly education fee for students at public universities is today approx. 5,000 Yuan, whereas the education fees at the private universities amount to approx. 50,000 Yuan (interview Liu Boucon). Actually, the national financing of the study places at the public universities have decreased by
24% during the period from 2000 to 2004, while the privately financed study fee has increased from 10.3% to 19.2% from 1995 to 2004 at the national universities, and from 17.2% to 40.1% at the regional universities.

Behind the massification of the educational system lies a two-stringed ambition, partly to aim at strengthening the general and broad system of higher education through incentives of the market economy, but also at prioritizing the elite universities. In China, great difference exists between the prestige and quality of the universities – and how much the universities are subsidized by the state. China’s educational strategy thus operates with a hierarchization of the educational system through prioritizing specific universities into achieving elite status. Nine universities have been nominated elite universities – the so-called “C9” universities, whose ambition it is to form an “Ivy League” parallel to American elite universities. These elite universities are in charge of less than 5% of the production of graduates in China, but they carry great research-related prestige. The public universities – and naturally in the highest degree the C9 universities – are more prestigious than the private ones. Having to pay 10 times more to attend a private university than a public one does thus not mean that the private universities are better. There are high admission requirements to the most prestigious universities, and if one cannot fulfil these, it is always possible to seek admission at the private universities – against a substantially higher study fee.

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<th>The C9 universities – China’s ‘Ivy League’</th>
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<td>Peking University</td>
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<td>Tsinghua University</td>
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<td>Zhejiang University</td>
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<td>Harbin Institute of Technology</td>
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<td>Fudan University</td>
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<td>Shanghai Jiao Tong University</td>
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<td>Nanjing University</td>
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<td>University of Science and Technology of China</td>
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<td>Xi’an Jiaotong University</td>
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The educational reforms have also influenced the structure of the educational system. Traditionally, the Chinese educational system has been very much divided, inflexible with few possibilities for admission and graduation, and quite demanding where time is concerned. The reforms of the higher education sector thus have strived for establishing an educational structure to streamline the ways of the education and shorten the duration of the education. The objective is now to establish a system in which to complete a graduate study in 5-6 years, divided into Bachelor and Master levels, and with a possibility for a further PhD level in 3 years, in Western style. As a starting-point, a standardized, national, written test still functions as admission to every further and higher education in China; but with the reforms, specific admission tests directed more towards studying have been introduced into individual, more prestigious universities – primarily in the Beijing and Shanghai areas.
The Chinese educational reforms have in a very short time managed to expand the educational system into including significantly greater shares of the population than previously, and in relation to the higher educational system, an exponential increase of the production of graduates has taken place. The focus on establishing elite universities has also been fruitful in the sense that more Chinese universities, such as Peking University, Tsinghua University, and Fudan University, now are ranking the international lists of the most prestigious universities in the world. But the Chinese education reforms also have their share of problems. Professor Lui Boucon of Beijing Normal University has worked as an advisor for the Chinese Ministry of Education in connection with a new education reform towards the year 2020. He estimates that every higher education in China faces a number of significant problems/challenges.

One of the most significant problems concerns the quality of further and higher education. In line with the tremendous quantitative expansion of higher education, problems have arisen concerning the quality of education. For instance, it has proven difficult to find sufficiently qualified teachers in a number of areas (primarily in the Western provinces of China), just as wide belief exists that the Chinese educational system is having problems with introducing more up-to-date pedagogical/didactic principles and methods. Disproportionately great weight is attached to the ‘knowledge components’ of the teaching and far too little attention on how knowledge can be transformed and applied in practical contexts. Thus, to a great extent, the Chinese educational system is a closed system, with no traditions existing for the system to engage in dialogue with the surrounding society, and with periods of internship and collaborations with businesses thus on the whole being absent in the educational system.

These problems form the background for the new education reform towards 2020 to focus on three overall objectives (Outline of China’s National Plan for Medium and Long-term Education Reform and Development 2010–2020).

**Overall objectives for the Chinese education reform towards 2020:**

- To improve the quality of education by incorporating more up-to-date pedagogical methods and principles
- To create an educational system more open to society – there is even talk of directly creating a ‘learning society’!
- To shift focus from ‘huge resources’ to ‘human resources’ – thus a shift from quantitative to more qualitative priorities in developing the educational system.

Thus, the education reform is characterized by greater focus on modernizing the educational system into creating better opportunities for supplementary training and more interaction and interplay between the education sector and the industries. As an example, it is an objective of the reform that the number of people participating in further and continuous education whilst managing a job is to be more than doubled during the next 10 years. (From 166 mill. today to 350 mill. in 2020!)

Thus, great attention is attached to the modernization of the Chinese educational system – and not just to the expansion of it. The methods and the means – more quality in the educations, more interaction between the educational system and the trades and industries, new and more up-to-date pedagogical methods and principles, more supplementary training and continuous education, greater focus on competences as opposed to knowledge, etc. – resemble the ones known from the West.
Points for attention:

- How extensive are the quality problems existing in the Chinese educational system?
- Will it be possible to introduce modern teaching methods and pedagogical principles into the Chinese educational system before 2020?
- Which importance does it have for the engineering competences that the Chinese educational system does not allow more interaction with the industries?
Engineering educations in China

Historically speaking, the Chinese educational system has found inspiration from many sides. Historically speaking, China has had no engineering tradition of its own. Technological developments and the carrying through of technical innovations have been created through a practical, craftsman like tradition with no real academic approach. It is with the great Western influences, which began approx. 150 years ago, that engineering as a concept came to play a part in China. Not until after the Opium Wars were the first schools for educating engineers established by the French and Germans in the 1880s.

Varying “schools” have formed the Chinese engineering educations through time. The French and German engineering traditions were very influential during the former half of the 20th century. Following the Communist revolution, the educational system to a great extent was structured according to a Soviet ideal, and for the past three decades, the Anglo-American education structure has been the primary source of inspiration.

The two American researchers, Gary Downey and Juan Lucena (Downey & Lucena 2004), point to the existence of different traditions, ‘styles’, and engineering cultures rooted in historical and national developments. The French engineering tradition with its prestigious École Polytechnique has attached great weight to mathematical formalism and sound administrative and managerial knowledge, whereas the practical and more craftsmanlike aspects of the technical work receded into the background. In the German tradition, the attachment of the engineering profession to the industry through Fachhochschulen and technical universities has been great, and the German engineering educations have prioritized a more narrow technical expertise aiming at standardizing technological solutions. The English engineering tradition, on the other hand, is more characterized by freer experimenting, practical learning, and a more craftsmanlike approach to the solution of technical challenges.

The inspiration from these different engineering cultures are largely reflected in the Chinese engineering educations today. Thus, great difference exists between how the engineering educations are organized and practiced at different universities in China. At the most prestigious technical university in China, Tsinghua University in Beijing, the inspiration from the French École Polytechnique tradition is great. Here China’s future elite is educated in a tradition in which the technical education attaches great weight to educating future engineers into administrators and decision-makers in the state administration. The engineering education here attached great importance to being able to plan, administrate, and run major technical projects. In other places in China, the German engineer tradition has had greater influence – such as in the region around Shanghai. In the German engineering tradition, not so great weight is attached to the administrative and managerial elements in engineering work, while the narrower and more technical engineering professionalism is prioritized. Other universities in China were founded by English/American engineers in the period before the Communist revolution, and here the more craftsmanlike and practical approach has left its mark.

However, it is also evident that the Chinese engineering education has been under the influence of the Soviet model for the structuring of the engineering educations. During the 1950s and 60s, Soviet engineers to a great extent acted as advisors in China, and the Chinese engineering educations were largely re-formed according to Soviet ideals. In this period, the Chinese educational system was an integral part of the state’s planned economy, and the educations were narrowly targeted at the priorities and efforts, as prescribed by the plans. Where the engineering educations are concerned, this meant that many educations were organized with a very narrow and specialized focus aiming at qualifying the engineers into being purposively able to solve specified technical problems in very well-defined fields – such as in relation to the military industry. The Beijing Institute of Technology, which we visited, was during the 1950s and 60s established as a technological research and education unit for the Chinese military. The Soviet engineering tradition attaches great weight to scientific and technical knowledge acquisition during the education course. In that tradition, the education course itself attached no importance to the factor that the acquired knowledge also should be
transformed into practical problem-solving – that is something that does not need to be worked on until after the conclusion of the education when the acquired knowledge is to be applied in a work situation.

During the past decades, an Anglo-American tradition of engineer education has carried great influence in China. Partly, the general education structure is arranged according to American ideals with Bachelor, Master, and PhD levels – and partly, tendencies also exist in many places towards integrating the engineering educations with other professional subjects at comprehensive universities. But although the Anglo-American education tradition now largely is seen as a normative ideal for the development of the engineering educations, it is our impression (based on our interviews) that the educations to a great extent are characterized by the Soviet tradition of education. The curriculum for the most part is narrowly subject-defined in relation to scientific disciplines and very knowledge intensive with less weight attached to what is applicable, and the teaching form is largely based on lectures and literature studies and with no or very poor attachment to the trades and industries.

However, work is carried out on breaking with the Soviet scholastic tradition. At the Beijing Institute of Technology for instance, the international CDIO principle has been introduced into the teaching, in which teachers must be able to account for the principles according to which the teaching has been organized in relation to the process: Conceiving – Designing – Implementing – Operating. Here, the aim thus being that the teaching starts from cases and specific problems of the practical world. Similarly, several engineering universities are working with endorsing international quality standards and accreditation systems such as The Washington Accord. However, it has not been possible to investigate to what extent the Chinese engineering educations generally and actually apply and fulfil these standards.

Points for attention:

• How deeply rooted is the Soviet education tradition in engineering educations in China today?
• To what extent and according to which criteria do the engineering educations work with quality objectives?
Who are the Chinese engineers and what do they know?

What is an engineer today – in China? That is one of the most central questions, but also one most difficult to answer. The question has especially arisen in connection with various estimations of how many Chinese engineers are educated in China today. Our informants in China inform us that approx. one third of the 6.6 mill. graduates (China by Numbers 2012) educated in China in 2011 come from engineering educations – i.e., approx. 2.2 mill. engineer graduates in 2011.

Analyses carried out by researchers from Duke University (Gereffi et al. 2008) do, however, question the staggeringly high numbers. In this connection, they point to several issues. For great national differences do exist on how to define the concept “engineer”. China has – inspired by the Soviet influence – applied the term “engineer” very broadly to characterize people doing technical work – i.e., what we in the Scandinavian countries would describe as technicians. The Chinese engineering concept thus seems to cover a great span in relation to professional levels. However, uncertainty also exists as to how broadly the engineering concept applies. Are, for instance, the groups working with farming and foods also to be included into the engineering concept – and all professional groups working with information technology, programming, etc.? And just where exactly does the boundary lie between engineers and people with an education in natural science – for instance, in the bio-technological or nano-technological field? These delimitation problems render it very difficult to find a precise number of how many engineers are to be found in China. However, no doubt shall remain that the number of graduates in the engineering field is increasing rapidly in absolute numbers – not least in comparison with other countries. Also in relation to the production of highly qualified engineer graduates at PhD level, China leads the way.

![Graph showing first university natural sciences and engineering degrees by selected countries: 1999-2008](image1)

![Graph showing natural sciences and engineering doctoral degrees by selected country: 2000-08](image2)
The Chinese engineers naturally are spread in all engineering disciplines and directions, but as will be seen from the below figure, engineers working with electronic and information technology constitute the greatest field.

![Engineering disciplines in China](image)

There is no doubt that China is the greatest producer of engineers in the world, but on the other hand, great disagreement and uncertainty exist concerning the qualification level of the Chinese engineers – and not least their competence level. From our interviews with Chinese and international researchers, however, an overall picture emerges in relation to their knowledge, practical skills, and general competences.

In relation to the professional knowledge of the Chinese engineers, it is the general opinion amongst our informants that the Chinese engineers are on a relatively high level. The knowledge component, however, is relatively narrow and delimited by professional disciplines – and overall of a theoretical character. In the Chinese educational system, a general tendency has existed to delimit the teaching in relation to quite narrow disciplinary criteria within the individual engineering areas – such as mechanics, chemistry, construction, etc. The level of specialization is high and primarily governed by academic considerations and delimitations. The curriculum is split up into subject modules, exercises, and assignments in which the problem-solving is restricted to a strongly restricted solution space. The problems worked with are given, well-described, and ideal-typical in relation to professional criteria, and the analytical methods are defined in advance. The students’ tasks thus being to acquire well-defined principles and methods – but the students are not expected to test the methods on real and more complex problems – let alone problems vaguely defined and containing other elements than the narrow technical ones.

A widespread view amongst our interviewees is that the Chinese engineering educations do not equip the students with sufficient practical skills in the engineering work. Practice, internships, and ‘real-life problem solving’ are uncommon phenomena in the Chinese engineering educations, and no great weight is attached to craftsmanlike virtues. The general academization of the engineering educations manifests itself in an overspecialized focus on the knowledge content of the engineers and to a lesser degree on training the students’ practical skills to become able to plan, manage, and handle the work.
In addition to the lacking practical skills, it is also pointed out that the educations to no sufficient extent focus on developing the students’ *general competences*. Several of our informants point out that the lacking contact to the industry partly is complicating the development of the curriculum as relevant for the quickly changing needs of the industry, but also that the students are not equipped with the competences needed to get on in a modern and international business. Interpersonal skills, communications skills, and the ability to navigate in complex organizations are missing, just as our informants find it problematic that engineering graduates are not sufficiently trained to work in teams and complete projects. The teaching is usually classroom- and lecture-based, and no traditions exist for working in groups or with projects and ‘real-world-problems’.

**Points for attention:**

- Who in actual fact are ‘engineers’ in China?
- Do other ideals of engineering professionalism exist in China than in Scandinavia?
The teacher is always right

In China, the teacher is always right. Also even if he or she is not and everybody knows it, including the teacher him- or herself. It is the teacher who leads the way, telling what is important to learn. The students must be able to reproduce what the teacher says, and they are sitting, “pencils sharpened”, writing down exactly what the teacher is writing. Questions are allowed, elaborating questions, but under no circumstance may doubt be raised concerning the teacher’s knowledge. Both pupils and teacher find it humiliating if the teacher is not omniscient, and nobody wants to be in the situation in which the teacher “loses face”. The teacher is the elevated one to whom everybody listens and for whom everybody has respect.

This is also the case at university, at least the technical universities we visited. The teacher is addressed “Professor” and great respect surrounds the individual. No questions are asked that would reveal the professor to be not omniscient, and it is quite unthinkable that students believing themselves to have a different or more elaborated knowledge on a subject make themselves known. Respect surrounds the teacher and the professor, and nobody wants to change that.

On the other hand, simultaneously, the teaching at university is being criticized. The professors have no time for the students: no time to prepare good teaching or dedicate themselves to the students. The professors are very busy researching and publicizing their research results; it is on this they are continuously being assessed every year, so the students make allowances for their professors, although they really would like them to prioritize the students and their teaching more highly.

A university education in China (naturally dependant on which university is involved) is thus more akin to a kind of craft’s apprenticeship, in which the student follows the professor and learns from him or her. This means that they do not learn how to generate new ideas, but primarily to reproduce already existing knowledge. Nor do they learn how to discuss. To have another view, opinion, or knowledge, is seen as lacking respect for the professor. It is not seen as part of a knowledge exchange or a negotiation and a significant way in which to develop new understandings. This is a contributing factor in rendering it difficult for Chinese students to study in the Scandinavian countries, in which it precisely is expected that the students are active during teaching.

Records from our interviews with students in Beijing and Chinese students in Denmark
Chinese engineers’ career opportunities

By far the majority of the young people to finish high school continue at university. A relatively large part does, however, leave university after having completed their Bachelor’s Degree. This is possibly about to change these days when unemployment is increasing amongst the young university students with a Bachelor, making more students continue at university and take their Master’s Degree here. However, it tallies nicely with the strategy of the Ministry of Education that more people are to have longer, further and higher educations in China.

In China, it is possible to apply for a job in the coveted international businesses after a completed Bachelor, in order to gain experience, learn English, and earn good money. A Master’s Degree from abroad gives considerably greater opportunities, as Master-educated graduates are more coveted in China, but often also more expensive. The Chinese people with whom we talked did not imagine a lifelong career with the foreign firms. They find them more sensitive to the fluctuations of the market, and employment in international businesses involves greater risk of being fired. That is why some of the well-educated people later choose to change to national businesses that do not contain this risk. The national businesses are regarded as secure, but the pay level is lower, just as the possibilities for challenge in the work are different, as they adhere to Chinese traditions. The Chinese people with whom we talked in China estimate that once you have occupational experience, the risk of becoming long-term unemployed is not so great. However, for the highly-educated Chinese to find their footing in the labour market can be a problem. Our interviewees stated that approx. one third of all graduates are without a job after having finished their education – and this is a huge number in a country with the tradition that an education immediately leads to employment. This is a problem not just for the student him- or herself, but also for the entire family that often has invested nearly everything they own in their only child receiving an education, still in many places being regarded as an insurance in old age.

In China, the Chinese interviewees told us that the typical career move is about first taking a Bachelor and then applying for a job in an international business. Afterwards, taking a Master’s in China, or better still, abroad to get more experienced. The perspective is very different between interviewing Chinese people in China and Chinese studying or working in Denmark. In China, the interviewees have a perspective of returning to China, when first having achieved the international experience to ensure them a better job in China. In Denmark, far from all the interviewed Chinese harbour a desire to return to China. Some do, however. Zhenning Wu told us that she and her husband, who is completing his PhD in Holland, expect to return to China, as they feel responsible for taking care of their parents. She added that it was a generation issue. The Chinese born during the 1980s still feel this obligation, whereas the ones born during the 1990s are more likely to follow their own interests. Others possibly want to return for reasons of security, just like graduate student Xuemeng Li at DTU, Technical University of Denmark, who do not feel her parents’ pressure on her, but imagines that she is to go back, unless she meets the “love of her life” during her study.
Points for attention:

- Will more Chinese engineers take parts of their engineer educations at Western universities?
- Will more Chinese engineers seek a career in international businesses outside the borders of China?
- Will Chinese engineers increasingly acquire the values and practices of a Western culture?
Zhenning Wu took her Bachelor’s Degree in China, and afterwards applied at DTU because she was interested in Material Science and it was possible for her to get a scholarship here.

Coming to Denmark proved a great cultural upheaval, but she soon got used to it and came to like it. In China, she was used to the great respect that surrounded the teachers – being on formal terms and using surnames only, and the teacher would always speak first. Here, it is different. Greater respect exists concerning the students – she almost felt it as being equal – she feels no great difference between teacher and student. In Denmark, the way of studying is more open with much teamwork and independence concerning the solution of problems: something she enjoys. It was new to her and she appreciates these social competences. Concerning professional engineering matters, she does not feel that great a difference, but of course she has not done her Master’s Degree in China.

When she moved here, she first stayed at one of the DTU halls of residence, but after a year, she moved to a college in the Danish town of Nærum, as too many Chinese students were staying at the first college. She wanted to be integrated and meet more Danish people: that happened in Nærum. The Danish students met her with great curiosity, and they were wont to discuss. She appreciated the common cooking – she would cook Chinese food to great success – on the other hand, she learned how to make *risalamande* and other Danish dishes: what happened was a culinary cultural exchange.

Having completed her Master’s, she applied for a graduate programme with Maersk and got it. That meant visiting both the UK and USA, so she has expanded her competences with a more international profile. She has lived in the Danish city of Esbjerg for two and a half years and finds it ‘cool’.

She is married to a man who is also Chinese and who is finishing his PhD in Holland. They have known each other a long time before going abroad. They discuss what to do when he has finished. They feel an obligation towards their parents, and expect to go back to China. It is no obligation formulated by the parents – it is more of a “cultural thing”, as Zhenning puts it. She and her husband were both born in the 1980s, and here they still feel obligated as opposed to those born during the 1990s. They are more egotistical, says Zhenning. It is the speed with which society in China has developed that produces the difference, she feels.

Back in China, she will seek employment in an international firm. She estimates she cannot adapt to Chinese businesses – there being more perspective in the international ones.

*Interview with Zhenning Wu, former student at DTU, now employed in Maersk Oil*
We visited the development department of NNE Pharmaplan in Tianjin that employs approx. 300 Chinese engineers. We interviewed two Danish project managers about what their experiences were of collaborating with Chinese engineers, and to what they attached weight in recruiting Chinese labour. Here, the opinion was that the Chinese engineers generally are good at solving well-defined and traditional engineering tasks in which the objective and method for solution is well defined in advance. On the other hand, it is generally difficult to bring the Chinese engineers into play in tasks with a more ‘open-ended’ character that has no specified criteria for how the right result is to look. As a starting-point, recruiting engineers with fine diplomas and a relatively high knowledge level in the coveted areas presents no difficulty. On the other hand, it is difficult to ensure that the Chinese engineers in actual fact have the competences needed to function in an international business. However, the competence profiles of the Chinese engineers are in movement!

When employing Chinese engineers, NNE Pharmaplan naturally attaches weight to the applicants having a high engineering professional level. But that appears to present no problem – by far the most applicants come with good exam papers. Now it is more difficult in an employment to determine whether the graduates actually do manage to bring their professional knowledge into play. That is why, when recruiting, one works regularly with assessments in which the applicants are given assignments to solve with a view to demonstrating their skills and abilities. During the job interviews, the interviewer does try to reach a bit beneath the professional engineering facade, and enquires about the applicants’ interests, social lives, etc. Here, a Chinese engineer may find it strange to be asked about what he or she is doing in their spare-time or about what hobbies they may have. But the questions are deliberately asked to ascertain whether the job applicants may fit into a corporate culture characterized by informal Scandinavian values.

The Danish project managers felt it might prove difficult to hold on to the Chinese engineers. Many Chinese people are very much oriented towards prestige, high salaries, advancement, and careers; and meeting the expectations of the young Chinese engineers may prove difficult. Thus, corporate loyalty is not great – if a better paid job or a position with more prestige turns up, the Chinese engineers are quick to change jobs. The idea that the Chinese engineers are lacking corporate loyalty may even lead to the Chinese engineers not receiving the entrusted and important assignments and posts. NNE Pharmaplan, at any rate, shows reluctance in including the Chinese engineers too much in technical and business concerns with great competitive importance in relation to rival Chinese businesses.

Whenever NNE Pharmaplan did recruit Chinese engineers, female engineers turned out to fit much better into the Scandinavian business culture than the male Chinese engineers. The project managers found the women engineers more loyal to the corporation and easier to adapt to the informal and un-hierarchical managerial style. When viewed as professional engineers, they were equal to their male colleagues, but they displayed a higher degree of flexibility and readiness to change, and they did not attach so much weight to the material reward as their male counterparts. This meant that the collaboration between the female Chinese engineers and their Scandinavian colleagues went off easier and more smoothly.

It was also clear that it was easiest for the youngest generations of Chinese engineers to enter into the Danish business. Partly, their English skills are far better than those of their older colleagues, but the young Chinese would also appear to have acquired more Western values, manners, and customs.

However, great cultural differences remain, which became evident to us in connection with a workshop for Chinese engineers living and working in Denmark, as hosted by IDA, The Danish Society of Engineers. Very great interest existed in the workshop that focused on the cultural differences. The participants expressed the view that they found it quite difficult to get on in a Danish work culture. Partly, they find the Danes ‘reserved’ – they have no Danish friends and are not invited home. But they also desired knowledge of how to advance in a Danish business, and how to convince the Danes that also the Chinese could be right.
Meetings and dialogues during the work-day were very little appreciated, as they found them to be a mere waste of time. This shows some of the difficulties faced by the Chinese in Danish businesses – several have worked in Denmark for 5-10 years, and yet advanced only very little as compared to Chinese conditions.

Points of attention:

- What does the generational change mean in relation to engineer competences in China?
- What does gender mean in relation to Chinese engineer competences?
**Summing up: Strengths and Weaknesses, Opportunities and Threats**

As mentioned earlier, one should beware of generalisations – not least concerning conditions in China. Through our desk research – and in particular through our interviews in China – we discovered a variety of tendencies and indicators pointing in very different directions in relation to the Chinese engineers’ competences. As this report indicates, the Chinese engineering profession is undergoing change, and technological, structural, economical, and cultural dynamics are playing together and against each other, forming a complex picture indeed. It is evident that the Chinese engineering educations – just like the engineering profession in general – are under transformation. Thus, it proves difficult to adopt a distanced look at the contemporary, multifarious developments.

We shall, however, stick our necks out in this report and try to summarize our experiences through a SWOT analysis in which we attempt to evaluate the strengths, weaknesses, opportunities, and threats of the Chinese engineers’ competences on the global labour market. The perspective here is Scandinavian and, in a wider sense, Western. When, for instance, we assess how innovative and dynamic the Chinese engineer educational system is, it happens in the light of the standards and values set up in a Scandinavian/Western context. But that is the way it goes at the end of the day. Our analysis is thus a perspective one and quite interim – filtered through our Scandinavian eyes. Whether the described opportunities may be realized or the threats become actual weaknesses, only time will tell.

Our analysis is to be seen as a ‘snapshot’ in the year 2012. The ‘photographic development’ may draw the outlines of some key conditions, but the picture’s ‘solution’ leaves no possibility of detecting the details and nuances. The picture will also contain a number of ‘grey zones’ in which the same relations can appear as both advantages and disadvantages – such as the Chinese engineers’ high/narrow degree of specializing. Whether high professional specializing constitutes an advantage or not for the Chinese engineers depend highly of what role is cast by the international division of labour – but the question is indeed just how the international division of labour is about to change in the future.

**Strengths**

**High technical and scientific knowledge contents**

The Chinese engineering educations distinguish themselves by attaching great weight to a curriculum of mathematics and science. This means that the Chinese engineers generally have solid knowledge of mathematical and scientific formalisms and basic theories. The engineering graduates are able to solve advanced engineering problems and calculations in subject delimited fields. The educations are generally organized with regard to scientific discipline and great weight attached to the students acquiring theoretical depth in a specialized field.

**High degree of specializing**

The engineering educations attach great importance to scientific discipline and domain specialization. The legacy from the Soviet engineering tradition, in which the high degree of division of labour in the technological process of development and implementation was prevalent, can still be traced in the Chinese educational system. The engineering graduates thus acquire great professional depth in a field delimited concerning scientific discipline in which the specializing is organized within the traditional engineering professional special subjects.
Elite educations (few but prestigious)

During the past 30–40 years, the Chinese educational system has managed to create a number of prestigious technical and comprehensive universities ranking high in international ratings. The level of research in these universities is high, and worldwide an elaborated collaboration with other elite universities has been established. These elite universities enjoy particular attention from the state. The prestigious universities account for less than for 5% of the production of graduates in China.

Quantity – large talent mass

In 2010, more than 10 mill. Chinese students were examined at the central entrance examination to the higher educations (Gaokao) – twice as many as in 2002. Three fifths of these passed the test and thus acquired access to higher education. Approx. one third of the students at the higher education institutions engage in engineering disciplines. The talent mass of the engineering field is thus enormous in comparison with that of the Western countries. Traditionally, the interest for and application to the technical and natural science educations have been huge in China – but our informants point out that this condition possibly is about to change in the coming years.

Will to go abroad

Amongst the students interviewed by us in China a noticeable interest existed to go abroad to get (parts of) an engineering education at Western universities. Similarly, we detected great interest to work for international businesses in China or abroad. The Chinese youth is largely motivated to educate itself, and there is great prestige in taking educations abroad, just as it is considered prestigious to have occupational experience from international businesses.

Will to change

Chinese society has experienced tremendous changes over the past century, and in the engineering area during the past 30 years, a marked orientation has taken place towards Western educational ideals and organizational forms. A widespread interest in the Chinese (engineering) educational system exists in seeking cooperation with Western universities and in introducing Western educational principles and methods (such as e.g. CDIO) with a view to strengthening the quality of the engineering educations. Also amongst the students, great interest exists – although for a start it can prove difficult – in participating in more involving ways of teaching. To begin with, the Chinese education reforms have multiplied the production of graduates, and new education reforms now aim at improving the quality of the educations by introducing new teaching principles and learning methods.
Weaknesses

Narrow competences

As a consequence of the disciplinary subject structure of the educational system of engineers in China, as inherited from the Soviet tradition, the engineers acquire relatively narrow and theoretically founded competences. The engineers experience difficulties in solving complex and not clearly defined problems that are not structured in advance according to disciplinary standards and guidelines. In international businesses, this means that Chinese engineers often are assigned more routine tasks and assignments delimited beforehand.

Poor problem-orientation

The Chinese educations have no tradition for training the students in doing problem-oriented, explorative, and independent work. Large part of the teaching is organized around the ‘solution’ of problems well-defined and arranged in advance. Thus, the students are not trained in becoming able themselves to identify and define a problem in a complex situation with a view to ‘framing’ the problem towards an engineering professional solution. This means that the Chinese engineers often are set to do the more routine and standardized measuring and calculation jobs. The more design- and business-oriented engineering tasks thus pass the Chinese engineers by in the international businesses.

Lacking focus on ‘human skills’

The focus of the Chinese engineering educations on the narrow disciplinary fields has a tendency to marginalize the importance of other competences, such as collaborative, managerial, and communicatory skills, etc.

Varying quality in professionalism

Great variation exists in the quality of the Chinese engineering educations. In some places – especially in Central China – it is difficult to recruit qualified teacher resources for the educations, and the students are thus to a wide extent left to self-study. Thus, it is absolutely crucial from which university the engineers graduate. When recruiting Chinese engineers, it is therefore crucial to have a highly detailed knowledge of the status of the Chinese universities.

Lacking focus on practical skills

China has no great tradition for interaction between the educational sector/academia and the trades and industries. In many places, internship during the course of education thus plays no natural part of engineering educations. The transformation of the theoretical knowledge of the engineering graduates into practical skills thus to a wide extent takes place through informal training courses in the companies after employment. This means that the companies have to expect long training courses before Chinese engineers can become productive for the businesses.
Lacking innovative competences

The Chinese educational system does not stimulate the students to explorative and innovative work forms. Similarly, the (education) system neither stimulates an ‘entrepreneur culture’ to get the students to establish ‘start-up’ companies.

Cultural barriers

The barriers that prevent the Chinese engineers from competing with Western engineers over the jobs in the international companies are hard to map, but considerable nevertheless. Naturally, language difficulties are an obvious barrier, but the younger generation of Chinese people is becoming increasingly better at English. The barriers are more about how Chinese engineers manage to form part of businesses run and organized according to Scandinavian values and principles of flat hierarchies, autonomy, etc.

Opportunities

Improving the quality of the educations

The Chinese state focuses greatly on the modernization of the Chinese educational system – not just on the expansion. The methods and the means – more quality in the educations, more interaction between the educational system and the trades and industries, new and more up-to-date pedagogical methods and principles, new and innovative learning and teaching methods, more further and continuous education, greater focus on competences as opposed to knowledge, etc. – resemble the ones known from the West. The objective for China’s education reform towards 2020 point at:

- Improving the quality of the educations by incorporating more up-to-date pedagogical methods and principles
- Creating an educational system more open to society – creating a ‘learning society’ is directly mentioned!
- Shifting focus from ‘huge resources’ to ‘human resources’ – thus a shift from quantitative to more qualitative priorities in relation to the development of the educational system.

New generations with altered ‘mindsets’

The young Chinese you meet in the big cities such as Beijing and Shanghai are dressed in Western fashion, listen to Western music, and watch American television series and films – and simultaneously continuing old Chinese traditions and practices. The new generations of Chinese thus grow up in a globalized culture in which they learn English from the very first classes and are exposed to an international culture. At the same time, it is a widespread value in Chinese society that growth and prosperity for the individual and for the entire Chinese society are closely connected with education, research, innovation, and work – and that Western principles and virtues of learning, research, and innovation can be integrated into Chinese culture. Although great inspiration is gathered from the West, the young Chinese do not merely assimilate Western culture – they incorporate and transform elements from the Western culture into new hybrid, local – but still global! – cultural forms. The young Chinese are prepared to go abroad to learn something new – but many of them would also like to return to China to bring their new experiences into play.
Threats

The cultural barriers are too high

Although a widespread interest prevails for Western culture along with a will to incorporate Western values and virtues into Chinese culture, how well it succeeds can always be questioned. Our experience with the Chinese students met in China and Denmark is that they in many ways are hesitant and foreign to many of the practices prevalent to the West – for instance, the critical position towards authorities. Although, as a starting-point, Chinese students are positive towards modern interactive and explorative ways of teaching, such as problem- and group-based learning forms, they do find difficulties in adopting this practice. The Chinese basic school is typically based on factual knowledge acquisition and authoritarian ways of teaching not stimulating to the critical and reflexive competences of the students. It is an open question to what extent this relation is rooted in a traditional Chinese culture, just as it is unclear how fast the entire Chinese teaching system can transform fundamental Chinese values, such as not to dispute the status of authorities.

Lacking teachers’ qualifications

We have witnessed a tremendous growth in the Chinese educational system on all levels – from basic school educations to the highest university educations. The number of highly educated graduates has multiplied during a few decades. This steep growth in the education sector – combined with the general growth in society – has meant that recruiting qualified teachers for the university educations can prove difficult – especially in the faraway provinces of Central China. As a result, the quality of teaching and educations varies quite a lot and many educations do not live up to international standards.

Unemployment

The unsurpassed growth in production of university graduates has led to problems of unemployment amongst the highly educated. Quality problems in the educations partly mean that many graduates have no sufficient level of qualification to hold jobs in international businesses, but another problem is that many Chinese businesses have no sufficient reception procedures for employing and applying the competences offered by the highly educated. The growth in the education level is thus out of step with major parts of Chinese working life. The consequences being that many highly educated people do not bring their academic competences into play and are forced to take on any odd jobs and unskilled work.

The political system may apply the brakes

You can but ponder the willingness and intentions of the Chinese regime to introduce democratic reforms, free press, or the like. But the increased level of education in society indubitably puts the Chinese government under pressure. More and more Chinese are familiarizing themselves with Western democratic values by studying in the West, working in businesses with modern managerial forms, etc. This will naturally challenge the Chinese regime, and it is an open question whether a counter-reaction may come from the regime in the form of a slow-down of the reform initiatives, the internationalization, and the opening up of Chinese society towards Western influence.
**STRENGTH**
- High knowledge content
- High degree of specialization
- Elite educations (few but prestigious)
- Quantity – large talent mass
- Will to go abroad; Will to change

**WEAKNESS**
- Narrow competences
- Poor ‘problem-orientation’
- Lacking human skills
- Varying quality in professionalism
- Lacking practical skills
- Lacking innovative competences
- Cultural barriers

**OPPORTUNITY**
- Improving quality of educations:
  - more problem-orientation – modern pedagogy
  - professional comprehensiveness – more international orientation
- New generations with altered ‘mind-sets’
- Increasing orientation towards Western cultures

**THREAT**
- Cultural barriers too great
- Lacking teachers’ qualifications
- Unemployment
- The political system may apply the brakes

**Chinese Engineers**
China – a station on the way. Destination: Global Engineering?

The Chinese engineers possess many strengths, but also many weaknesses. Great opportunities exist for them to fulfill greater potential and place themselves more centrally in international businesses – and thus increasingly become competitors of Western and Scandinavian engineer labour. But also threats exist to slow down the Chinese engineers’ onward march onto the global engineer labour market. Whether the opportunities are fulfilled, or the threats become actual barriers, only time will tell. Our little study of the Chinese engineering educations and the Chinese engineers’ competences has revealed a number of central issues opening up many other and new questions in relation to the Chinese engineer culture, the Chinese (engineering) labour market, and the industrial development of the country. However, our study also gives cause for another and more overall reflection, which we shall use to conclude this report.

For questions can be raised at just how central the issue really is of the Chinese engineers’ entry onto the global labour market. In part, the Scandinavian engineers are not just competing with Chinese engineers, but also with Indian and Eastern European ones. Indeed – Scandinavian engineers are actually also competing with American, Russian, and Brazilian engineers. In addition, China is a huge country in which the majority of the Chinese engineers by far work for and in Chinese companies in China. That nearly 2.2 mill. engineer graduates are educated a year in China must be compared to the fact that China has a population approaching 1.4 bill. And similar calculations can be made where India is concerned.

These objections are not meant to tone down the importance of the question of the Scandinavian engineers’ competitiveness on the global engineering labour market. On the contrary, the purpose is to clarify the issue. The point being that it must be realized that not alone does the engineering labour market become still more global – the production of engineering labour also increasingly exceeds the nation state borders. When asked whether the Scandinavian engineering students are acquiring the right competences, whether they are able to compete on the global engineering labour market – for instance, in competition with Chinese engineers – it must be remembered that the companies are not alone in acting on the global market. So are the universities – where the engineers are educated – as well. The global race of the companies to attract the best talents is followed by a global competition between the universities to produce the best engineering graduates. And here, the nation state borders are transgressed.

It is important to investigate whether the Chinese universities produce engineers with a high professionalism to compete against the Scandinavian engineers on the international market. But it is just as important to observe how the hunt for the global talent mass is intensified by global universities establishing local campuses everywhere on the globe and extending their virtual education offers in a liberalized education market (e.g. Slaughter & Rhoades 2004). We can see how great international universities establish themselves in China and other places in the world to absorb local talent mass. New York University/Polytechnic, for instance, has established itself as a ‘Global Network University’ with permanent campuses in places such as Shanghai, Singapore, Tisch, and a brand new, large campus in Abu Dhabi in The United Arabic Emirates (http://www.nyu.edu/global.html). New, large research and postgraduate units such as KAUST crop up in the Saudi Arabian desert and attract the best scientists and the most talented students from around the world (http://www.kaust.edu.sa/). Slaughter & Rhoades thus point out that the academic educations increasingly are acting and basing their existence on capitalist market terms and that nation state borders gradually are playing minor roles for the universities’ expansion and hunt for new students with talent and/or money. This development tendency is called ‘Academic Capitalism’. Until now, primarily American, European, and Australian universities have been setting the trend in the new academic education market, but also financially strong Middle-Eastern universities such as KAUST now join in the global race to attract the best human resources. Which importance Academic Capitalism will have for the Scandinavian engineering educations and the Scandinavian engineer is difficult to say, but the development should perhaps give cause to re-formulate our question whether the Chinese engineers are to be considered rivals to the Scandinavian engineers. A more general and crucial question, however, is how the Scandinavian engineers
will manage in the global competition in which new engineers increasingly receive international engineering educations – offered by elite universities with a global horizon.

Points for attention:

- Which attention is the competition from Chinese engineers to have in the future?
- Where to look if one is to have an eye for the new challenges – Academic Capitalism?
List of informants

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• Professor Carl Mitcham, Colorado School of Mines
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• Lecturer Xu Eric Hong-Tao, University of Shanghai for Science & Technology
• Student Wu Rachel, University of Shanghai for Science & Technology
• Student Yang Qing, University of Shanghai for Science & Technology
• Professor Harold P. Sjursen, New York University Polytechnic Institute
• Student Xuemeng Li, Danmarks Tekniske Universitet
• Professor Shan-Dong Tu, Vice President, East China University of Science and Technology
• Professor Da Hsuan Feng, Senior Vice President, National Tsing Hua University
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