



Analysis of Software Engineering Degree Establishment in Europe

Natalia Juristo
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Contents of the talk

1. Motivation
2. Influential factors in SE degree establishment
 - The role of undergraduate programmes in maturing a profession
 - How much SE knowledge is taught by the different SE higher education alternatives?
 - Labour market
 - Accreditation and Licensing
3. Findings

Motivation

- Several authors have for years advocated setting up SE degree programmes as separate from CS degree programmes
- Is Europe following this trend?
 - SE degree programmes are not being established at the same rate in Continental Europe as in the English-speaking countries

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Motivation

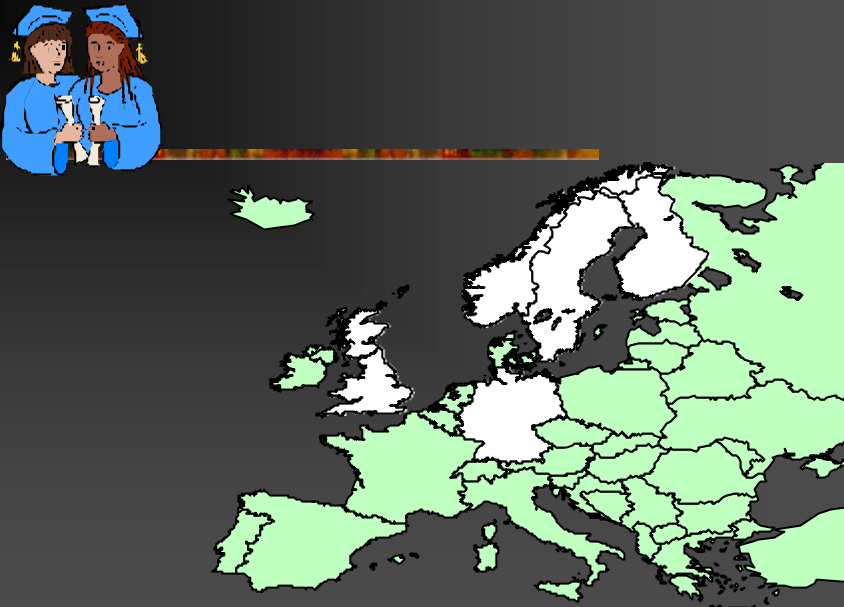
Number of SE degree programmes in Europe

Country	Programs on SE	Source
Denmark	0	Danish Conference of Rectors
France	0	ONISEP (government site)
Germany	2	German Conference of Rectors
Italy	0	Offerta Formativa (government site)
Portugal	0	Portugal Universities Foundation
Spain	0	University Council
Sweden	17	Studera (Formations site in Sweden)
United Kingdom	69	University & Colleges Admission Service

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A map of Europe is shown with a light green color scheme. In the top left corner, there is a small illustration of two graduates in blue caps and gowns holding diplomas. A horizontal bar with a colorful, abstract pattern is positioned above the map.

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The illustration depicts a person in a white coat and hat standing at a signpost with several arrows pointing in different directions. One arrow points to a question mark. To the left is a globe, and to the right is a computer monitor. A question mark in a blue circle is in the top left. A horizontal bar with a colorful, abstract pattern is positioned above the globe.

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Influential factors in SE degree establishment

- The role of undergraduate programmes in maturing a profession
- How much SE knowledge is being taught by the different SE higher education alternatives?
- Labour market demand for software engineers
- Accreditation and Licensing

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The role of SE programmes in maturing SE as a profession

- Measures aimed at professionalising SE
 - Initial Professional Education
 - Accreditation
 - Skills Development
 - Certification
 - Licensing
 - Professional Development
 - Code of Ethics
 - Professional Society

[Ford & Gibbs, 1996]

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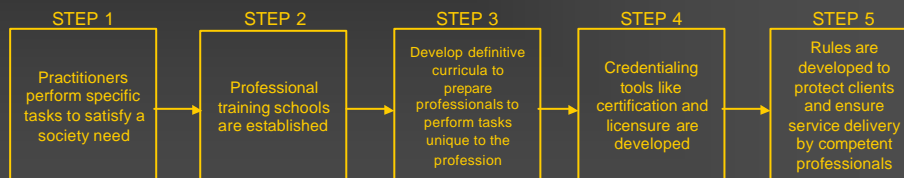
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The role of SE programmes in maturing SE as a profession

- Others Models of Professional Development
 - Wilensky, 1964
 - Greenwood, 1957
 - Matassarini-Jacobs, 1984

The role of SE programmes in maturing SE as a profession

- Others Models of Professional Development
 - Wilensky, 1964



The role of SE programmes in maturing SE as a profession

- Others Models of Professional Development
 - Wilensky, 1964
 - Greenwood, 1957
 - Systematic theory
 - Authority
 - Community sanction
 - Code of ethics
 - Culture

The role of SE programmes in maturing SE as a profession

- Others Models of Professional Development
 - Wilensky, 1964
 - Greenwood, 1957
 - Matassarini-Jacobs, 1984
 - A profession is a lifelong occupation with a specific set of competencies based on theoretical and practical knowledge acquired at higher education institutions; the goal of its members being a lifelong commitment to the individualized service of mankind; this service being based on the needs of each client and guided by a strong code of ethics

The role of SE programmes in maturing SE as a profession

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	Code of ethics	Education in accredited training schools	Definition of a body of knowledge	Certification	Licensure	Society need	Continuous professional development	Creation of professional societies	Initial skills development	Sanction of the community	Culture of profession
Ford & Gibbs 1996	X	X		X	X		X	X	X		
Greenwood 1957	X		X	X	X					X	X
Matassarini-Jacobs 1984	X	X	X			X	X				
Wilensky 1964	X	X	X	X	X	X					

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The role of SE programmes in maturing SE as a profession

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■ Computer Science vs Software Engineering

- The study/construction dichotomy has led to the creation of specific SE degrees separate from CS degrees, which would make it possible to train future software development professionals better
- **However!!...** The degree equivalent to CS in Europe is called **Computing** and is traditionally taught at technical universities or engineering colleges

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The role of SE programmes in maturing SE as a profession

Computing vs SE programmes in Europe

Country	Computing degrees	Number of comp. programmes	Number of SE programmes
Denmark	Informatik	7	0
France	(Ingénierie) Informatique (Genie) Informatique	174	0
Germany	(Ingenieur) Informatik	148	2
Italy	(Ingegneria) Informatica	42	0
Portugal	(Engenharía) Informática	34	0
Spain	(Ingeniería) Informática	48	0
Sweden	Informatik Informationsteknik	461*	17
United Kingdom	Computing	2834/33*	69

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The role of SE programmes in maturing SE as a profession

■ Outcomes

- The establishment of specific degree programmes is not a necessary condition of professional maturity
- The separation of SE degrees from CS degrees is not so critical if SE is taught as specialisation within a Computing degree programme

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How much SE knowledge is taught in the different undergraduate education options for SE professionals?

- SE higher education options
 - SE degree programmes
 - Computing programmes with SE track
 - Computing or CS degrees with compulsory subjects on SE

How much SE knowledge is taught in the different undergraduate education options for SE professionals?

SE degree programmes

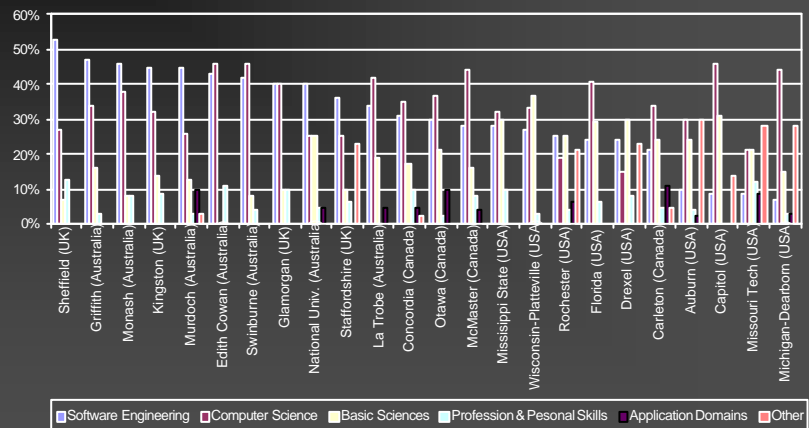
Europe	USA
Institute of Technology (Ireland) Kingston University (UK) Manchester Metropolitan University (UK) Sheffield Hallam University (UK) Staffordshire University (UK) University of Glamorgan (UK) University of Hull (UK) University of Paisley (UK) University of Westminster (UK) University of Stuttgart (Germany) University of Lund (Sweden)	Auburn University Capitol College Cogswell Polytechnical College Drexel University Embry-Riddle Aeronautical University Florida State University Milwaukee School of Engineering Mississippi State University Missouri Tech Monmouth University Montana Institute of Technology Rochester Institute of Technology Southern Polytechnic University University of Michigan-Dearborn University of Oklahoma University of Texas (Arlington) University of Texas (Dallas) University of Wisconsin-Radcliffe
Canada	Australia
Carleton University Concordia University University of Guelph McMaster University Memorial University of Newfoundland University of New Brunswick University of Ottawa Simon Fraser University	Australian National University University of Canberra Edith Cowan University Griffith University University of Melbourne Monash University Murdoch University Swinburne University of Technology La Trobe University

How much SE knowledge is taught in the different undergraduate education options for SE professionals?

- Types of Knowledge:
 - SE-specific Knowledge
 - Knowledge of General CS
 - Knowledge of Basic Sciences
 - Knowledge concerning Personal Skills Development and the Profession
 - Knowledge of Application Domains

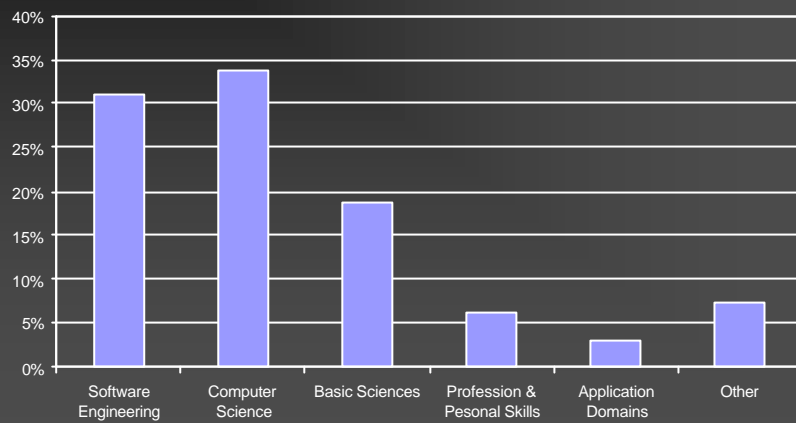
Distribution of compulsory knowledge in SE programmes

How much SE knowledge is taught in the different undergraduate education options for SE professionals?



How much SE knowledge is taught in the different undergraduate education options for SE professionals?

Mean for the Knowledge Types in SE Degrees

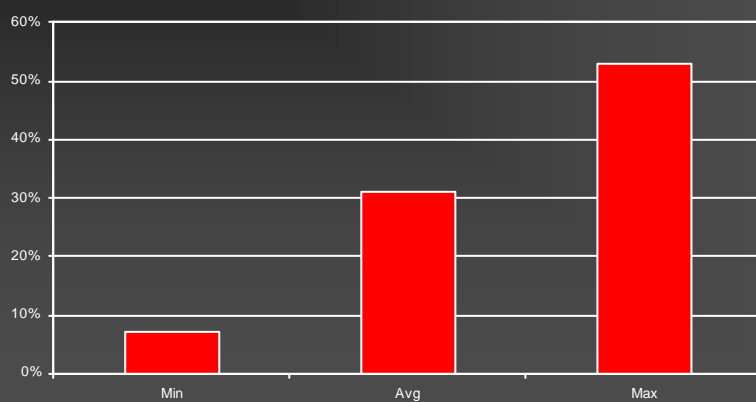


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How much SE knowledge is taught in the different undergraduate education options for SE professionals?

Specific-SE knowledge in SE degree programmes



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How much SE knowledge is taught in the different undergraduate education options for SE professionals?

Computing programmes with a SE track

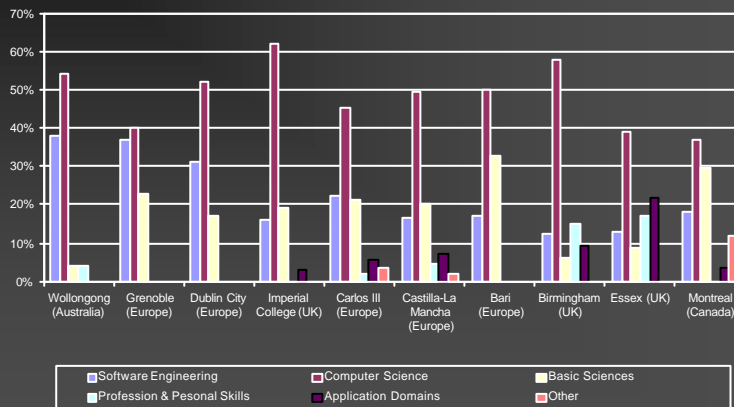
Europe	USA
Institut National Polytechnique Grenoble (France) INSA-Toulouse (France) Imperial College (UK) Dublin City University (Ireland) Universidad Carlos III (Spain) Universidad Castilla - La Mancha (Spain) Università de Bari (Italy) Birmingham University (UK) University of Essex (UK) Università di Genova (Italy) Université de Technologie Troyes (France) Université de Technologie de Belfort-Montbelliard (France) Université de Technologie de Compiègne (France)	
Canada	Australia
Montreal University École Polytechnique Montreal	University of Wollongong

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How much SE knowledge is taught in the different undergraduate education options for SE professionals?

Distribution of compulsory knowledge in Computing programmes with a SE track

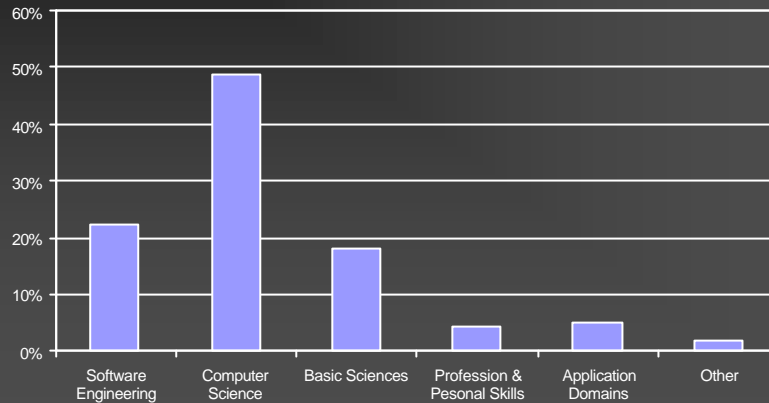


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How much SE knowledge is taught in the different undergraduate education options for SE professionals?

Mean for the Knowledge Types in Computing with SE Track

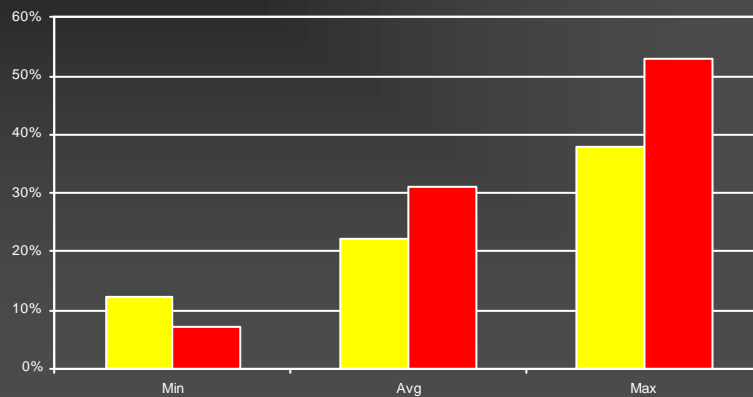


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How much SE knowledge is taught in the different undergraduate education options for SE professionals?

Specific-SE knowledge in Computing with SE Track



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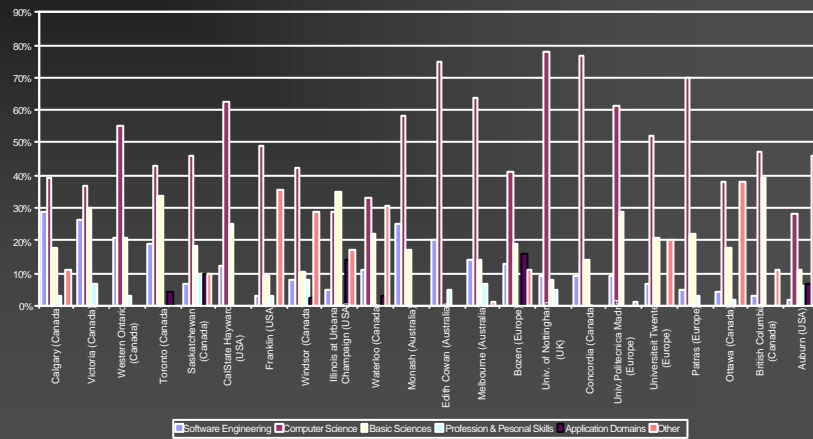
How much SE knowledge is taught in the different undergraduate education options for SE professionals?

CS or Computing programmes with compulsory subjects in SE

Europe	USA
Univ. of Nottingham (UK) Universiteit Twente (The Netherlands) Technical University of Madrid (Spain) University of Bozen (Italy) University of Patras (Greece)	Auburn CalState Hayward Franklin University Illinois at Urbana-Champaign Rowan University
Canada	Australia
University of Windsor University of Waterloo University of Ottawa University of British Columbia Concordia University University of Calgary University of Saskatchewan University of Toronto University of Western Ontario University of Victoria	Monash University Edith Cowan University University of Melbourne University of Sydney Bond University

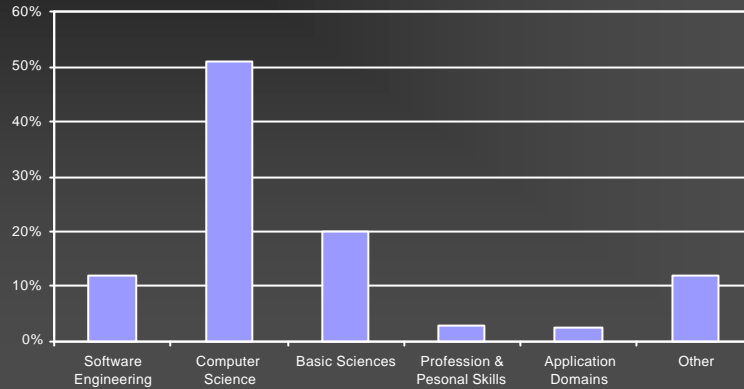
How much SE knowledge is taught in the different undergraduate education options for SE professionals?

Distribution of compulsory knowledge in CS programmes



How much SE knowledge is taught in the different undergraduate education options for SE professionals?

Mean for Knowledge Types in CS or Computing

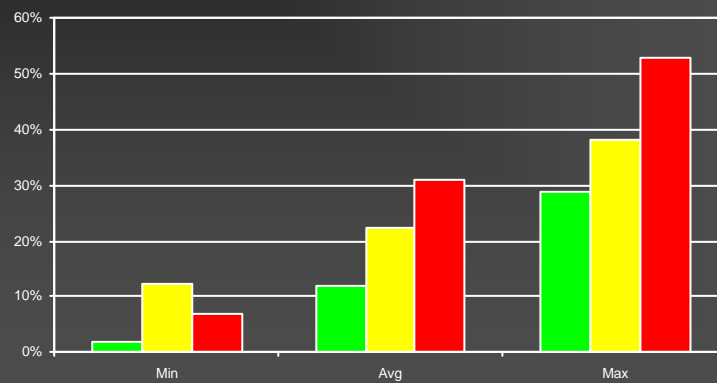


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How much SE knowledge is taught in the different undergraduate education options for SE professionals?

Specific-SE knowledge in Computing or CS

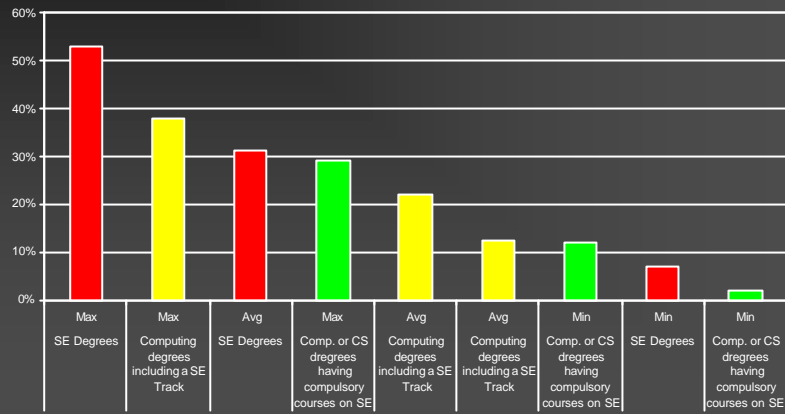


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How much SE knowledge is taught in the different undergraduate education options for SE professionals?

Comparing Specific-SE knowledge

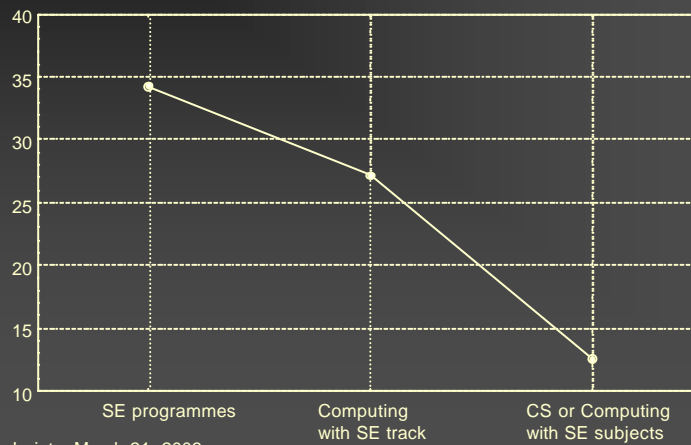


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How much SE knowledge is taught in the different undergraduate education options for SE professionals?

Plot of MEANS— Specific-SE Knowledge RAO R (10,60)=5,82; p<0000



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How much SE knowledge is taught in the different undergraduate education options for SE professionals?

■ Outcomes

- The knowledge required by a software development professional cannot be covered by a few subjects included in CS or Computing programmes
- Specific SE knowledge can be accommodated in SE degree programmes or in tracks in Computing degree programmes.
- There appears to be no statistically significant difference with regard to the amount of SE-specific contents taught in the two programme categories

Labour market demand for software engineers

- In Europe, the Job Profiles report indicates:
“Fastest growing ICT occupations are software engineers, analysts and programmers”
- In the USA, the Department of Labor’s Occupational Outlook Handbook notes:
“Computer software engineers are projected to be the fastest growing occupation from 2000 to 2010”

Labour market demand for software engineers

Profiles required by industry

JOB TITLES (CAREER SPACE)	JOB TITLES (US D. OF LABOUR)
Application programmer	Computer programmer
Software architect	Computer software engineer, applications
Software engineer	
System developer	Computer Software engineer, system software
Technical system designer	
Integration technician	
Maintenance & support specialist	Computer support specialist
Network designer	Network and computer systems administrator
	Network systems and data communications analyst
Computer scientist	Computer & information scientist
Systems architect & design scientist	
	Database administrator
	Computer hardware engineer

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Labour market demand for software engineers

■ Outcomes

- The differences between the English-speaking and Continental European countries with respect to the establishment or otherwise of SE-specific degrees are not market related.
- The software development occupations require professionals to hold a Bachelor degree or equivalent, but reports suggest a wide range of syllabuses: CS, SE, information science, management information systems, etc.

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Influence of accreditation on the establishment of SE degrees

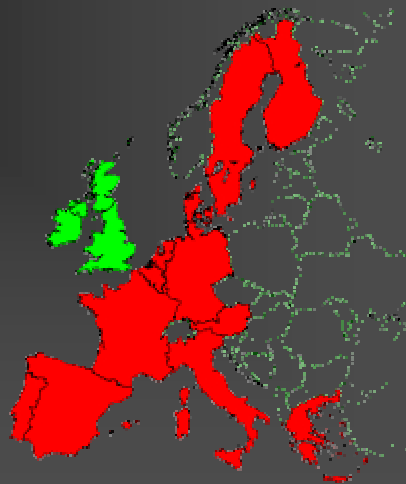
- Accreditation types
 - Ex-ante accreditation demands that the quality of the programme be assured before any teaching is done. Such quality is normally measured in terms of the syllabus's adherence to a given standard syllabus.
 - Ex-post accreditation certifies the quality of a programme after the syllabus is in operation. As the course has actually been taught, other criteria, apart from the actual syllabus, can be assessed.

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Influence of accreditation on the establishment of SE degrees

Accreditation systems in European Union until 1990



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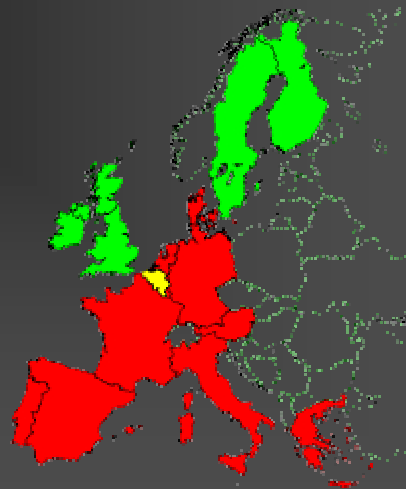
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Influence of accreditation on the establishment of SE degrees

- The two accreditation types have similar capabilities and offer similar guarantees with respect to the quality of the education taught at higher education institutions
- The main purpose of the ex-ante accreditation system is to achieve homogeneous student training

Influence of accreditation on the establishment of SE degrees

Accreditation systems in European Union after 1990



Influence of accreditation on the establishment of SE degrees

- Degree proliferation according to accreditation type:
 - There is a greater proliferation of degrees in ex-post accreditation countries
 - The ex-ante system limits degree proliferation
 - Note SE degrees in Europe occurs initially in the countries with ex-post accreditation

Influence of accreditation on the establishment of SE degrees

	(USA: 57)	(Italy:14)	(Denmark: 11)	(Germany: 26)	(Spain: 18)
	Accredited Programs in Engineering [ABET, 2003]	Official Engineering Degrees in Italy [MIER, 2003]	Official Engineering Degrees in Denmark [DCR, 2003]	Official Engineering Degrees in Germany [HRK, 2003]	Official Engineering Degrees in Spain [CCU, 2003]
Transportation engineering		Ingegneria civile	Civil engineering	Civil engineering	Ingeniero de Caminos, Canales y Puertos
Surveying engineering					
Civil engineering					
Construction engineering					
Urban Systems engineering					
Water engineering					

More

Influence of accreditation on the establishment of SE degrees

- Process for a SE degree in ex-ante countries:
 - Convince Computing
 - Convince other engineering disciplines
 - Convince the Ministry of Education

The relationship between licensing and degrees

- In Continental Europe, degree holdership in a given discipline is equivalent to a licence in this discipline
- In US, in spite of the extensive manoeuvrability of universities for degree establishment, number of available licenses is very limited

The relationship between licensing and degrees

(USA: 13)	(57)	(Italy: 14)	(Denmark: 11)	(Germany: 26)	(Spain: 18)
NCEES Professional Boards	Accredited programmes in Engineering [ABET, 2003]	Official Engineering Degrees in Italy [MIER, 2003]	Official Engineering Degrees in Denmark [DCR, 2003]	Official Engineering Degrees in Germany [HRK, 2003]	Official Engineering Degrees in Spain [CCU, 2003]
Civil Engineering	Transportation engineering	Ingegneria civile	Civil engineering	Civil engineering	Ingeniero de Caminos, Canales y Puertos
	Civil engineering				
	Surveying engineering				
	Construction engineering				
	Urban Systems engineering				
	Water engineering				

More

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Influence of accreditation on the establishment of SE degrees

■ Outcomes

- The ex-ante and ex-post accreditation systems cause differences in the degree proliferation rate
- There is a huge gap in the number of accredited engineering degrees awarded in the USA as compared with the degrees awarded in the Continental European countries. So, SE is no exception in this respect
- The fact that degree holdership implies licensing in Europe makes the creation of degrees just as complex and slow as licensing is in the USA

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Why are SE degrees not being established at the same rate in Continental Europe as they are in the English-speaking countries?

- SE professionalisation does not demand SE-specific degrees.
It calls for a suitable initial education oriented at professional practice
- SE programmes do not guarantee the teaching of more specific-SE knowledge.
Some Computing with SE tracks have more compulsory SE subjects
- Labour market demand for software engineers is similar in EU and USA.
- Huge gap in number of US accredited engineering degrees as compared with those in Continental Europe.
So, SE is no exception in this respect
- Degree holdership implies licensing in Europe
Creation of degrees is as complex and slow as licensing is in the US

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