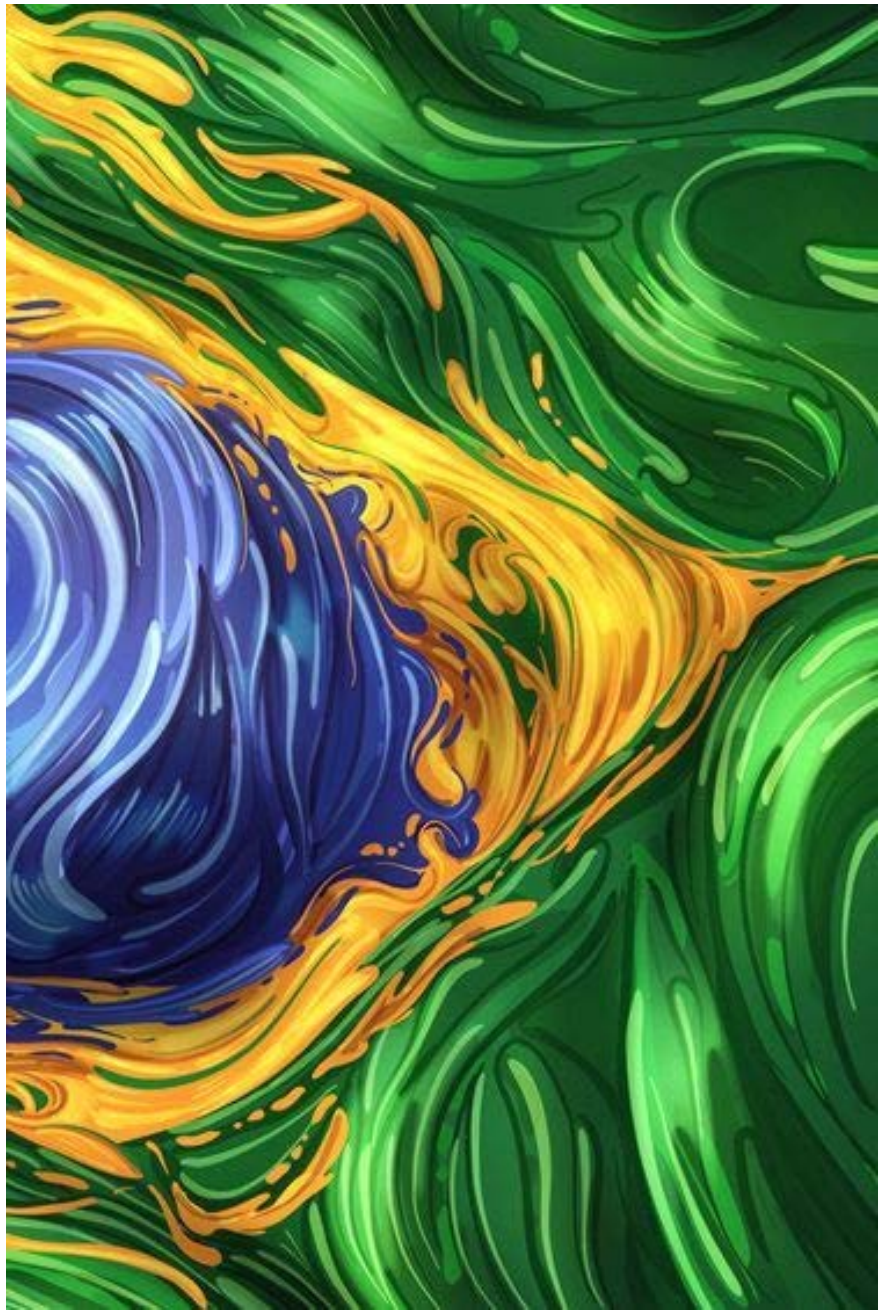


Chemical Engineering in Brazil: Education-Occupation Match and Mismatch

Ofélia Araújo, UFRJ/Brazil

Trends and Challenges in Chemical Engineering Education

ACKOWLEDGMENTS

Prof. Eduardo Mach Queiroz – UFRJ

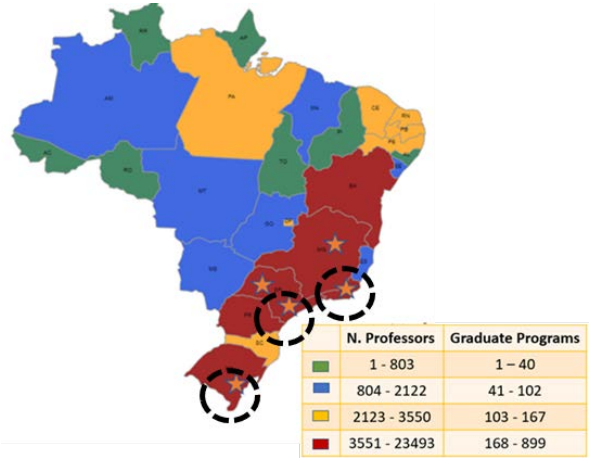
Prof. Rita Maria de Brito Alves – USP

Prof. Claudio Luis Crescente Frankenberg – PUC-RS

BRAZILIAN UNIVERSITIES

University	N. Students	2017 University Rank	Chemical Engineering Rank	Administration
Universidade Federal do Rio de Janeiro (UFRJ)	39,951	1st	3rd	Public (Federal)
Universidade de São Paulo (USP)	61,994	3rd	1st	Public (State)
Pontifícia Universidade Católida do Rio Grande do Sul (PUC-RS)	21,799	18th	18th	Private

http://ruf.folha.uol.com.br/2017/ranking-de-universidades/



https://geocapes.capes.gov.br/geocapes/

BSc

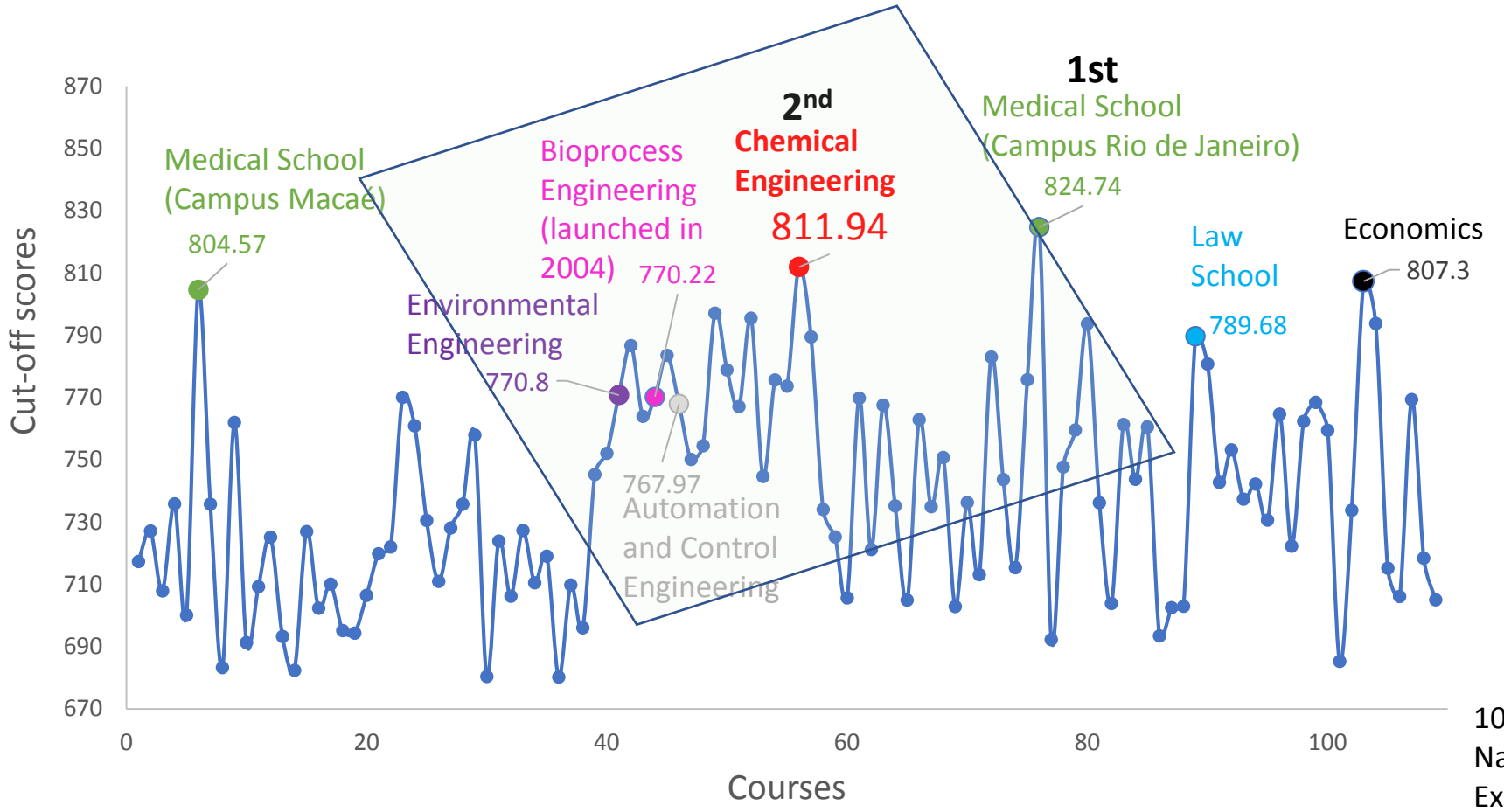
137 ChE Courses
2,673 ChE/year

- 110 UFRJ
- 60 USP
- 42 PUC-RS

CHEMICAL ENGINEERING AT UFRJ, USP AND PUC-RS

	UFRJ		USP	PUC-RS
	EPQB/EQ	COPPE		
Enrolled students: BSc	1036	0	368	378
MSc	188	68	79	0
PhD	247	75	66	0
PM	67	0	0	0
Graduating students: BSc	110	0	60	42
MSc	59	15	23	0
PhD	29	14	12	0
PM	12	0	0	0
Undergraduate Candidates / Accepted student	NATIONAL ENTRANCE EXAM (ENEM)	-	20.9	2.7
Number of professors	85 (24% hired since 2013)	17	29	14
Professors with non-Chem.E. degree	~30%	~10%	~10%	0%
Enrolled students/Professor	18.1 **13.2**	8.4	**17.7**	**27**
Students Graduating (BSc+MSc+PhD)/year/Professor	2.5 **2.3**	1.7	**3.3**	**3.0**

CUT-OFF SCORES IN ENTRANCE EXAM – UFRJ (2016)



109 out of 177 use National Entrance Exam Scores

https://blogdoenem.com.br/notas-de-corte-sisu-2016-ufrj/

CURRICULAR STRUCTURE

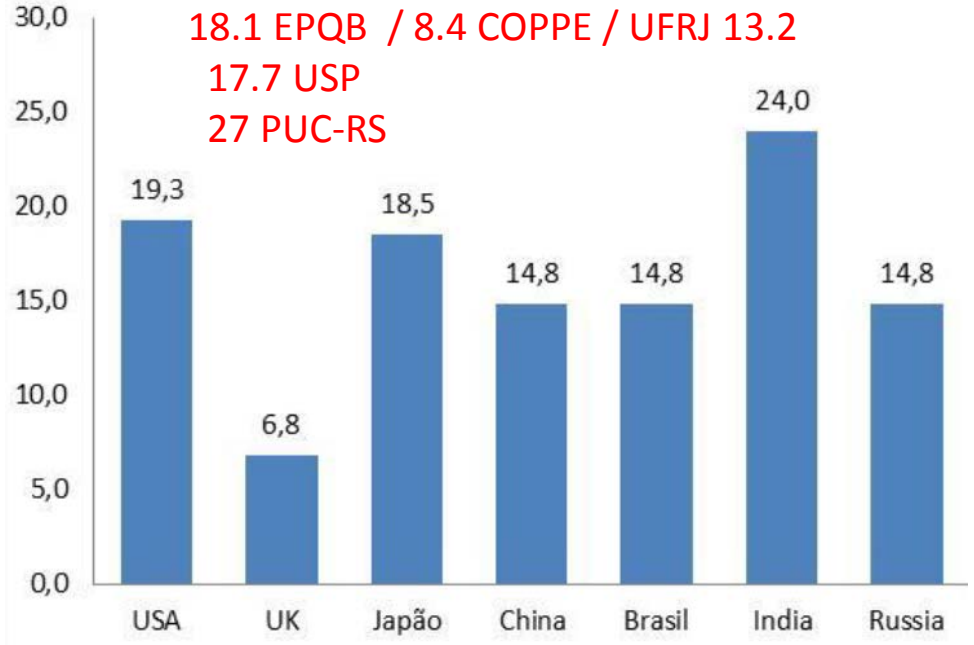
UNDERGRADUATE	UFRJ	USP	PUC-RS
Total hours	3600h	4060h	3600h
Courses	Mandatory courses (Fundamental and Applied), ellective courses (Fundamental and Applied), Laboratory classes, Simulators, Senior Project, etc		
Entrepreneurship	Ellective courses, “junior companies”	“junior company”	Not informed
Internships	196h	480h	160h
Integration grad./undergrad.	Scientific Initiation Grad. Courses as ellective classes.	Scientific Initiation Grad. Courses as ellective classes.	Scientific Initiation

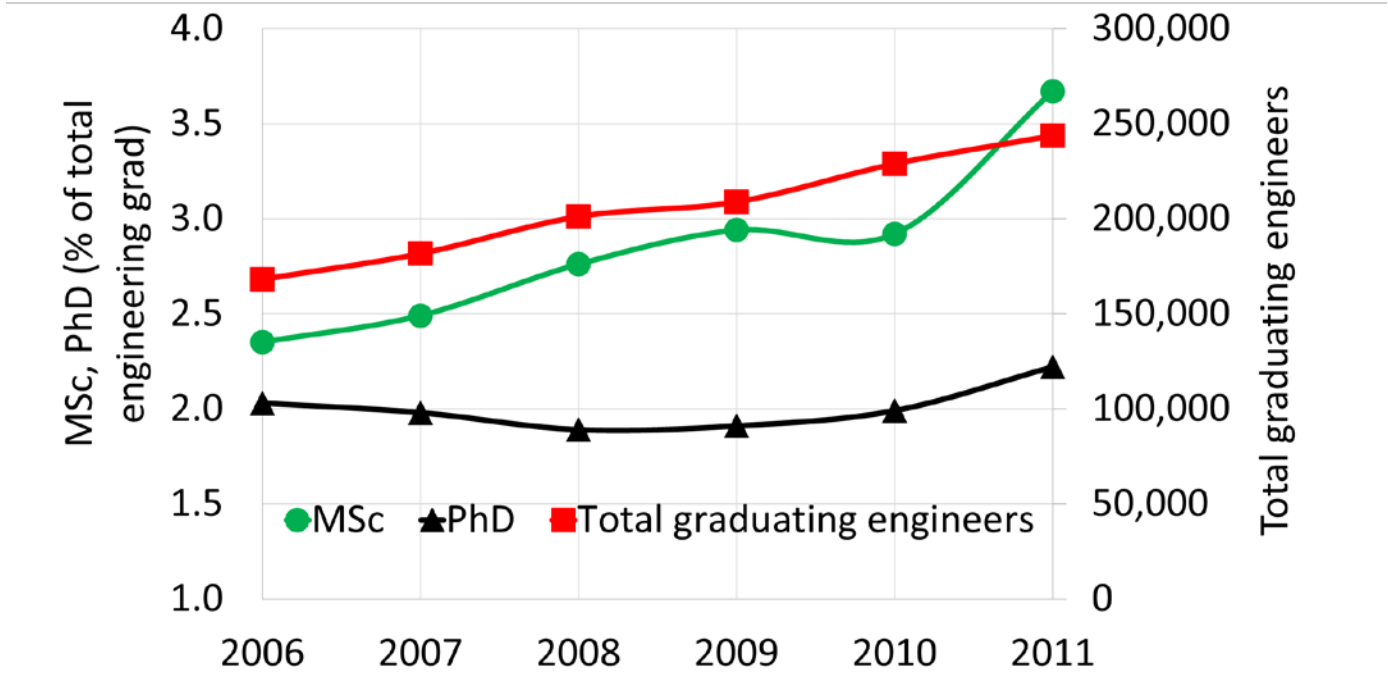
GRADUATE	UFRJ		USP (7)	PUC-RS
	EPQB (6)	COPPE (7)		
Total hours	360h (MSc)+140h(DSc)	360h (MSc)+140h(DSc)	360h (MSc)+140h(DSc)	360h (MSc)+140h(DSc)
Curriculum	MSc: 2 curricular paths (“engineering” & “technology” paths), each with 4 fundamental and 4 research-oriented courses, Seminars. DSc: MSc+4 research-oriented courses	2 Fundamental and 6 research-oriented courses. DSc: MSc+4 research-oriented courses	MSc: 1 fundamental, 4 research-oriented and 1 Adv.Research Topics. DSc: MSc+4 research-oriented and 2 Adv. Research Topics	-

ADDITIONAL INDICATORS

GRADUATE	UFRJ		USP (7)	PUC-RS
	EPQB (6)	COPPE (7)		
Professors	45 (53%)	17 (100%)	23 (79%)	-
Enrolled Grad.Stud./Professors	11.5	8.4	6.3	-
Graduating Students/Professor	2.2	1.7	1.5	-

Students/Professor in Engineering
18.1 EPQB / 8.4 COPPE / UFRJ 13.2
17.7 USP
27 PUC-RS

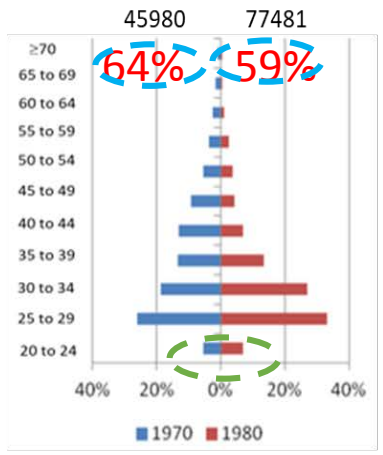


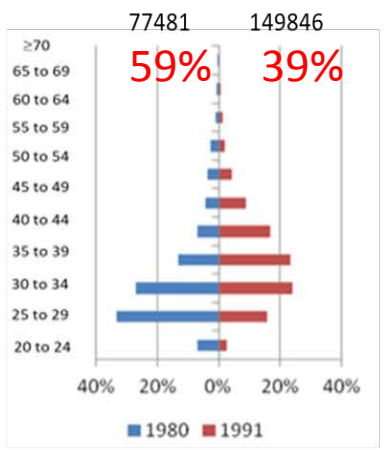


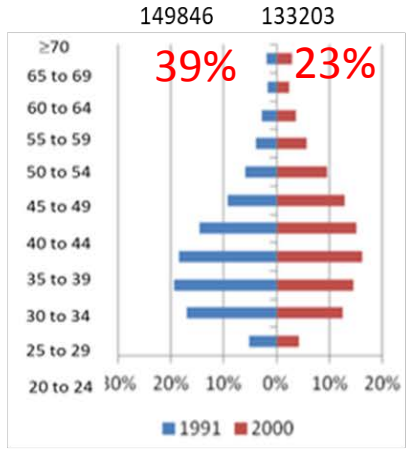
TRENDS IN ENGINEERING IN BRAZIL

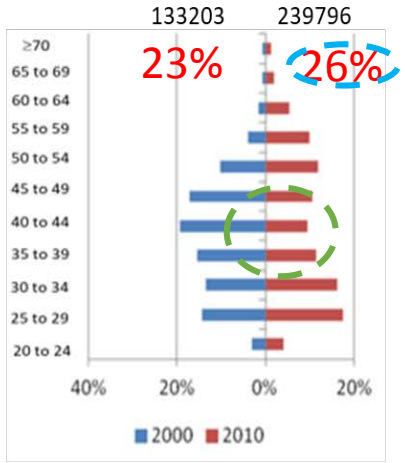
AGE PYRAMIDS OF ENGINEERS IN BRAZIL

Engineers with jobs in typical occupation

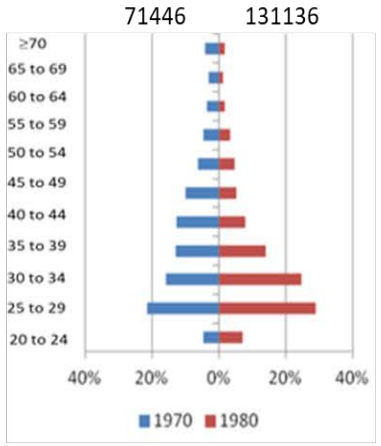


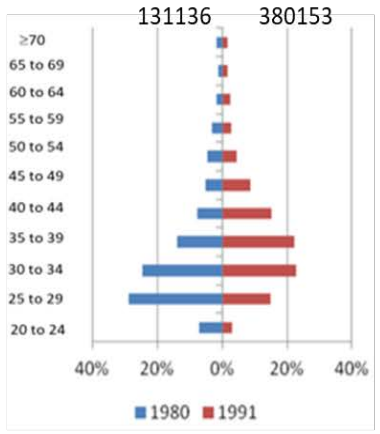


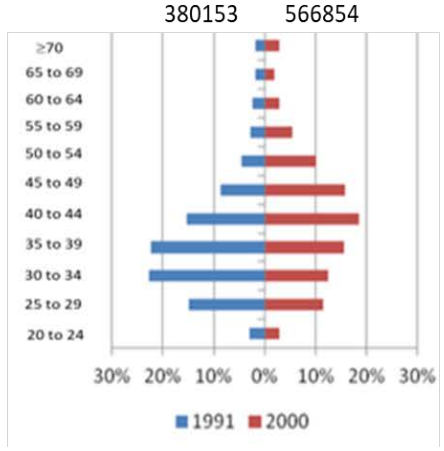


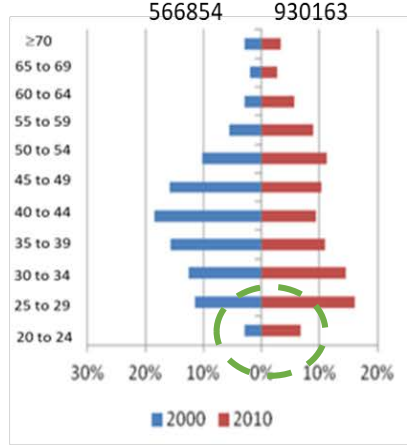


Graduated engineers



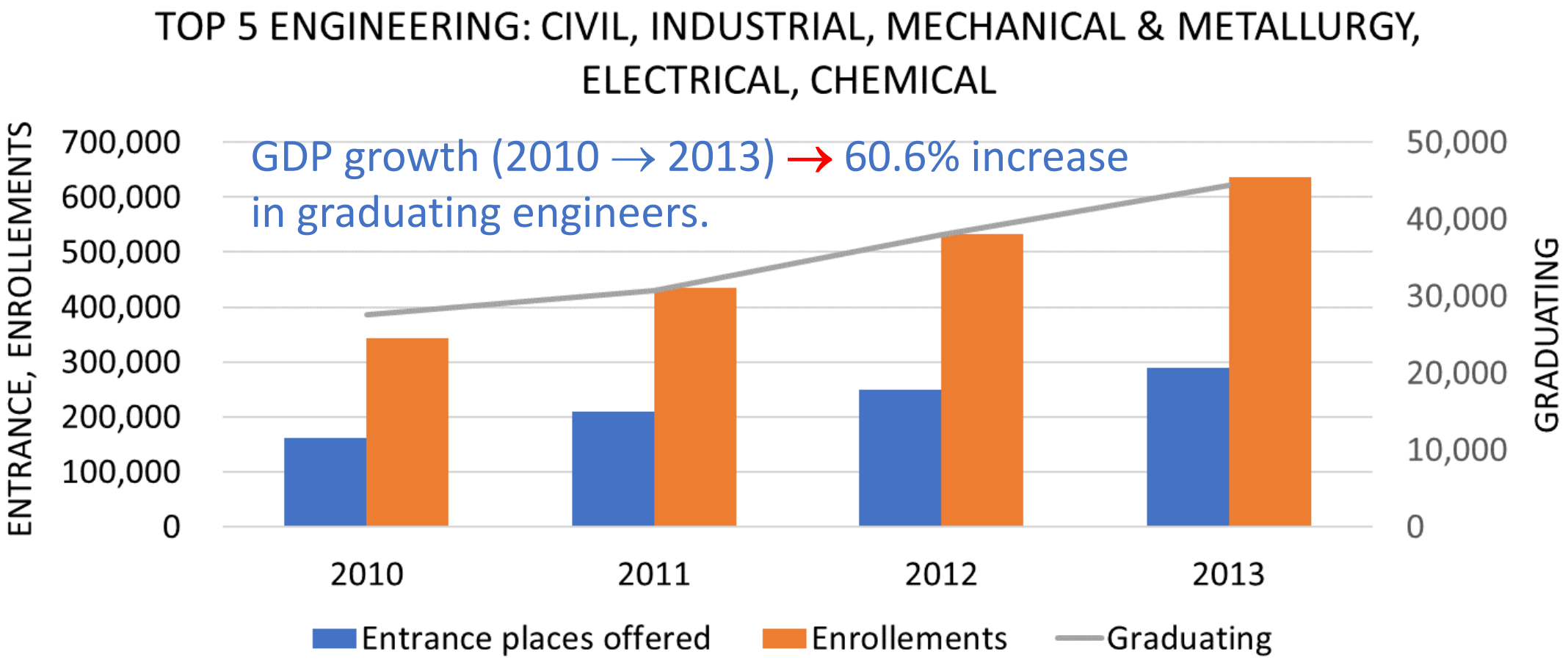






- Modest economic growth in the 80s/90s → reduced engineers in typical jobs → **generation gap** → ageing of engineers (age range 35-59 shows shortage);
- 3.5% average GDP growth from 2000-2010 → **young engineers.**

TRENDS IN ENGINEERING IN BRAZIL



3.5% average GDP growth from 2000-2010
Expansion of education

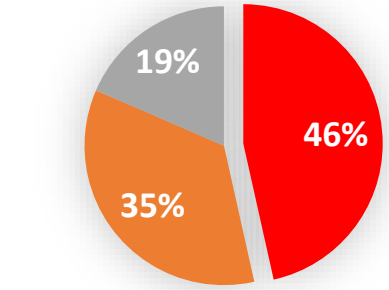
→ Number of young engineers doubled
Unemployment reduced from 4% to 2%.

http://ruf.folha.uol.com.br/2017/ranking-de-universidades/

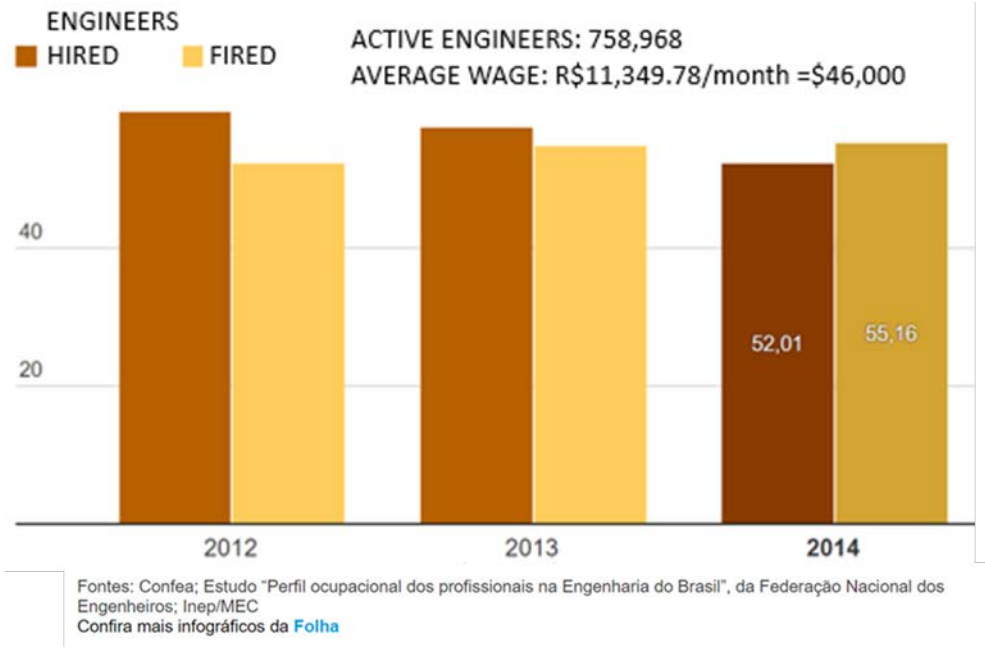
IMPACT OF SLOW GROWTH OF GDP AND DEPRESSED O&G INDUSTRY

https://data.worldbank.org/country/brazil?view=chart

Chemical Engineers



- Unemployed
- Continued Education
- Employed



In 2016, in Rio de Janeiro, > 46% of newly graduated Chemical Engineers were unemployed.

https://betaeq.com.br/index.php/2015/09/09/as-dificuldades-dos-primeiros-passos-dos-engenheiros-quimicos/

PhD/MSc OCCUPATION

- Employed engineers

  2006: MSc = 3,950 , PhD = 3,407. 44% of PhD preferred academic positions, and 16% research and development

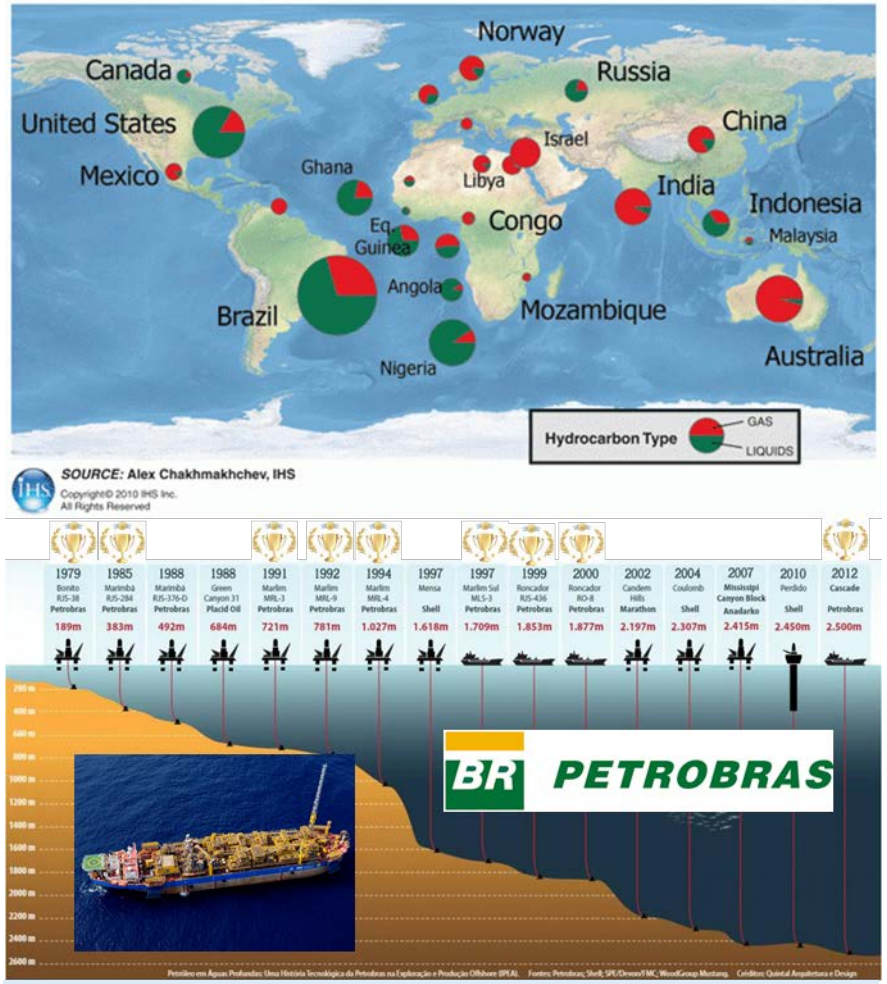
  2011: MSc = 8,950 , PhD = 5,402. 35% of PhD preferred academic positions 17% research and development

- Number of engineering graduates per 10,000 inhabitants is low. In 2012:
  - South Corea: 19.2
  - Portugal: 14.6
  - Canada: 5.4
  - USA: 5.2
  - **Brazil: 2.8**

http://www.iea.usp.br/pesquisa/grupos/observatorio-inovacao-competitividade/publicacoes/online/engenhariadata-tendencias-e-perspectivas-da-engenharia-no-brasil-relatorio-2013/at_download/file

- Efforts to build human resources take 10–15 years to show relevant impact. In that context, Brazil is positioning itself well for the future.

NICHES FOR ChE IN BRAZIL



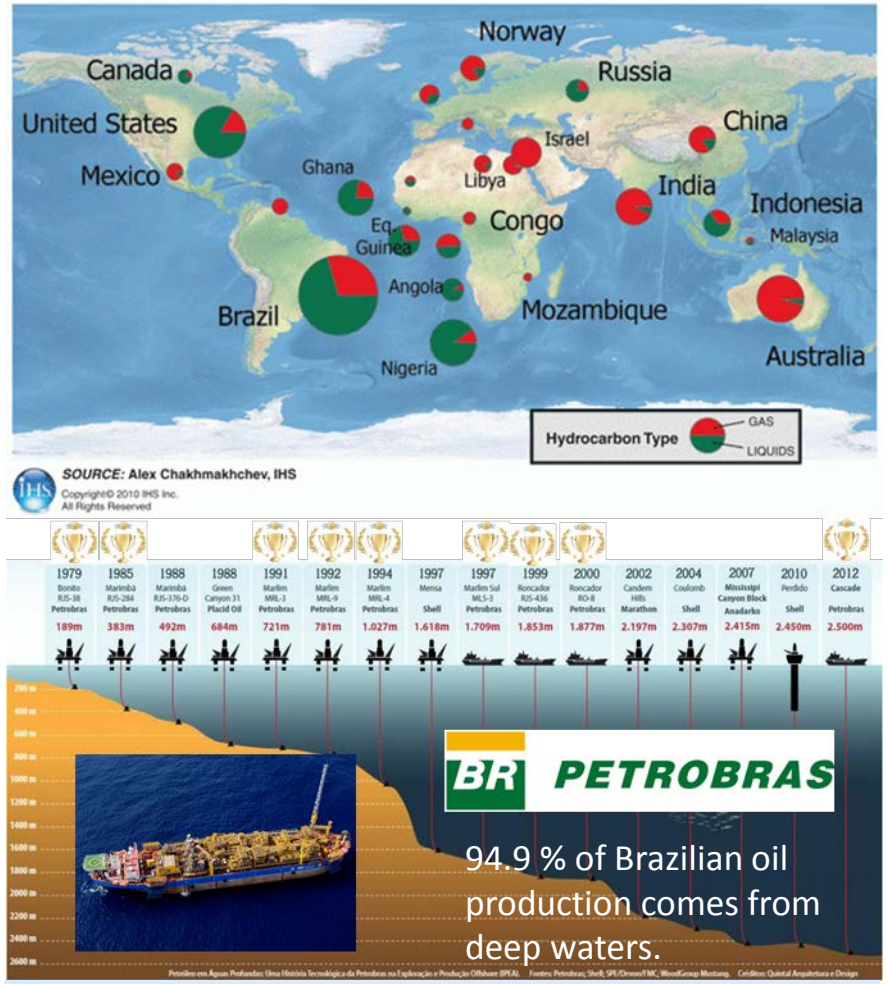
The BP Energy Outlook forecasts a 16% and 43 % increase in oil and natural gas consumption by 2035.

Brazil has over one-fourth of the world's plants, animals, and micro-organisms found in natural habitats.

O&G:

- ❑ CO_2 separation → new materials (solvents, membranes, sorbents) and advanced processes;
- ❑ Ultra-deepwaters → unmaned operation / automation and control;
- ❑ CO_2 injection, Pipeline transport → Leak detection / fault diagnosis/soft sensors;
- ❑ Gas dehydration, corrosion inhibition, etc → molecular engineering
- ❑ CO_2 conversion → new catalysts and process technologies
- ❑ Expansion of natural gas production → gas to liquids processes, gas chemistry
- ❑ Environment regulations → emissions reduction

THE FUTURE: NICHES FOR ChE IN BRAZIL



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Bioindustry:

- ❑ Biomass diversity → flexible biorefineries;
- ❑ Conversion of biomass to energy → advanced conversion technologies; new metabolic routes;
- ❑ Agricultural wastes to biofuels→ pre-treatment and processing technologies to 2nd generation biofuels;
- ❑ Collection, harvesting, supply and handling of agriwastes
- ❑ Increased yield → engineered micro-organisms, new catalysts
- ❑ Water – energy nexus

FINAL REMARKS
EDUCATION-OCCUPATION MATCHING

- Educational investments expectation: skills and knowledge will be applied on the labor market – Education/Occupation Match
- Matching education and occupation leads to lower unemployment and vacancy rates, and higher productivity and wages.
- Employability is disturbed by social and economic variables, and technology progress.
- Education, with long response time, is a slow-reacting process, and should be directed to national technology niches - resources and competitive advantages, and global problems (climate changes, sustainable development and social well-being).
- Chemical engineers education should be robust, resilient and tuned for a fast-paced world .