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**Educating Generalists versus Specialists - A Comparative  
Analysis on National Framework Plans for Engineering  
Education in Norway before and after 2003**

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### **Facts about Norwegian Education and Training (1998)**

<b>Population</b>	<b>Category</b>
<b>590,000</b>	<b>Pupils in compulsory education</b>
<b>164,000</b>	<b>Pupils in upper secondary education</b>
<b>174,000</b>	<b>Students in higher education</b>
<b>1,000,000</b>	<b>Adults in various full time or evening courses</b>
<b>85,000</b>	<b>Teachers in compulsory education</b>
<b>23,000</b>	<b>Teachers in upper secondary education</b>
<b>11,300</b>	<b>Academic staff (full time equivalents)</b>



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**The basic principles and priorities of Norwegian education policies have been focused on these elements:**

- **A high general level of education in the entire population**
- **Equal opportunity for all in access to education**
- **Decentralisation of educational administration**
- **Meeting long-term and short-term qualification requirements of the labour market**
- **Emphasis on a broad and general initial education, leaving specialisation to later stages and further training at work**
- **Lifelong learning (based on a "cradle to grave" definition)**
- **A comprehensive education system with easy transition between levels and courses**



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**The Norwegian government has also introduced essential curricula for the learners in order to meet the future demands:**

- **Abilities of being creative**
- **Ability to define and solve problems (ability to think analytically and scientifically)**
- **Ability to cooperate and participate actively**
- **Ability to use ICT and a variety of methods in the education and training process**
- **Ability to select information from huge amounts of sources and references**
- **Ability to play an important part in the ordinary running of the school or working place through democratic participation**
- **Ability to be enterprising**
- **Ability to communicate openly and a high degree of communicative competence**
- **Ability to acquire, evaluate, integrate and make use of knowledge leading to competence**
- **Ability to promote ethical values and appreciate multi-cultural respect**



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TABLE II: National Framework Plans for Engineering Education in Norway, A comparison of 2003 against 1996 in Overall and Partial Goals

Content	2003 Plan	1996 Plan	Changes in 2003 Plan
Overall goal	Educating theoretical, technical knowledge with practical skills. Interacting between technology, environment, individuals and society. Understanding of innovation and entrepreneurship. Meeting society's current and future demands.	Educating theoretical, technical knowledge with practical skills. Educating professions. Interacting between technology, environment and society.	Educating engineers. Individuals are involved and integrated into interaction between technology, environment and society. Understanding of innovation and entrepreneurship. Meeting society's current and future demands.
Partial goal	Balancing of science and technology courses.	Balancing of basic mathematic, theoretical and technological courses.	More general science courses focused rather than purely mathematic courses focused.
Partial goal	Not taking this element into 2003 plan.	Acquiring sufficient knowledge on new technology for company's innovation process.	Not taking this element into 2003 plan.
Partial goal	Developing of abilities for innovation and entrepreneurship.	Creating positive attitudes toward knowledge and entrepreneurship.	Focusing on pro-active abilities rather than attitude creating only.



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The newer plan has listed up a number of essential requirements and expectations for the future engineers:

- Implementing knowledge of mathematics, sciences and technology
- Identifying, formulating, planning and solving technical problems in a systematic approach within one speciality/area
- Specifying solution requirements in a systematic approach
- Planning and conducting experiments, as well as analyzing, interpreting and utilizing the experiments' outcomes
- Constructing a component, a system or a process to reach and obtain specific results
- Using modern instruments, techniques and appropriate skills in daily work/tasks
- Cross-section cooperating to solve the complicated problems
- Communicating efficiently with others experts in other specialities/areas
- Understanding and practicing professional and ethical responsibility
- Undertaking quality concepts and implementations in every relevant area
- Participating in innovation and entrepreneurship processes
- Balancing technological solutions with economic, organizational and environmental aspects



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TABLE III: National Framework Plans for Engineering Education in Norway,  
A comparison of 2003 against 1996 in course Compositions

Content	2003 Plan (accounted in ECTS)	1996 Plan (accounted in ECTS)	Changes in 2003 Plan
Course type	Basic Courses 50-60 including (minimum): Mathematics 25, Physics 10, Chemistry and Environment 10, Computer Techniques 5	Basic Courses 45 including these: Mathematics 24, Physics 6, Chemistry and Environment 9, Computer Techniques 6	Increasing Mathematics and Sciences Basic Courses in 5-15 ECTS (Compulsory)
	Social Science Courses 15-20	Social Science Courses 15-18	No specific changes
	Technical Courses 75-90	Technical Courses 90 ( Speciality 30, Major courses 60)	No longer distinction between speciality and major courses, possibly 15 less ECTS
	Optional/voluntary Courses 10-20	Optional/voluntary Courses 12-18	No specific changes
	Final Project Work 10-20	Final Project Work 12-18	No specific changes
Total ECTS	180	180	No specific changes



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TABLE IV: National Framework Plans for Engineering Education in Norway, A comparison of 2003 against 1996 in Working and Teaching Methods

Content	2003 Plan	1996 Plan	Changes in 2003 Plan
Degree	Bachelor of engineering (bachelor i ingeniørfag)	College engineer (høgskoleingeniør)	Integrating with international degree systems
Quality assurance	Course plan settled by the institution level, including learning goal, teaching methods, evaluating process and relevant requirements.	Quality control and evaluation for course's learning goal, teaching content, methods, organizing, syllabus, R&D relevance, etc.	Decentralizing of course plan settlement to the institution level.
Working & teaching methods	Focusing on learners' abilities of cooperation, communication and practical problem solving skills, focusing on cross-section issues, implementing practice training, integrating final project with external companies or organizations.	Following the pedagogical principles, focusing on learners' abilities to seeking knowledge, learning skills, self-engagement, introducing institution for first year students, opportunities for practice arrangements, teaching information analysis skills.	More focusing on interactive abilities, such as cooperation, communication, cross-section skills. The practice became a more important step of teaching activities.
Evaluation	Assuring engineering students have learned and implemented knowledge and competence which satisfy the overall and partial goals.	Evaluating learning effect, developing and improving teaching methods, and evaluating institution's teaching levels.	More focusing on the learners and their competence upgrading after learning.



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### **A summary of changes from 1996 plan to 2003 plan:**

- **The 2003 plan is a short and concise plan**
- **The 2003 plan has removed the definitions of traditional engineering disciplines, so there is no detailed criteria and requirements for each discipline**
- **The 2003 plan has decentralized the course content and descriptions, so that each education institution has their freedom and space to develop and define these courses**
- **The 2003 plan focuses on the learners/students, thus the end users of engineering education, while the 1996 plan considered institutions are the targeting groups for requirement and expectations**
- **The 2003 plan has defined and expected skill-based requirements as learning outcomes, such as an engineer's abilities of systematizing, analyzing, cooperating, communicating, participating and balancing of different aspects**
- **The 2003 plan seems to be a more dynamic and flexible guide for engineering education, so there is freedom and space to implementing for each institution, while the 1996 plan seems to be rigid in definitions of each discipline, major, speciality and even course content**
- **The 2003 plan expects a future engineer will be able to perform different tasks in different situations and environments, thus a generalist of engineering, while the 1996 plan seems to consider an engineer rather as a specialist with in-depth knowledge of technical specialities/areas**
- **The 2003 plan has integrated the Norwegian engineering degree (høgskoleingeniør) system into an international standard (Bachelor of engineering)**



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**A Reflection on Modern Quality Philosophy:  
Quality is fitness for use**

**A Question for the 2003 Framework Plan:  
Are we going to educate generalists of engineering?  
Are generalists fitness for the future society use?**

**Are we having paradigm shifting for the modern  
engineering education and formulating a future  
profile for engineers?**