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Implementing the concept of C(onceive) D(esign) I(implement) O(operate) at Gdańsk University of Technology

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Implementing the concept of C(onceive) D(esign) I(implement) O(operate) at Gdańsk University of Technology

Michał Wasilczuk
Edmund Wittbrodt
Andrzej Zieliński

presented by M. Wasilczuk
at FEANI Seminar
Gdansk, 8.10.2014

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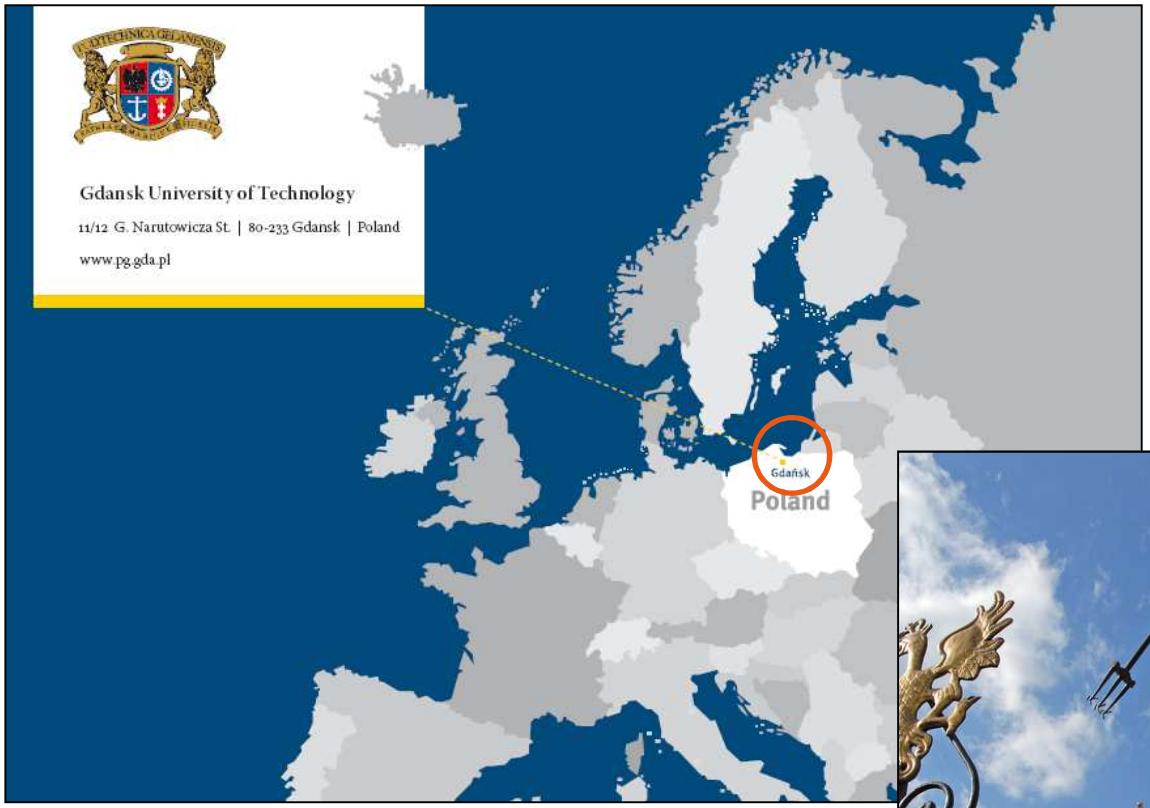
Gdansk – GUT environment



A thousand-year old settlement

Known as World Capital of Amber

Gdansk - hometown of Hevelius, Farenheit, Schopenhauer, Grass and Walesa

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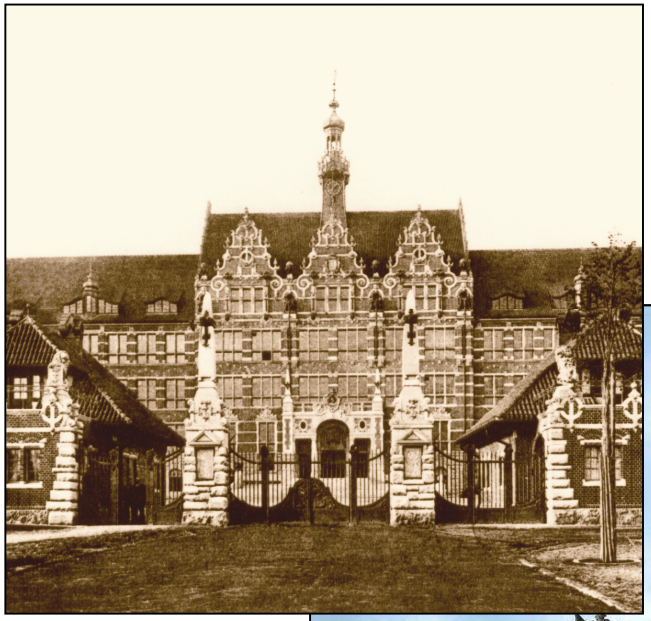
Gdansk University of Technology - introduction



110 Years of Tradition

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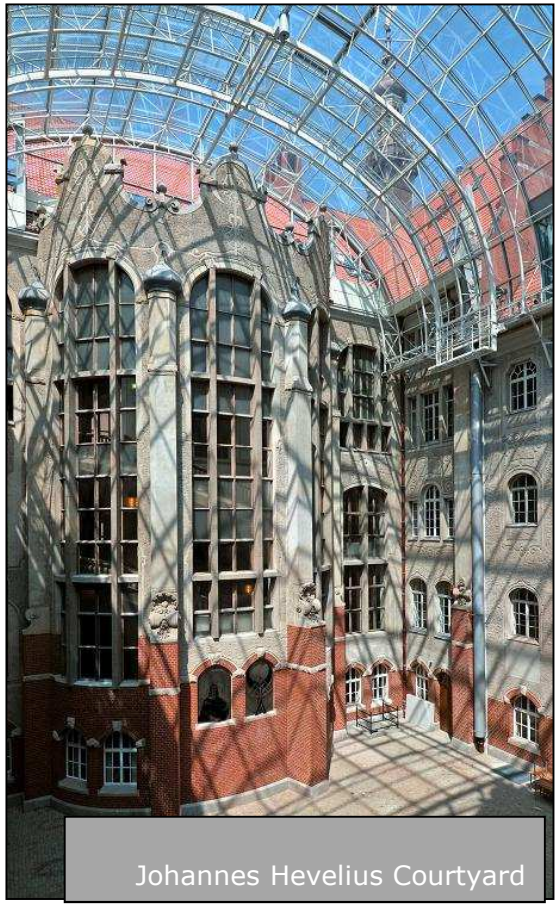
Contemporary GUT



Johannes Hevelius Courtyard

Faculties

Faculty of Architecture

Chemical Faculty

Faculty of Electronics, Telecommunications and Informatics

Faculty of Electrical and Control Engineering

Faculty of Applied Physics and Mathematics

Faculty of Civil and Environmental Engineering

Faculty of Mechanical Engineering

Faculty of Ocean Engineering and Ship Technology

Faculty of Management and Economics

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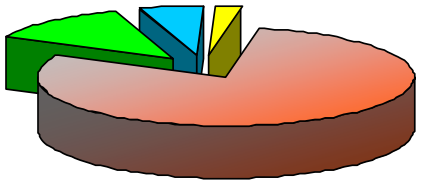
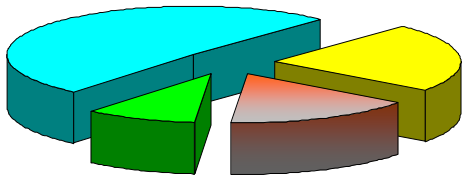
Contemporary GUT in numbers

Number of students and participants



Number of didactic and scientific staff



Number of students and participants

total	26 900
Full-time studies	21 432
Part-time studies	3 352
Postgraduate studies and MBA	1 532
Doctoral Studies	584

Number of staff

Total	1 183
Professors	193
Associate professors	115
Doctors	602
Other teachers	273

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Introduction to CDIO idea/organization

Main assumptions of cdio

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CDIO is based on a commonly shared opinion that engineering graduates should be able to: Conceive – Design — Implement — Operate complex engineering systems in a modern team-based engineering environment *(from cdio.org)*.

An education system that stresses the fundamentals, set in the context of Conceiving – Designing – Implementing – Operating systems and products:

- **A curriculum organised around mutually supporting courses, but with CDIO activities highly interwoven**
- **Rich with student design-build-test projects**
- **Integrating learning of professional skills such as teamwork and communication**
- **Featuring active and experiential learning**
- **Constantly improved through quality assurance process**

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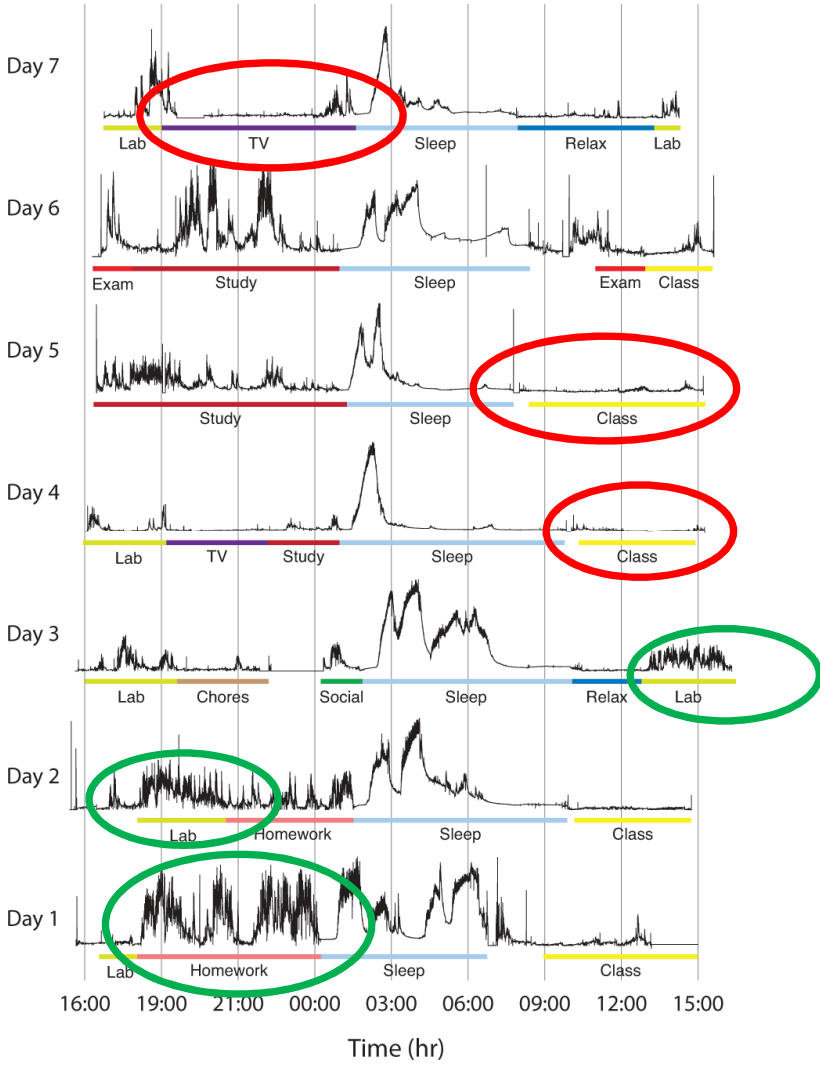
Introduction to CDIO idea

Important features

- **Active learning** – interesting results of measurements of electrodermal activity of a student over one week[1)]

- **Project Based Learning**



1) Poh, M.Z., Swenson, N.C., Picard, R.W., "A Wearable Sensor for Unobtrusive, Long-term Assessment of Electrodermal Activity," IEEE Transactions on Biomedical Engineering, vol.57, no.5, pp.1243-1252, May 2010

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Important ideas around CDIO

"The formulation of the problem is often more essential than the solution." Einstein

Understanding the Impact of A Changing World on Education in the 21st Century:

- Knowledge has become a free commodity--, growing exponentially, changing constantly
  - From scrolls to tablets to books to the internet
- As a result, all students need new skills for continuous learning, careers, and citizenship
- "Digital natives" are differently motivated to learn than digital immigrants

So What? Now What?

The World No Longer Cares What You Know . . .

The World Cares What You Can Do With What You Know:

Do you have the skill?

Do you have the will?

Creating Innovators:
The Culture of Schooling vs The Culture of Innovation

- Individual Achievement versus Collaboration
- Specialization versus Problem-based, Multi-disciplinary Learning
- Risk Avoidance versus Trial and Error
  - The resilience and self-confidence that comes from surviving "failure"
- Consuming versus Creating
- Extrinsic versus Intrinsic Motivation
  - Play, Passion, and Purpose = perseverance

Why You Can Pass Tests and Still Fail in the Real World?

Eric Mazur Harvard – speech during CDIO Intl Conf. MIT/Harvard June 2013

Slides from Tony Wagner – Creating Innovators at CDIO Annual Conference MIT/Harvard, June 2013

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CDIO initiative origin

•Engineering education programs throughout much of the 20th century offered students plentiful hands-on practice: Accomplished and experienced engineers taught courses that focused on solving tangible problems.

•But … scientific and technical knowledge expanded rapidly, engineering education evolved into **the teaching of engineering science**. Teaching engineering practice was increasingly de-emphasized.

•As a result, industry in recent years has found that graduating students, while technically adept, **lack many abilities required in real-world engineering situations**.

•Major companies created lists of abilities they wanted their engineers to possess (e.g. Boeing's Desired Attributes of an Engineer). … the Accreditation Board of Engineering and Technology, ABET, listed its expectations for graduating engineers.
•…. faced with the gap between scientific and practical engineering demands, the educators took up the challenge to reform engineering education. The result of the endeavor is the worldwide CDIO Initiative.

CDIO established in 2000 by

LINKÖPINGS UNIVERSITET

AVANCEZ 1829

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

KTH VETENSKAP OCH KONST

ROYAL INSTITUTE OF TECHNOLOGY

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Gdansk University of Technology in CDIO

Prof Andrzej Zieliński *(former Vice Rector for International Cooperation)*, **and Dr Sylwia Sobieszczyk** *(former Vice Dean for Education at the Faculty of Mech Eng)*
were the people who were infected with the CDIO idea and their enthusiasm and perseverence led to our admission to CDIO Initiative in May 2011

GUT was a host of regional CDIO meeting in September 2011

GUT is the only Polish university being a member of CDIO initiative

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12 CDIO standards

Standard 1 The Context – CDIO Philosophy
Standard 2 Learning Outcomes – CDIO Syllabus
Standard 3 Integrated Curriculum
Standard 4 Introduction to Engineering
Standard 5 Design-Implement Experiences
Standard 6 Engineering Workspaces
Standard 7 Integrated Learning Experiences
Standard 8 Active Learning
Standard 9 Enhancement of Faculty Competence
Standard 10 Enhancement of Faculty Teaching Competence
Standard 11 Learning Assessment
Standard 12 Program Evaluation

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Evaluation criteria

Scale	Criteria
5	Evidence related to the standard is regularly reviewed and used to make improvements.
4	There is documented evidence of the full implementation and impact of the standard across program components and constituents.
3	Implementation of the plan to address the standard is underway across the program components and constituents.
2	There is a plan in place to address the standard.
1	There is an awareness of need to adopt the standard and a process is in place to address it.
0	There is no documented plan or activity related to the standard.

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CDIO standards - comments

First steps/initial assumptions

CDIO as Context -

Adoption of the principle that product and system lifecycle development and deployment – Conceiving, Designing, Implementing and Operating - are the context for engineering education

CDIO Syllabus Outcomes –

Specific, detailed learning outcomes for personal, interpersonal and product and system building skills, consistent with program goals and validated by program stakeholders

Integrated Curriculum –

A curriculum designed with mutually supporting disciplinary subjects, with an explicit plan to integrate personal, interpersonal and product and system building skills

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CDIO standards - comments

Details and methods

Introduction to Engineering –

An introductory course that provides the fram
product and system building, and introduces e
skills

De

A c
bas

CD

Wo ***encourage hands-on learning of***
pro ***edge, and social learning***

Int

Inte ***acquisition of disciplinary knowledge,***
as well as personal, interpersonal and product and system building skills

Active Learning –

Teaching and learning based on active, experiential learning methods

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CDIO standards - comments

Assessment and Development

Enhancement of Faculty CDIO Skills

Actions that enhance faculty competence in personal, interpersonal and product and system building skills

Enhancement of Faculty Teaching Skills

Actions that enhance faculty competence in providing integrated learning experiences, in using active experiential learning methods, and in assessing student learning

CDIO Skills Assessment

Assessment of student learning in personal, interpersonal and product and system building skills, as well as in disciplinary knowledge

CDIO Program Evaluation

A system that evaluates programs against these twelve standards and provides feedback to students, faculty, and other stakeholders for the purposes of continuous improvement

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Polish higher education system vs CDIO ideas

There is a national accreditation commision in Poland.

We have just finished the process of changing from partly obligatory curricula (standards of contents on standarized courses covering more than 50% of study hours)

into

OUTCOME-BASED DEFINITIONS OF CONTENTS
(„National Competence Framework")

KRK

… unfortunately in many cases it was done in a top-down manner with a lot of paper-work imposed on faculties (poor vice-deans for education...) and faculty members (poor ourselves…)

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GUT in the higher education system

We have been very succesful in recruitment, due to:

- **State policy to promote technical and science study (including EU funded projects with special scholarships for students taking up study at STRATEGIC courses, introduction of obligatory matriculation exam in maths**
- **New, attractive courses**
- **Own promotional activity (OPEN days, science festivals, school visits etc.)**

HUMAN CAPITAL
NATIONAL COHESION STRATEGY

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GUT in the higher education system

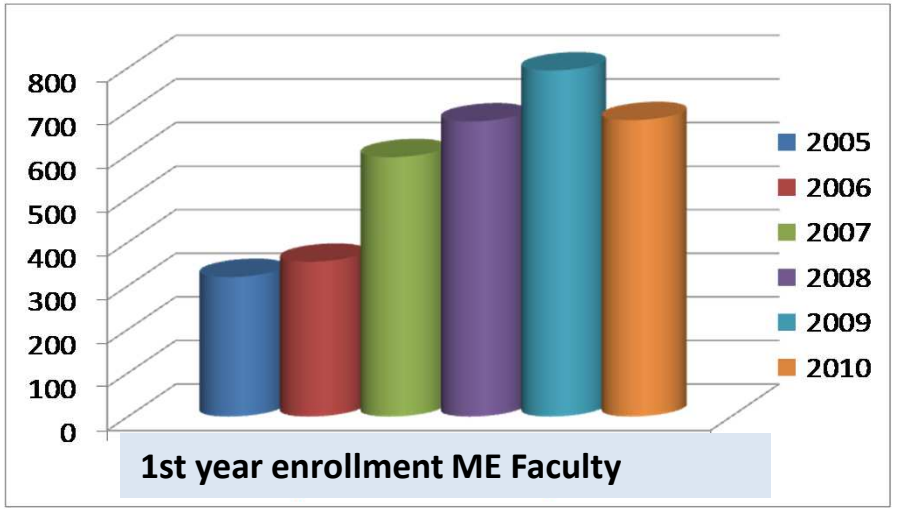
HUMAN CAPITAL
NATIONAL COHESION STRATEGY

More candidates are coming
they are better cadidates in terms of exam results

for example at ME Faculty rapid increase was observed in 2007 when new courses (**mechatronics, mechanical engineering in medicine, management and production engineering**) were started, but

…..there was no proportional increase in financing and number of staff decreased in most faculties

…. people are overworked, especially as simultaneously the requirements in the field of scientific activity increased (demands for faster degrees acquiring pace, more frequent assessments)



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INDUSTRIAL ENVIRONMENT
historical background

Before 1989 in Eastern Block Poland with a centralized economy and a large sector of heavy industry, universities had tight relations with big factories including R&D activity and positions for students for their apprenticeships, subjects and support for diploma projects and finally stable employment.

Pomerania Region - strong marine industry - four large shipyards – many smaller factories including strong sector of hydraulic machinery and ventilation/air conditioning/cooling equipment.

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INDUSTRIAL ENVIRONMENT
post transformation changes

New companies take over, including mainly IT companies, biotechnology, small shipyards, small machine building/automatics and control companies, but still the industry in the northern Poland is relatively weak.

The industrials are the strongest supporters, but they are in majority SME's representatives, so the financial support from the industry (especially in northern Poland and in economic crisis time) is insufficient for thousand of graduates each year. Support scale depends on the field - better in IT field and very low in civil engineering, which is huge education field in Gdańsk and a big, but very dispersed branch of local economy.

The interest of industrials in modifications of curricula was demonstrated by the active participation of Alumni Society in the conference organized at GUT and devising a manifest to the university and local authorities

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Facilities development program

INFRASTRUCTURE AND ENVIRONMENT
NATIONAL COHESION STRATEGY

~15 MEUR project

Rebuilding the laboratory facility into a students space and adding a 5th floor for laboratory rooms at the Faculty of Mechanical Engineering

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Facilities development program

INFRASTRUCTURE AND ENVIRONMENT
NATIONAL COHESION STRATEGY

Students' space at the Faculty of Architecture

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Project of TEACHING infrastructure development

INFRASTRUCTURE AND ENVIRONMENT
NATIONAL COHESION STRATEGY

Building, rebuilding, modernization…

But also: GUT Senate resolution No 88/2013/XXIII from 22nd May 2013

… In all curricula **students group projects** should be carried out as an elective component during undergraduate courses and as an obligatory componenet in Master Courses.

… It is recommended to **build interdisciplinary (interfaculty) project teams**

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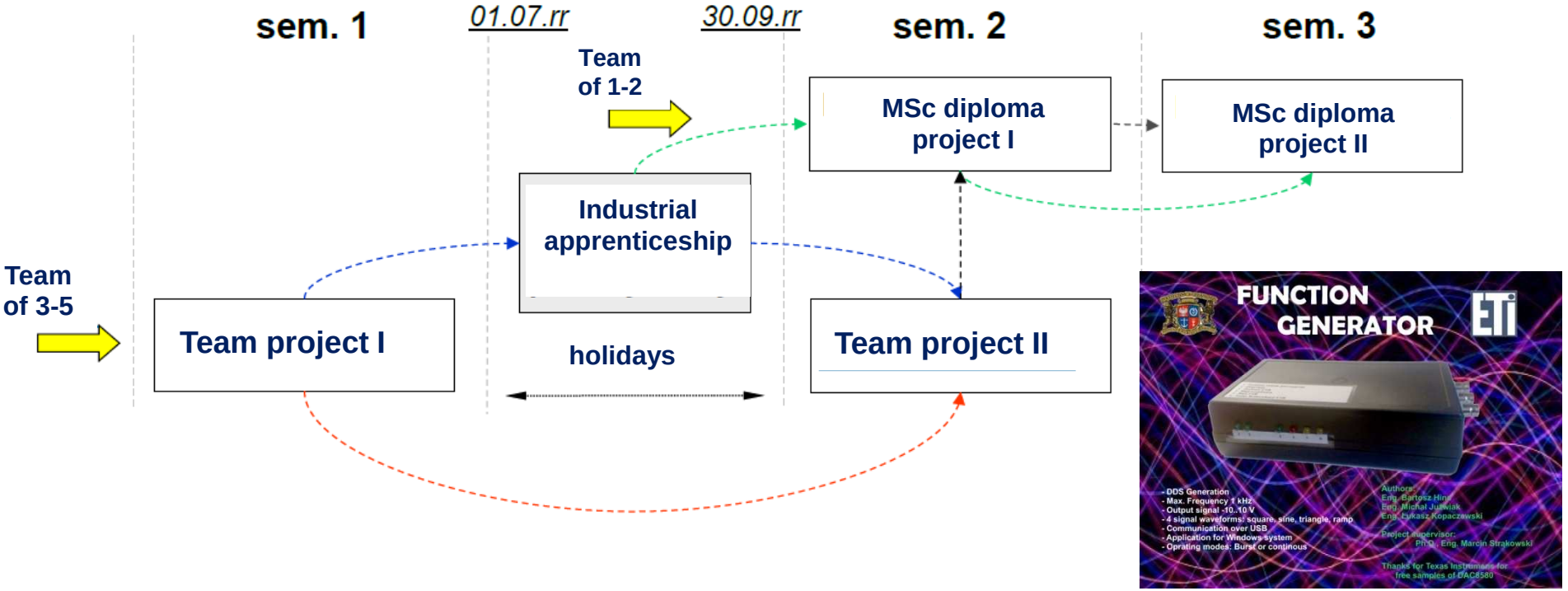
What we already have

GOOD practises: Faculty of Electronics, Telecommunications and Informatics runs a course named TEAM PROJECT at the MSc level with a two semester duration + (summer apprenticeship).

3-5 people groups develop projects ORIGINATING FROM THE INDUSTRY – software, a useful electronic device, etc.



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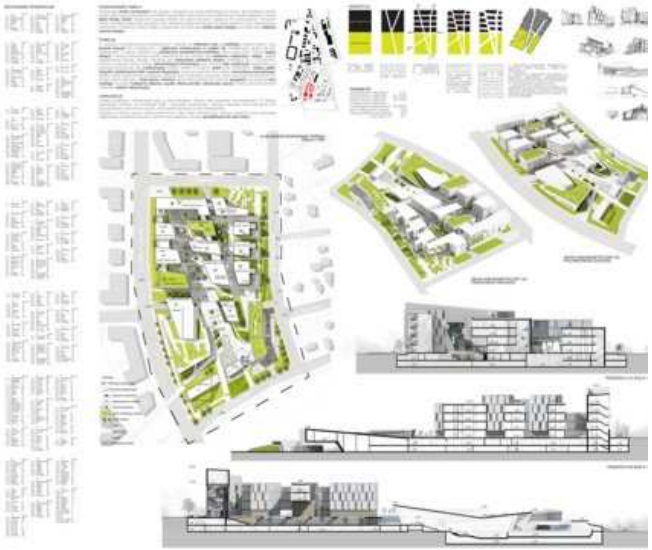
What we already have

GOOD practises: Faculty of Architecture runs their projects in the form of architectural competition with many teams working on the same subject and the final evaluation

They also run the project of small houses/settlements in the DESIGN STUDIO – during certain hours the students work together and have adivisors (specialists) of many branches available in one time (structural design, water, sewage, electricity systems, urbanists etc.)



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What we already have

GOOD practises: at many faculties **SOME DIPLOMA PROJECTS** are arranged as team projects resulting in building a prototype devices – car enthusiasts are probably most common, but recently also medical devices are built

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What we already have

Many ENTHUSIAST and CAPABLE students who are ACTIVE in various students science organizations – ocean engineering ones being probably the most successful

International Dutch Open Solarboat Challenge 2011, Holland – WINNERS,
Dong Energy Solar Boats Challenge 2014 – Class B winners

… and LAST BUT NOT LEAST a Rector who is devoted to carrying out deep changes in education system

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Recent development plans

Introduction of a new English language course – ENERGY SYSTEMS:

- **run by 3 faculties – Faculty of Electrical and Control Engineering, Faculty of Mechanical Engineering, Faculty of Ocean Engineering and Ship Technology**
- **start in October 2015**
- **35-40 people**
- **based on CDIO idea**

Why:

- **drive towards internationalization - internal analysis showed that we need to come up with an UNDERGRADUATE COURSE to attract foreign candiddates (China, India, Eastern Europe) – up till now more Master courses in English were run**
- **Attractive field**
- **As general/universal as possible – comprising several faculties**
- **Creation a new course involves a lot of beaureacracy**

Hence a choice of an existing „interfaculty" course and its modification according to CDIO standards to improve attractivity/recriutment potential

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Recent development plans

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program CDIO

ECTS	semestr I	II	III	IV	V	VI	VII
1	ochr. Wł	**Fundamentals of group activity**	WF	WF	**Renewable energy resources**	przedm spec.	spec
2	BHP		**Introduction to CAD/CAM**	**Intermediate CDiO project**			spec
3	**Communication**	Podst funkcjonowania przeds	Zarz finans				spec
4		Mat II	**Machine Design I**	zast mat w technice			spec
5	Mat I		zast mat w technice	Maszyny elektr.	Podst automatyki		praca przej sem. Dypl.
6			Fiz II		**Machine Design III, project**		
7	Chem	Fiz I	Mech.	**Machine Design II**	Przesyłanie energii		projekt dyplom. Inż.
8	**Technical English**	Mech			Technolo i masz energ.		
9	geom i graf inż.	Podstawy elektrotechniki i elektroniki	Elektrotechn i elektron	termodyn	Maszyny cieplne/Siłownie wiatr		
10			Paliwa oleje	Mech. Płynów			
11	Gosp i syst energ.	**Introductory CDIO project (electrotechnical)**	Techniki wytw		Podst eksploat. Masz	**apprenticeship**	
12		Techniki wytw		Miernictwo	Rynek energii		
13	Ochrona środ w energ	Materiały konstr.	Termodynamika	Podstawy energoelektron.	racjonal użytk. Energii		przyg do egz

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CONCLUSIONS

Problems for CDIO implementation in GUT (more generally, at many Polish universities):

- over-regulated rules of creating curricula/courses imposed by certifying bodies;
- financial problems including lack of modern equipment, NOT SUFFICIENT FINANCING OF EVERYDAY OPERATION (in MIT – Medical Design Course ca 4000$/yr for each project in the field of medical engineering[4])
- deficiency of labs and lecture rooms (GUT number of students has grown rapidly)
- weak industry in northern Poland, not ready to cooperate and to take part in co-financing of student diploma projects – 20-30 subjects needed per year for each course;
- overworked staff not ready for changes and lacking knowledge in the field of soft skills training;
- deficiency of staff ready for modern teaching and training of soft skills.

On the other hand, financing of the infrastructural projects for sure increases the motivation and improves the conditions of implementing CDIO at GUT. It also shows the involvement of University authorities into adoption of the new teaching methods.

[4] *Nevan Hanumara et al.: Classroom to Clinic: Merging Education and Research to Efficiently Prototype Medical Devices*

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Thank you for your attention

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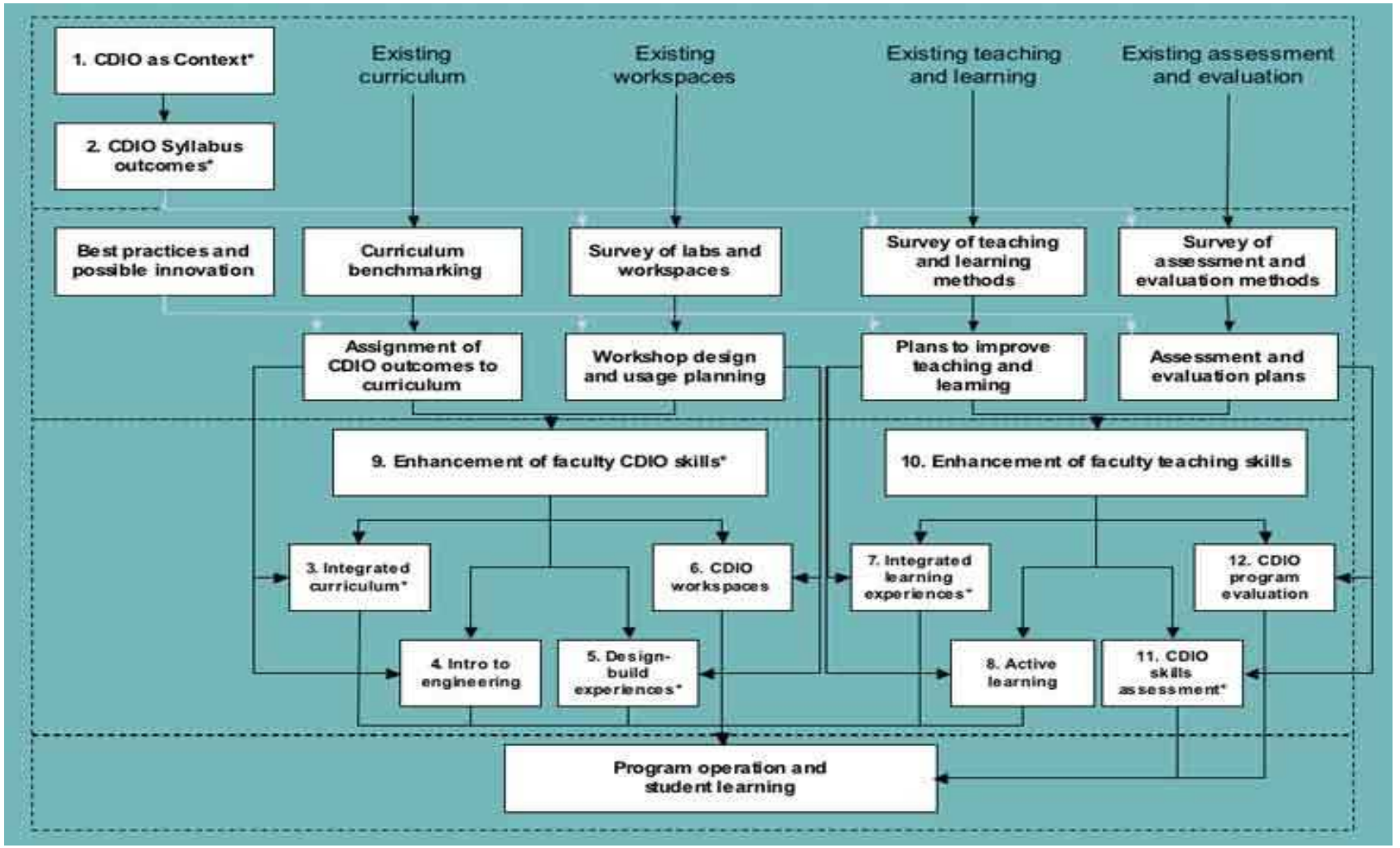
CDIO adoption chart



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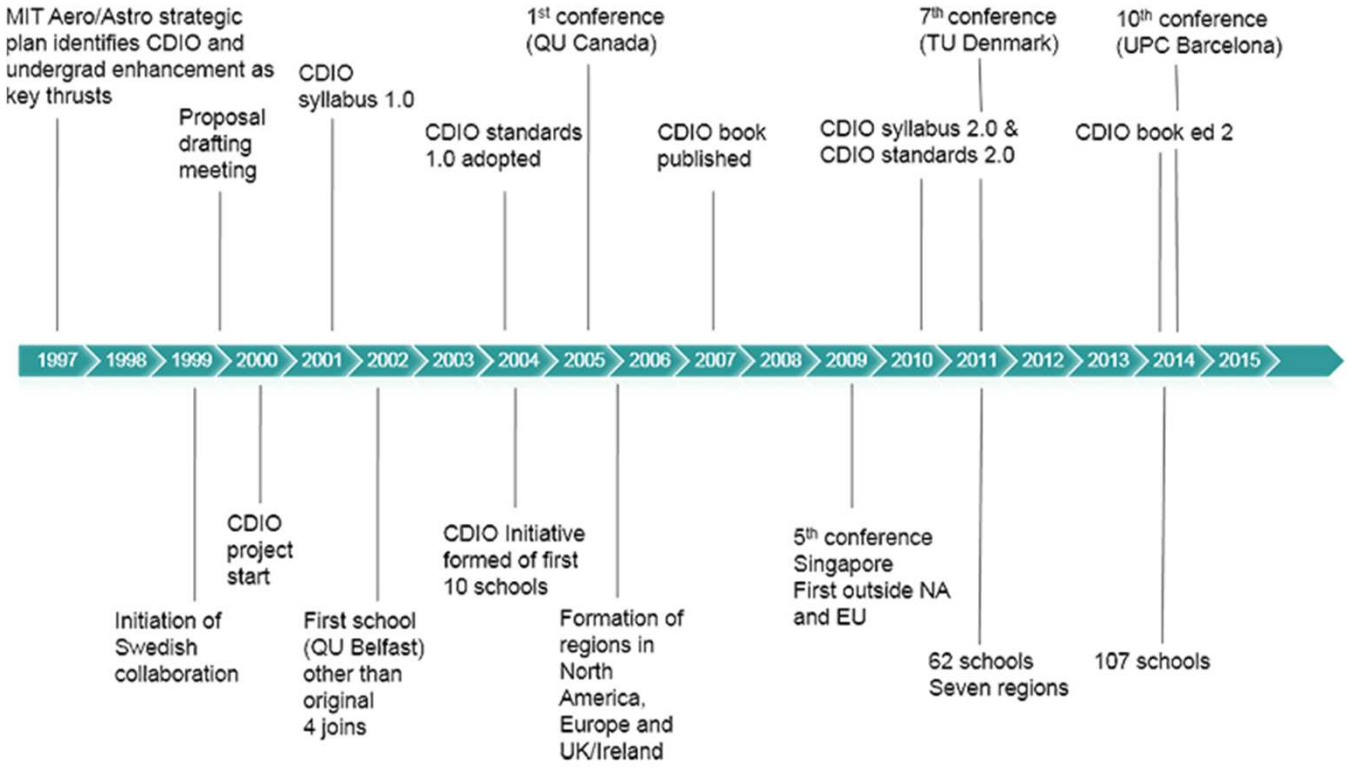
CDIO history

CDIO established in 2000 by

ROYAL INSTITUTE OF TECHNOLOGY



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CDIO implementation problems

… details…

- **szerokich kontaktów przemysłowych zapewniających dostarczanie rocznie dla kierunku 20-30 tematów (z ewentualnym finansowaniem materialnych kosztów tworzenia prototypu)**
- **bieżących środków na realizację tych projektów (w MIT – Medical Design Course ok. 4000$ na projekt z obszaru urządzeń medycznych [4)])**
- **uwolnienia zakupów do projektów studenckich z gorsetu PZP**
- **powszechnych kwalifikacji kadry do prowadzenia projektów zespołowych (podstawy psychologii, zarządzania projektami, rozwiązywania konfliktów, etc.)**
- **spokojnej atmosfery sprzyjającej refleksji nad nauczaniem i wypracowaniem rozwiązań zamiast miotania się w ciągłej gorączce drastycznych zmian i pogoni za wskaźnikami**

[4)] **Nevan Hanumara et al.: Classroom to Clinic: Merging Education and Research to Efficiently Prototype Medical Devices**

CZEGO NAM BRAKUJE?

Wewnętrznego przekonania o potrzebie/celowości ponownej rewizji programów nauczania – uczelnie wdrażające skutecznie rewolucyjne innowacje w nauczaniu w 70-80% były do tego zmuszone przez poważne czynniki wewnętrzne i zewnętrzne – słabą rekrutację, niską skuteczność nauczania, niski stopień „zatrudnialności" absolwentów, a także narzucone zmiany przepisów, restrukturyzacje itp.[2)], tylko w 5-10% zmiany były zainicjowane przez kulturę innowacji i zbiorową odpowiedzialność wewnątrz instytucji[2)]

Kierunków nauczania gotowych „na ochotnika" podjąć ten wysiłek i zdolnych do mobilizacji kadry do gruntownej rewizji programów – nieskuteczne na dłuższą metę według badań są kosmetyczne zmiany[2)], ważniejszy dla powodzenia zmian według badań[3)] jest nieformalny autorytet niż formalna pozycja i uprawnienia kierownika studiów (program leader).

1) Ruth Graham – Achieving excellence in engineering education: the ingredients of successful change

2) Johan Malmquist et al.: Program leadership from a Nordic perspective – program leaders' power to influence their program