Strategies for Higher Engineering Education Towards Economy Globalization:

University-Industry Cooperation and Education Globalization

Jianzhong Cha Ph.D.

UNESCO Chair Professor on
Cooperation between Higher Engineering Education and Industries
Professor & Vice Chairman of Academic Committee
Beijing Jiaotong University, China

Board Member and Guest Professor
Group T Leuven University College, Belgium

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Introduction of the UNESCO Chair

1. Background

- Initiated and supported by Minister of Education of China, Dr. Zhou Ji
- Proposal was submitted in March 2003, approved by UNESCO in Oct. 2004, started in Feb. 2005
- The 14th UNESCO Chair in China since 1992
- Aim at strategy for Chinese engineering education reform

2. Objectives

1) Through research (projects, graduate study), and knowledge transfer（teaching, training, conferences and workshops) to discover, summarize, publisize, promote importance, necessity, mechanisms, models, rules, regulations of university-industry cooperation

2) Best case study and publicity, set up example colleges

3) facilitating collaboration between high-level internationally recognized researchers and teaching staffs of the universities and other institutions in PR China, the Asia and Pacific Region, and other regions in the world

3. Work done since Feb., 2005

- February 2005: Signing ceremony of the UNESCO Chair at Beijing Jiaotong University. A keynote speech was delivered by Prof. Zhang Xinsheng, Vice-minister of Education.
- December 2005: Publication of the results of a research project commissioned by UNESCO Beijing Office, entitled *University Industry Partnership in China: Present Scenario and Future Strategy*.

http://www.unescobeijing.org/programs/view.do?channelId=004002004001002007

- December 2005: First Symposium on Cooperation between Higher Engineering Education and Industries, held in Suzhou, China.
- July 2006: Interview of chairholders and broadcast on Sohu

  http://learning.sohu.com/20060710/n244181941.shtml
- November 2006: Second Symposium on Cooperation between Higher Engineering Education and Industries, held in Leuven, Belgium.
- Keynote speeches to 20 national and international conferences, and 25 universities and colleges
- Planning weekly TV program on university-industry cooperation with Chinese Educational TV Station

Status and Needs (1)

- High speed growth in past 20 years in China
  - World factory (good infrastructure, cheap labor with reasonable education, OEM）
  - Positive: accumulating capital, working force, experiences
  - Negative: low value added, environment and resource problem
- Tendency to upgrade industries in China
  - Labor cost increasing, value of Chinese currency increasing
  - Sustainable development (environment, natural resources,…)
  - Requirements from Multi-nation companies (R&D, services-oriented sectors, BPO)
  - Requirements from domestic enterprises（ODM，WTO…）

Solution for being global manufacturing power with sustainable high speed growth？

Industry upgrade

Status and Needs (2)

- Needs for innovation from industry upgrade
  - Knowledge creativity -> Industry innovation
    ->Business model innovation
  - Establishment of complete innovation system in society
- Needs for globalization from industry upgrade
  - Globalized market, global manufacturing and supply chain
  - Global standards(communication, electronics, services,…)
  - Education globalization—international standard talent
- Needs for talents from industry upgrade
  - Versatile type （multidiscipline, team work skill）
  - + Creative type（Problem solving and innovation ability）
  - + Multicultural type（foreign language, international affairs, communication skill…）

Status and Needs (3)

- Industry upgrade needs more quality engineers

  in China:

  - multi-nation companies need 750k quality graduates in 5 years, 60% total available resource

  - need 75k management talents working in international environment, only 3000-5000 in place

  - short of 500k IT talents every year, annually increased by 20%, but only 70K per year come out from colleges

  in Europe: short of 2.5 million engineering related professionals for next 5 years

  in USA, workforce for science and engineering increased 1.5 times in 20 years, but enrollment of engineering study for citizen and PR decreased by 20%

Worldwide shortage of quality engineers!

Status and Needs (4)

- Engineering education resources
  - 2006: 70k engineers from USA, 700k from China
  - China: Enrollment—800k engineering college students, 1 million high vocational school students
  - Percentage of engineering study in higher education

    China>35%, Japan<20%, Germany<15%, UK<8%, USA<6%

Desired attributes of an engineer

source: Boeing Management Company

- A good understanding of engineering science fundamentals
- A good understanding of design and manufacturing process
- A multi-disciplinary, systems perspective
- A basic understanding of the context in which engineering is practical
- Good communication skills
- High ethical standards
- Ability to think both critically and creatively-independently and cooperatively
- Flexibility: the ability and self-confidence to adapt to repid or major changes
- Curiosity and desire to learn for life
- A profound understanding of importance of team work

Problem and Gap (1)

- Gap between engineering education and industry needs

  - 160k out of 1.6m Chinese engineers are qualified to work at multi-nation companies
  - Less than 10% of Chinese engineering graduates are qualified to work for multi-nation companies
  - 25% for India, >80% for Belgium or other developed countries

Problem and Gap （2）

- Problems of engineering education
  - Methodology :

    Instruction based education– teacher centered (Han Yu “About Teachers”, 1200year ago)

    Project based education – learnging by doing, student centered
  - Mechanisms: isolated education system, lack interactivity with industry and society
  - Target in human resource market: engineers vs. scientists

    Tsinghua: The Candle of Engineers before 1965, Not now

Problem and Gap （3）

- Curricula design: academic-driven, nationwide unified, aiming at complete knowledge for disciplines, no input from industry
- Contents of courses: bias to theory , unified text books, lack practice and application sections
- Teaching method: one way teaching skill, lack teamwork and projects, NO student presentation
- Teaching force: with high academic degree (Ph.D., postdoctoral) lack industrial background and experiences
- Appraisement system: bias to theoretical work and grades of exams, lack evaluation on practical ability, NO industrial appraisal on students

Problem and Gap （3）

- Reflection of problems and gap in labor market
  - Industry complains shortage of competent college graduates with adequate knowledge, skill and experiences
  - Graduates complain no chance to practice in college study, no confidence in job hunting
  - Parents complain high cost for kids' high education, but low chance to find a satisfied job
  - Universities are facing difficulty to arrange internship for students due to lack of necessary funding and support from industry
  - Government finds bottleneck of high quality human resources for industry upgrade and innovation due to gap between university and industry

Paradox: College graduates feel difficult to get jobs, but industry feels difficult to get good employees from colleges

The scale and speed of industry upgrade depends on the speed, quality and scale of providing talents by engineering education

Strategies for engineering education reform

1.University-industry cooperation: government, industry, education, students and parents work together

- To form complete chain for talent cultivation
  - To set up education target according to needs of industry upgrade – engineers for economy globalization
  - To incorporate industry needs and expertise into all stages of education process
  - To reinforce competitiveness and innovation, industry should work with education institutions for competent talent cultivation
  - To integrate university culture and industry culture
- To form complete chain for innovations: from knowledge innovation to market innovation

The responsibility of the whole society !

2.Engineering education globalization

- To make use the best education and student resources worldwide for global job market
- International standard of engineering education: quality talents to meet requirements of multinational companies, globally employable
- International university-industry cooperation (more than 120k Chinese students study abroad each year)
- English program for international students (Shanghai Jiaotong Univ., Group T, …)
- Joint International Colleges to introduce the best education systems into to China (Xi'An Jiaotong and Liverpool; Shanghai Jiaotong and U.Michigan), or to the world (Confucius institutions)
- Integration of different cultures

Two strategies for future engineering education : U-I Cooperation and Education Globalization

What MIT Is Doing in Engineering Education？ (1)

- Fighting with crisis of American engineering education due to shrinking student resource， MIT and Boston TV station launch weekly TV program to promote engineering profession
- Moving into project-based learning
  - a pilot for 60 freshmen last year with positive outcomes assessment
  - trying to figure out how to scale projects up for all students
- Shifting curricular focus away from engineering science and analysis toward product design/creation in ways that industry, NSF, NAE have called for :

  CDIO (conceive-design-implement-operate)

What MIT Is Doing in Engineering Education？ (2)

- Rethinking and reforming engineering education to face criticize from industry

  Bernie Gordon:

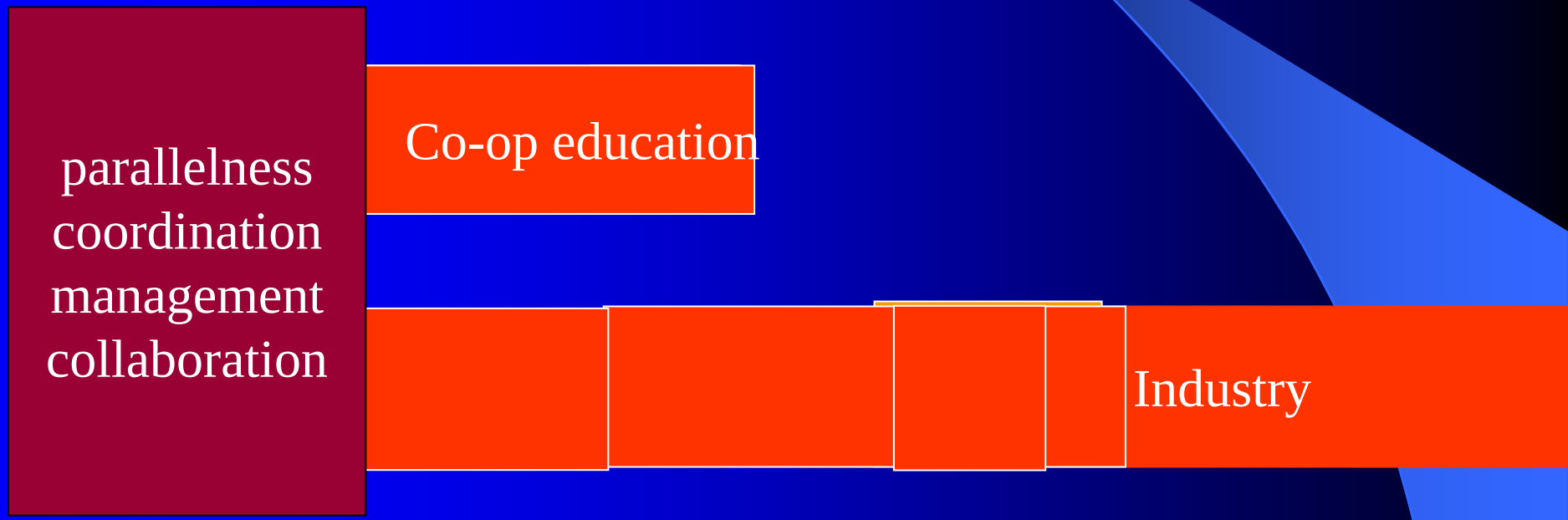
-Society…around the world…is not entirely pleased with the current state of general engineering education

-Engineering education should be torn down and started over

- Desperately figuring out how to get more engineering students to study abroad - globalization

Models of engineering education

Concurrent Engineering Education



Necessity of Co-op Education

- Schneider's rationale (1906)

1. many elements of most professions cannot be taught successfully in the classroom, but require practical experience for adequate mastery

2. most students will need or want to work during their post-secondary education, but the work performed is usually menial and unrelated to their course of study

Necessity of Co-op Education –cont.

- More rationales for nowadays hi-tech-society（2007）

1. Shorter lifecycle of new knowledge（IT：1 year）
2. Shorter period of new knowledge transferred to industrial applications (VC)
3. Multi-disciplinary nature of hi-tech industry（BPO）
4. More knowledge produced, fixed or shorter educational program（3+1 in EU）
5. Less patience of industry in training for large quantity of quality graduates(1-3 m for IT vs. 18m for airplane industry）
6. Much slower of universities upgrading in teacher force, curricular, textbook, equipment than industry development
7. Faster speed of spreading out of knowledge intensive industry than traditional industry (BPO vs. OEM)

Must find new approach for engineering education
-- cooperation with industry

Co－Op Education
one of models for talent cultivation

What is Co-op Education?

- Formally integrates a student's academic studies with work experience with participating employers
- Students alternate periods of experience in appropriate fields of business, industry, government, social services and professions

Criteria

1. Co-op employer approved by co-op education institution
2. Students engage production work
3. Students get paid for their work
4. Students are mentored and directed by co-op education institution in their work
5. Students are directed and appraised by their employers
6. Working time is at least 30% of study time at school

Benefits from Co-op Education

- University Benefits
  - increased enrollment with top quality students
  - Co-op students enrich educational community from work terms
  - well-qualified graduates assume productive role in society
  - enhanced visibility and reputation in community
  - feedback from employers on program curriculum
  - More opportunities for collaborative research projects with industry

- Student Benefits
  - a well-rounded education balanced by practical training and theoretical study
  - opportunities to gain relevant employment skills and realistic expectations of the work force
  - opportunities to test and gain broader understanding of career options
  - maturity and self-esteem as productive members of work force + confidence and skills working with others
  - good résumé, job search skills and a network of contacts upon graduation
  - financial remuneration helping to defray educational costs

Industry Benefits

- Reduced Recruitment Costs
  - enjoy year-round supply of highly motivated and capable students
  - can select applicants with good academic quality and practical training in workplace
  - have cost-effective means of evaluating future employees
- Effective Human Resource Management
  - employees' development in supervising co-op student
  - co-op students bring in enthusiasm and new ideas and approaches

100th Anniversary of worldwide Co-op Education (1906-2006)

- Over1500 universities in 43 countries offer Co-op Education Program (MIT, GeorgiaTech, RIT, NYU, UCB, UCL, UW, UM, WPI….)
- 200K students from 1000 universities of USA in Co-op Education Program supported by 120k employers
- USA view Co-op Education as strategic importance

  Search for new directions in education and new means to cope with problems of highly technological society

  Co-op Education movement will aid in progress of U.S. economy and ultimately increase its power in new global marketplace

Case Study

University of Waterloo, Canada

- 50 years practice since funded in 1957
- 50% students participant，switching between school and industry every 4 months with over 3000 industrial partners
  - Higher employment rate：97.6%; higher permanent job offer: 91.1% vs.77.9% by average
  - Most innovative and overall best university in Canada; most welcome university by industry (Bill Gates); first class university worldwide

Group T Leuven University College

- 5E education paradigm（Engineering, Enterprising, Educating, Environmenting, Ensembling)
- Cultivating talents for industry: cradle for internationally competitive engineers
- Over 60% Board members of Group T from industry, joining Boards of industrial organizations；over 200 industrial partners
- Teaching force：1/3 from industry;1/4 professors partly work in industry; over50％ teachers have industrial work experiences
- Assessment: 50% jury from industry

Curricula design

Focus on integral engineering: all Group T freshmen study four basic domains of engineering:

- Matter - > chemistry
- Energy - > mechanics, thermo dynamics
- Information - > mathematics, ICT, electronics and computer sciences
- Life - > biochemistry

Beyond engineering: important role of enterprising, management and communication – 5E concept

- Cost accounting
- Enterprising, business game simulation
- Marketing and financial management
- Group dynamics, human behavior, presentation techniques
- These courses represent 10-15% of Group T education profile

- Classroom learning to Stimulate personal skills/competencies of students: group discussion, student presentation
- Updating course contents according to industry needs
- “Beyond Class”: For 50% of contact-hours Group T is using alternative learning methods
  - Experiments, exercises
  - 5E-projects, integrating engineering, enterprising and communication/education skills
  - Bachelor thesis, Master thesis (in-company projects)

Results of Group T Education

- Before graduation, 97% to 100% of GROUP T students have a job
- Over 100 Chinese students graduated from Group T: 30% work in multination companies, 65% study for advanced Master and Ph.D. – internationally competitive engineers
- most welcome engineering school by industry

- 查老师： 见信好！ 很高兴在Group-T能跟您偶然碰面，不过那时您已经正要离开，没能多聊一会儿，深感遗憾。
- 时间匆匆而过，我已经在Group-T 学习生活了13个月了。这13个月的经历,学习和接受的训练以及以后的几个月将要带给我的都将成为我一生的财富。**Group-T 给我感触最深的地方是她处处凸显对能力的培养，一个工程师应该具备的能力----专业技能，解决实际问题，沟通交流还有流利的国际语言都会在Group-T不同的课程中得到锻炼培养。** 现在开始做Bachelor Project了，跟比利时的学生一组 。我们的主题是为PDA和手机编写一套Group-T 学生的个人信息，课表查询软件，要求用到蓝牙技术实现移动设备与服务器的连接。一步步做下来，其实已经在以工程师的角度解决问题了。**这几个月来对这个学校更进一步的认识就是Group-T 是为公司培养人才的地方，可以称得上是'工程师的摇篮'吧。**
- 暑假的时候在当地的一户人家里打工，他们经营一家乐器生产销售公司并在努力向中国发展，现在在深圳设立了自己的工厂。他们断定未来的市场在中国而且觉得汉语非常重要，于是他们千方百计让他们的孩子学汉语。**跟他们聊天的时候，他们经常提到他们需要的是'实战型'的人才，而Group-T的办学理念正好跟他们的观点契合一致，这也许是Group-T的毕业生容易找到工作的原因吧。** 当我的视野不断扩大的时候，发现机会和选择无处不在。我在Group-T的锻炼就是在为这些机会做准备的吧。 总之，很珍惜这次留学 的机会，很感谢'宏志'奖学金这个项目。从山区农村走进大学的时候，是没有预料到如此多而广的变化的。**衷心希望有更多的学生，尤其是山区农村的孩子也能有机会接受别样的教育。**
- 希望您再来Group-T的时候，有幸跟您再次碰面。
- 祝您安康。
- 宏志学生：张芬芬
- 2006年11月25日

- The most impressive thing to me from Group T is its emphasis everywhere on cultivating students' capability to be an engineer such as technology, problem solving skill, teamwork, communication and international language skill, which are carried out at all courses and training process
- Group T is really a place to cultivate talents for industry, is a real cradle for international engineers
- This is why Group T graduates can easily find good job in industry

--- Zhang Fenfen, a Hongzhi student of Group T, originally from Xi'an Jiaotong University

Suzhou Industrial Park Institute of Vocational Technology (SIPIVT)

- Slogan： Our Goal: To meet the needs of Industry

- Target: Cultivating technicians according to standard of multinational companies

- Over 50% board members from industry: advisors and decision makers for SIPIVT

- Customized classes to meet industry's needs
- Balance in hard skill (science & technology) and soft skill (teamwork, communication, professional ethic, …）

- Teaching force:
  - 60% from industry
  - 70% “Double Professional Titles” (instructor & engineer)
  - Policy to encourage teachers working in industry as visiting engineers
- In-company training
  - Over 400 partner companies, most in SIP
  - For 1 year out of 3 years program
  - Set up in-school teaching factories (engaging production: precision fabrication, carton production…）

- High employment rate and quality

  Above 97% vs. 60% nationwide

  90% in manufacturing center of Yangtze River Delta, including most multination companies

  10% take internship abroad and result in employment afterwards

  80% play backbone role in companies after two years employment（line-leader, group leader, technician, engineer, trainer）

- Fusion of school culture and companies' culture: ISO9000 certificate

- One of demonstrative vocational schools in China

Whenever companies look for talents,
they first think about IVT

Conclusions

- Industry upgrade depends on massive versatile, innovative and international type of talents
- Industry upgrade brings challenge and opportunity to engineering education
- University-industry cooperation and education globalization are two strategies for future engineering education to become cradles of engineers for global industries and economy
- China has to adopt two strategies to reform its engineering education in order to become cradles of international engineers, based on its abundant resources of engineering students, large scale of engineering education and huge job market for quality engineers

联合国教育、科学、文化组织

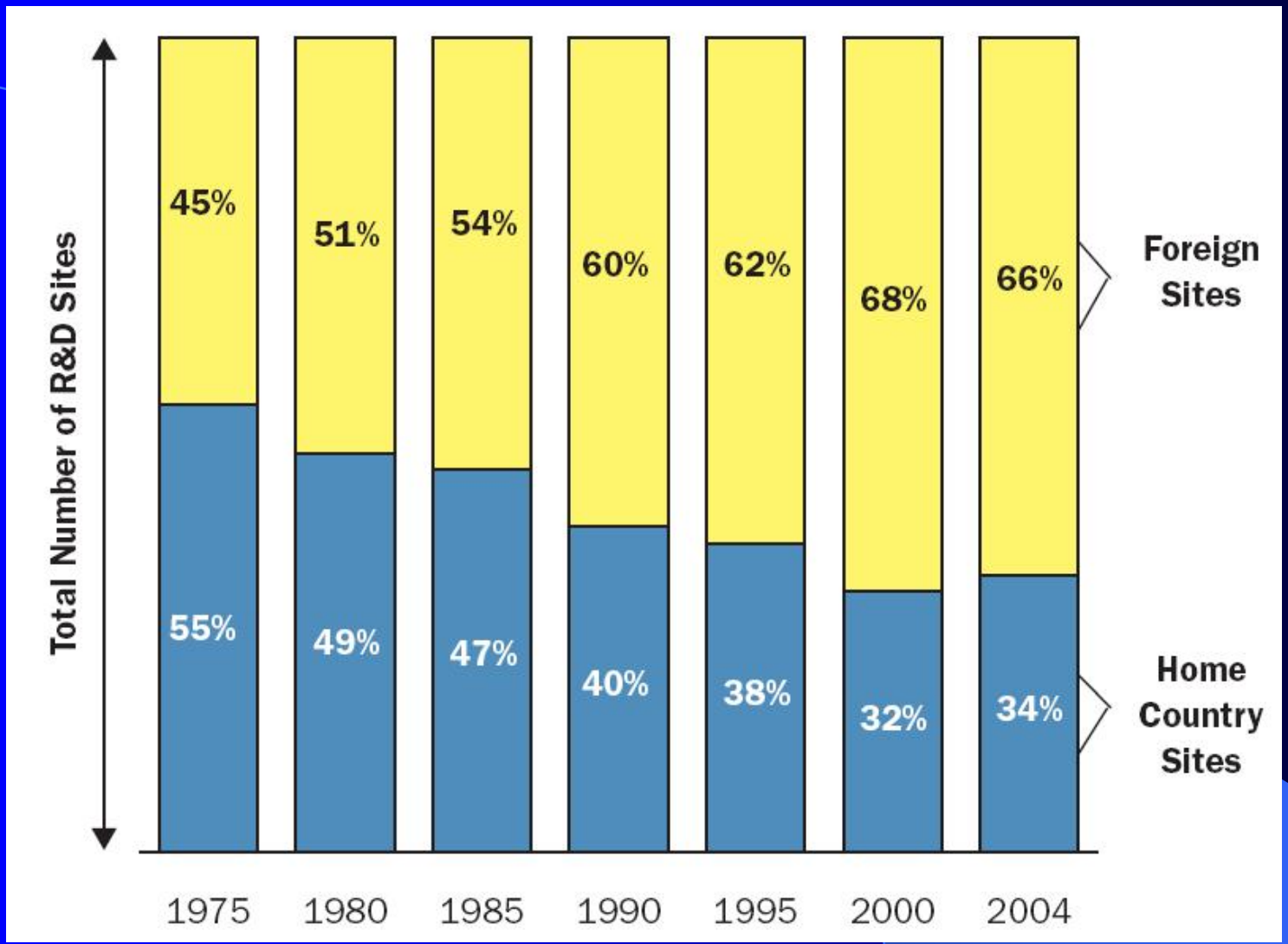
Thank you!

Q&A

Growth in Foreign Research & Development Sites

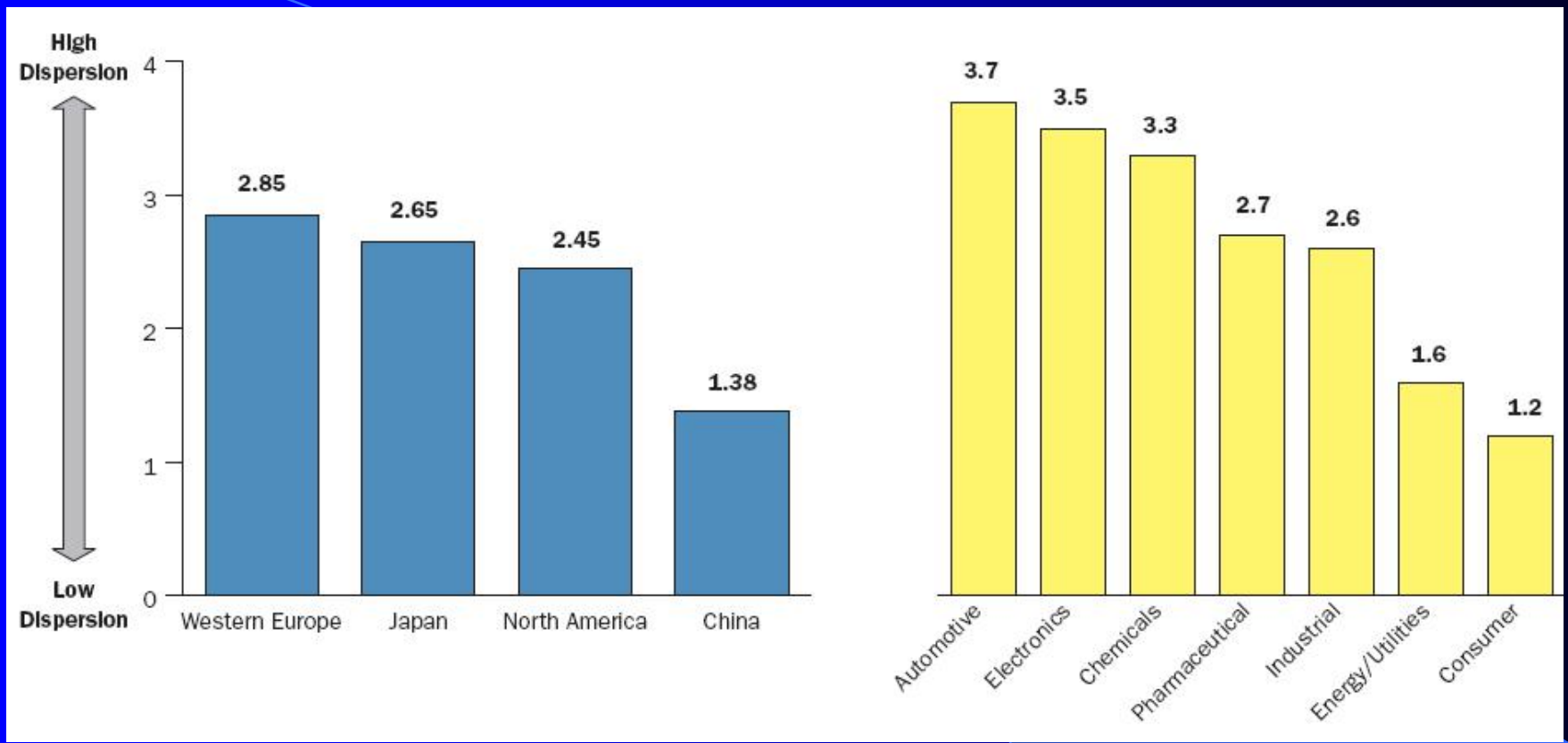
base on investigation on 186 companies from 19 countries of 17 industrial sectors

source：Booz/Alien/Hamiton of INSEAD



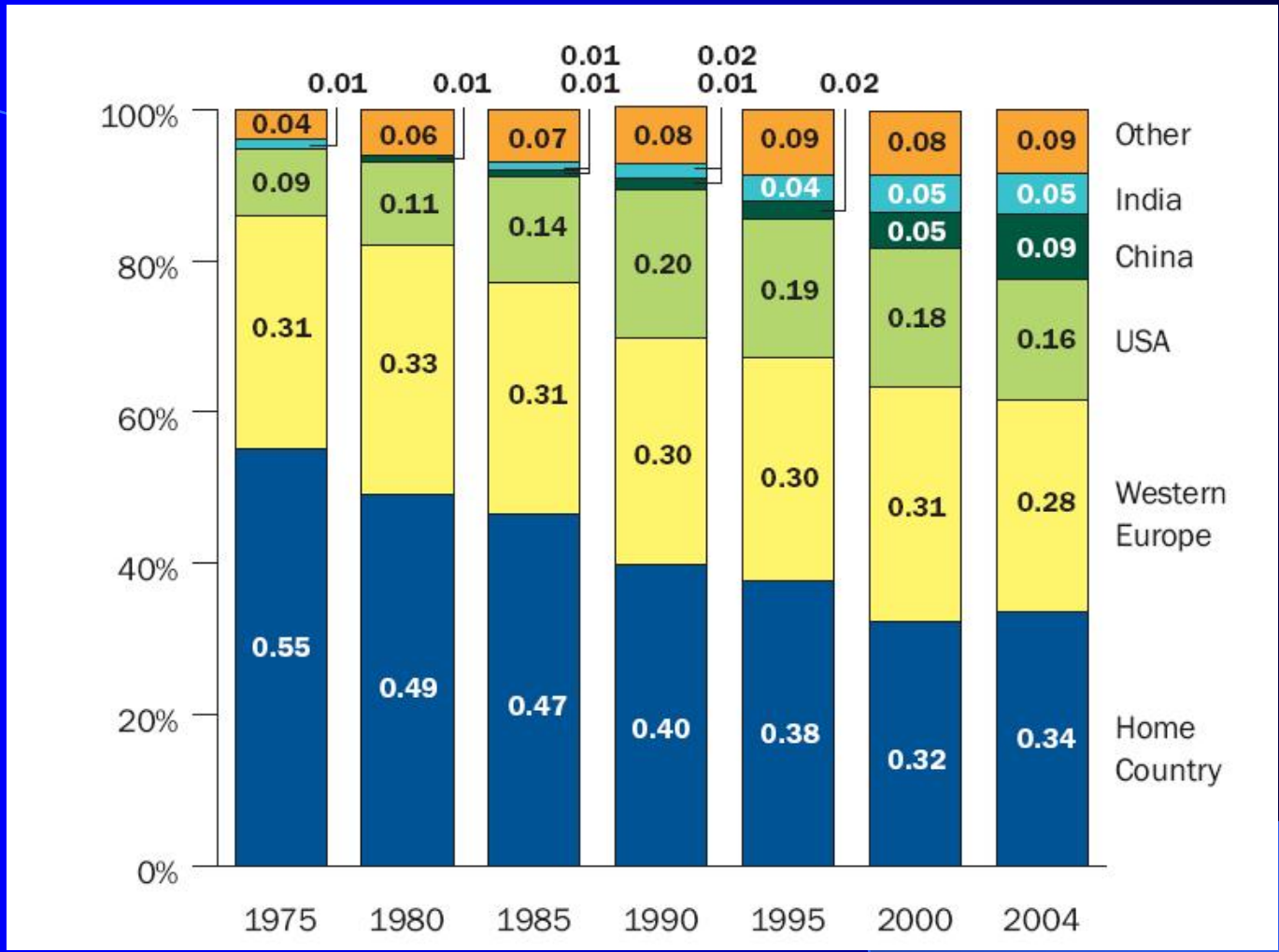
Globalization Index by Company Home Region and Sector

source：Booz/Alien/Hamiton of INSEAD



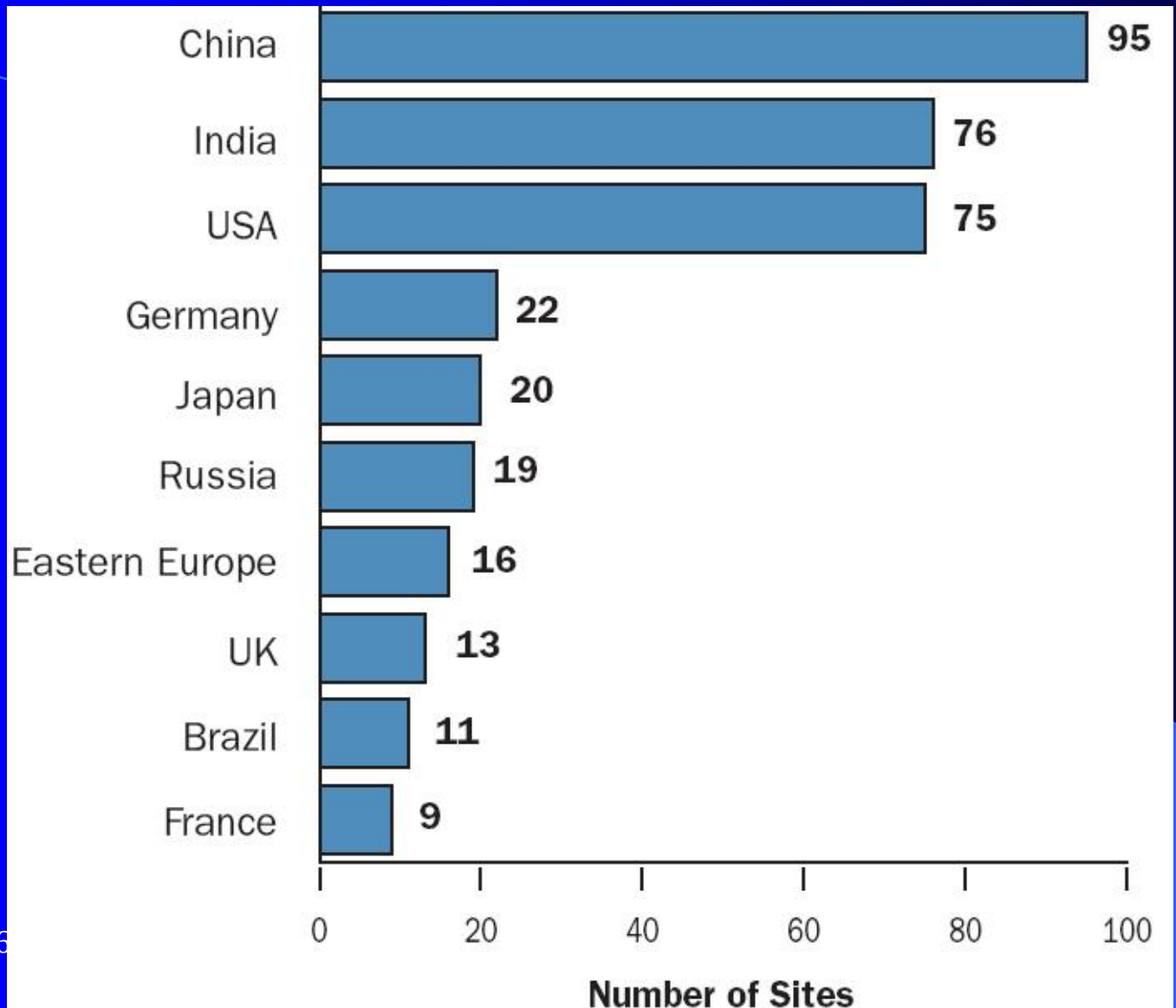
Changing Distribution of R&D Sites

source：Booz/Alien/Hamiton of INSEAD



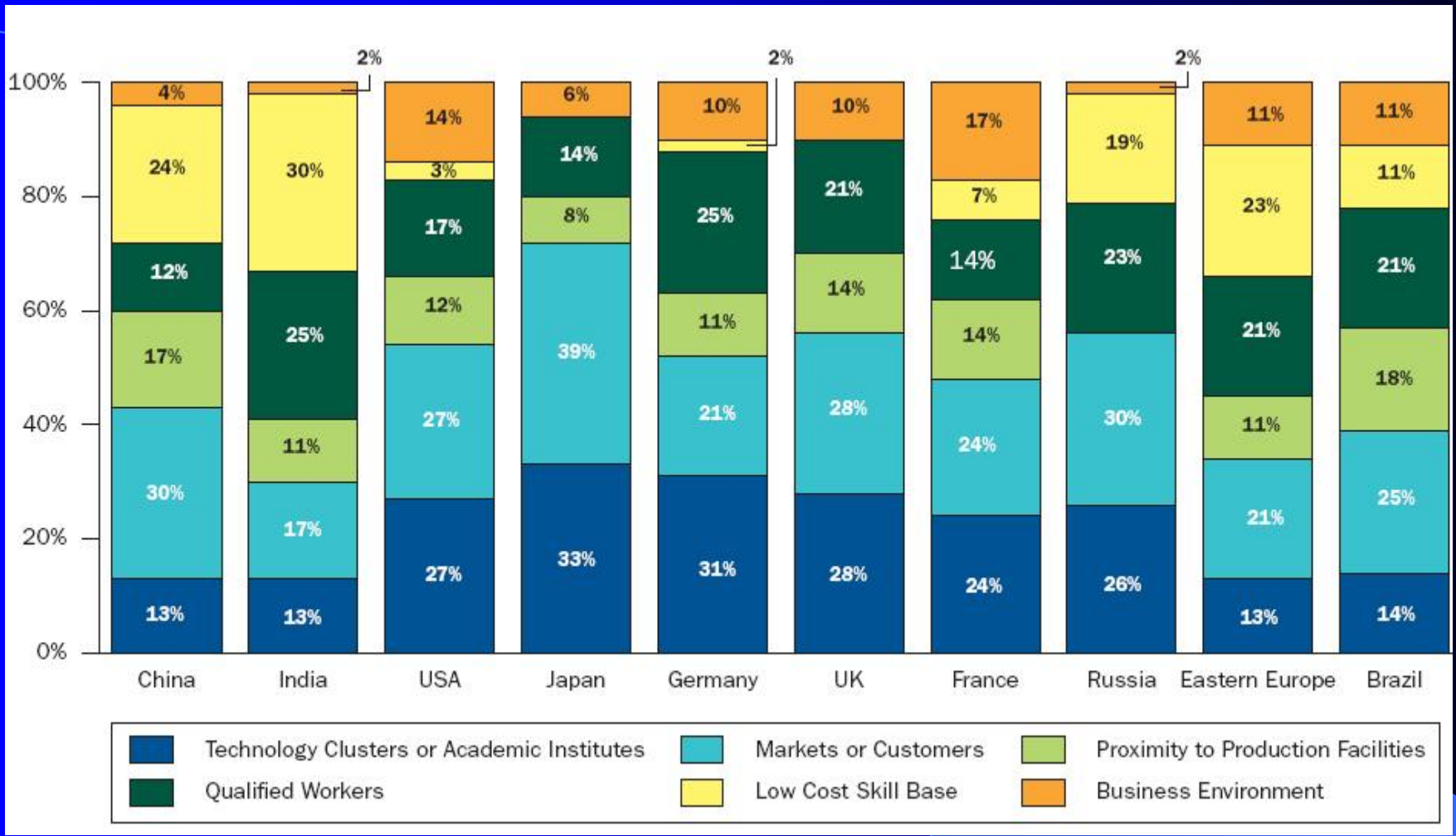
Locaitons of New R&D Sites in Optimally Configured Network

source：Booz/Alien/Hamiton of INSEAD



Drivers of Future R&D Sites

source：Booz/Alien/Hamiton of INSEAD



Global Master Project

Use your 5 E's and work for a real industrial project

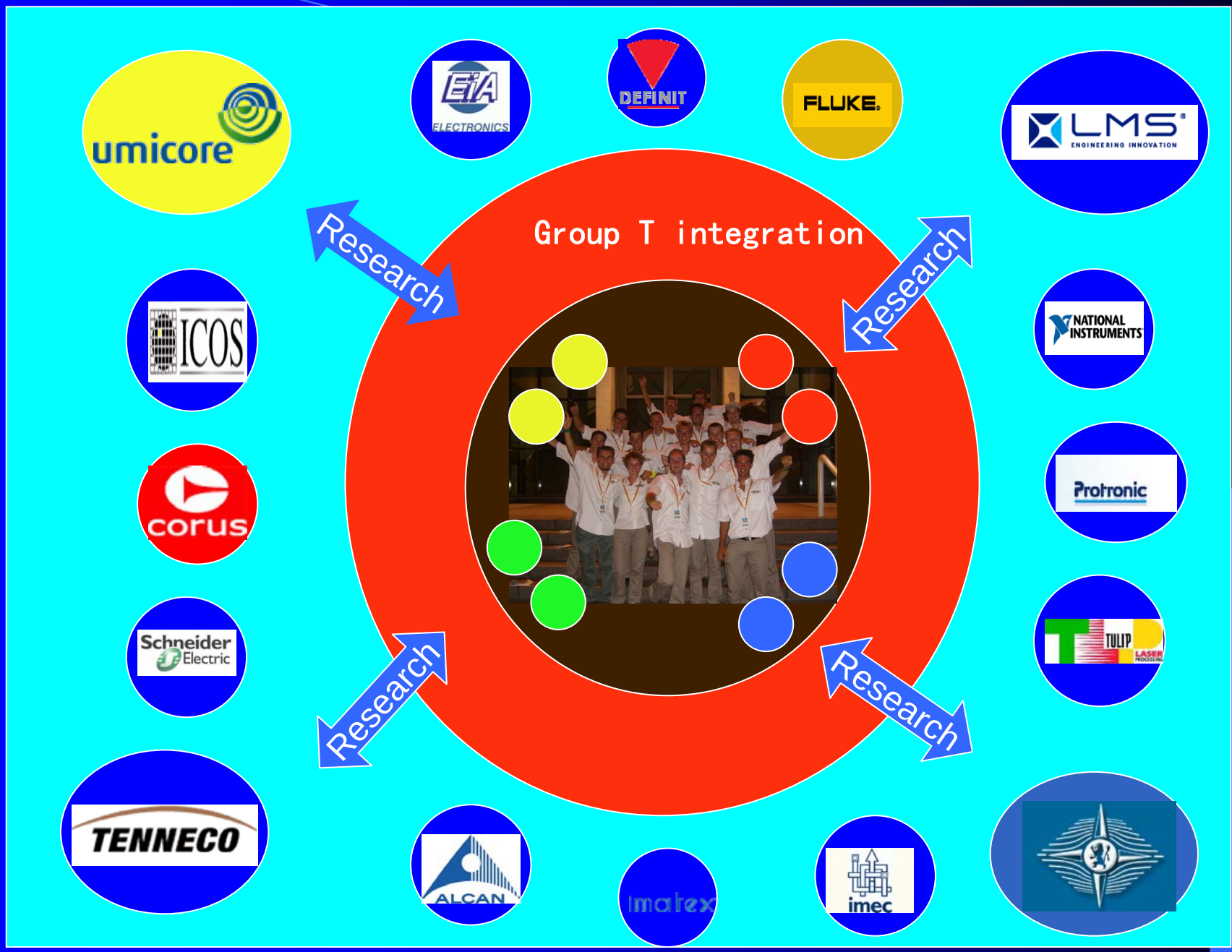
together with fellow students

together with professionals

together with a network of companies

Graduate with an extra E

EXPERIENCE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corus
Protronic
Schneider Electric
TULIP
LASER
TENNECO
ALCAN
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UMICORE SOLAR TEAM

We don't build a CAR
We create the FUTURE

TOP TECHNOLOGY

Aerodynamics

Body

Frame

Suspension

Batteries

Solar Cells

Motor

UMICORE SOLAR TEAM

We don't build a CAR
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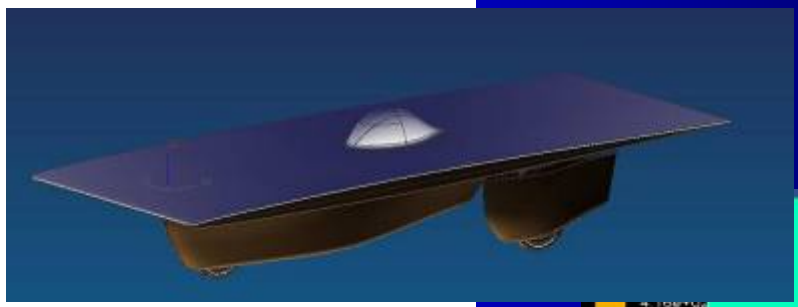
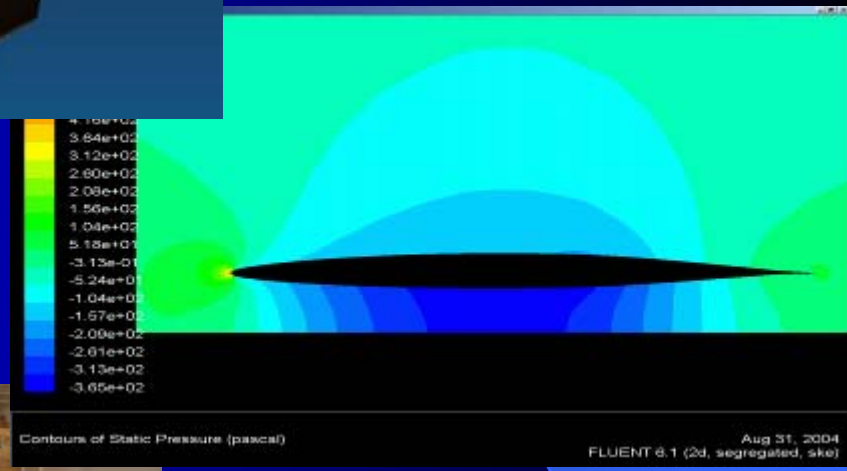


Aerodynamics



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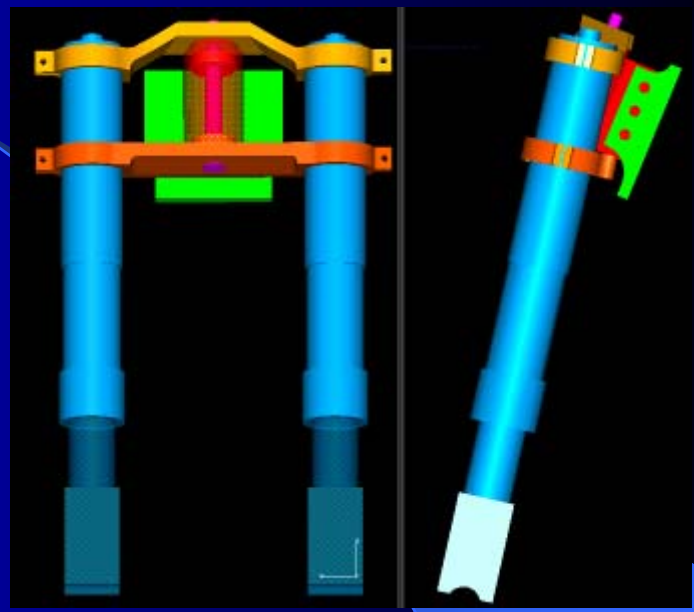

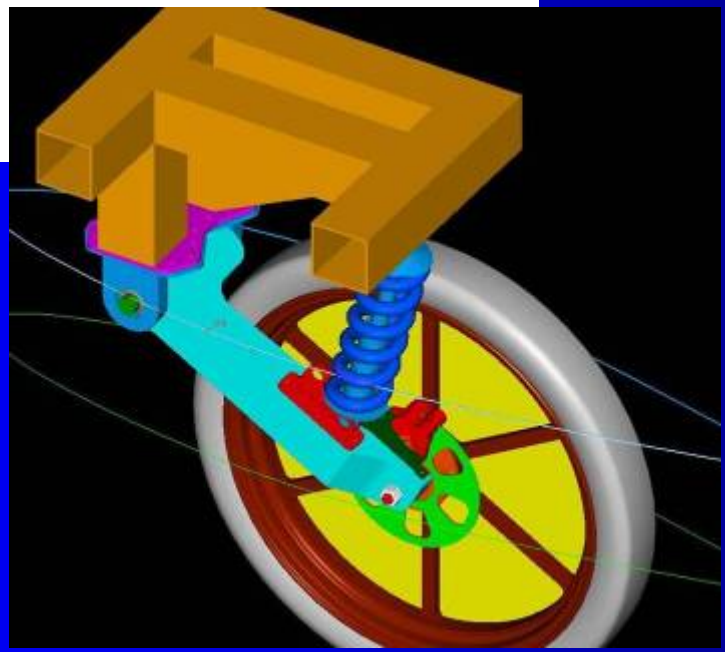

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UMICORE SOLAR TEAM

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- Aerodynamics
- Body
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- ***Motor***

UMICORE SOLAR TEAM

We don't build a CAR
We create the FUTURE

Name	Umicar
Dimensions	Length 5,00m Width 1,80 m Height 0,93m
Weight	±200 kg (excl. Driver)
Chassis	Aluminium Frame, Carbon Fiber Body
Air Capacitance	Cx = 0,074 (normal car: Cx = 0,35)
Propulsion	Inwheel motor, 98% efficiency
Solar Array	3000 Gallium-Arsenide Solar cells
Battery	26 Lithium Polymer Batteries
Top speed	150 km/h
Project Costs	1.000.000 Euro

FIRST BELGIAN SOLAR CAR

UMICORE SOLAR TEAM

We don't build a CAR
We create the FUTURE

UMICORE SOLAR TEAM

We don't build a CAR
We create the FUTURE

World Championship

r Solar Cars

3，000 km

UMICORE SOLAR TEAM

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We create the FUTURE