Chapter 9
The education specific part of the study programme for

Master of Science in Engineering – Innovation and Business

Study start 2009

Content**:**
Job profiles
Competencies
Subject columns
Profile
Structure and semester modules

Description of 7-10 semester including value argumentation, competence goals and reference to modules

Approved by the Academic Study Board of the Faculty of Engineering on 20 august 2009

§1 Job profiles

Innovation and Business is a master of science in engineering that combines creativity, innovation, entrepreneurship and engineering courses. The student becomes a market-oriented engineer who is able to deal with different types of products in which business skills and technology assessment are combined. A master of science in Innovation and Business provides the students with special core competencies within the following areas:

- Creativity, Design and Innovation management skills for managing innovation and developing product and business concepts
- Product driven entrepreneurship with emphasis on developing primarily mechatronic products
- Solid competencies in business administration and marketing for evaluating market and business opportunities
- Elaborated skills in Mechatronics

These competencies enable the graduate to work in various jobs, especially interdisciplinary and cross-functional job functions are areas where the combination of both business and engineering skills could be utilized. Understanding the process from development of product ideas to develop a business plan makes the graduate an important link between various specialists within an organization. Emphasizing the international dimension during the education fosters opportunities within more global job functions. Finally, graduates have the possibility to pursue a career within academia. Possible job profiles for a graduate are:

- **Open Innovation Engineer**
  The Open Innovation engineer is able to create in an open R&D environment. His oral and written communication skills allow him/her to exchange and realize ideas creatively and dynamically. The profound economical and technological knowledge allows him/her to recognize and realize market-oriented ideas faster and better than the competitors

- **Innovation Manager**
  The Innovation Manager is able to coordinate and lead the innovation development process. His communicative, economical and technological skills allow him/her to manage innovation development across different departments and across companies.

- **Business Developer**
  The Business Developer/Innovator is able to detect and analyze signals for change and development on the corporate level as well as on the institutional or regional level, in order to develop bearing strategies that are both economically and technologically sound. His/Her specific communication skills together with the profound knowledge of economies and technology allow him/her to coordinate and mediate between the institutional level and the corporate level.

- **Entrepreneur**
  Entrepreneurs who are willing to combine expertise and entrepreneurship are able to take the challenge to develop, market, and manage an own idea from the beginning through to the end. Graduates of Innovation and business acquired the needed skills to develop an own product and to market it.

- **Innovation Process Designer**
  The Innovation Process Designer is able to develop, to implement and to orchestrate the interdisciplinary and multidimensional process of innovation. Independently of whether this process is situated on the institutional or the corporate level.

- **Strategic Procurement Engineer**
  The strategic procurement engineer has the economical and technological knowledge as well as the communicative skills to adjust and coordinate institutional supply and demand with market supply and demand. While he/she does this he/she applies his/her knowledge in order to identify market chances and foster technologies that best serve the institutional medium and long-term goals, e.g. wind energy, sustainable materials, water management, waste management, etc.

- **Researcher (ph.d.-Student)**
  The graduate has the possibility of entering academia and pursuing an academic career within the university. The societal demand for knowledge and innovation as a means to gain competitive advantage and improve quality of life increases the need for innovation researchers.

§2 Competence profile of the education

The student should after graduating as master of science in Engineering in Innovation and Business have solid competences within the fields of mechatronics, innovation and business. The education will enable the students to handle the process from exploring and discovering new ideas to planning, managing and finally realizing an own business concept, and the student should has gained the knowledge to start up their company or to proceed with a career in industry or academia.

The student acquires the following competencies:

- Can understand, apply and reflect upon knowledge on an international research level within one or more subjects of the subject columns of the education
- Can understand and reflect upon the existing knowledge within the subject areas in a scientific way
- Is able to identify relevant scientific research problems within the subject area presented in the subject columns
- Can apply and evaluate different scientific methods and use them in relation to scientific writing
- Be able to evaluate the innovation process and select and realize promising product and business ideas. Through advanced innovation management skills, the student can from a theoretical point of view assess the innovation process. This encompasses analyzing both intra-organizational as well as inter-organizational aspects affecting how innovations should be managed and supported. The student can then identify and evaluate value networks in which there could exist potential for the co-creation of value important for growth and competitiveness
- Be able to understand the complexity and diversity of developing products and managing a project. Understanding the complexity is achieved through advanced skills in understanding the collaborative design process, product development techniques, project management methods and other working methods. Further, the student is able to analyze. plan and organize a project as well as use social competencies in the management process
- Be able to understand and apply design thinking and design approaches in the development of new products or business concepts
- Be able to apply advanced knowledge in mechatronics enabling the student to participate in development activities in industry or as entrepreneurs in the start up of their own company.

- Be able to analyze and evaluate business opportunities. Advanced competences in business administration enables the student, in a scientific way to evaluate business opportunities, integrating external information about e.g. markets, competitors, customers etc.

§3 Subject columns of the study programme

The competences are acquired by studying the topics in the below listed subject columns during the programme.

Innovation management and scientific methods

- Strategic innovation management
- Innovation process
- Internal and external innovation competences
- Value networks
- Customer/user innovation
- Controlling and budgeting innovation activities
- Research methods

Entrepreneurship and project management

- Business plan development and implementation
- Raising venture capital
- Establishment of a business/company
- Operation management and facilities
- Supply chain management
- Logistics
- Quality management
- Project management methods

Design and creativity

- Design thinking
- Design studies
- Professional roles (participatory innovation, social design and human centered design)
- Innovation and technology visions
- Creativity techniques
- Barriers to creativity
- Creativity organizations

Business administration and management

- Company analysis
- Management accounting
- Cost measurement
- Investment
- Financing
- Budgeting
- Organization design and changes
- Organizational management and strategy
- Strategy and cost management
- Technology management

- Marketing in a company or organization
- Consumer behaviour
- Global marketing management
- Consumer and business to business marketing
- Internet commerce

Mechatronic Product Development
A: Mechanical product development and manufacturing

- Methodical product development
- Sketching techniques
- 3 D modeling
- User-experienced design
- Selection of materials and technology
- Engineering mechanics
- Mathematical modelling
- Product documentation for preparing manufacturing
- Design review
- Prototyping
- Machine elements
- Strength of materials
- Operation management
- LEAN production
- Computer simulation of manufacturing

B: Intelligent electronic product development

- Electronic circuits and components
- Electronic simulation
- Analyzing and designing analogue circuit-realized systems
- Building LAB models
- Digital hardware design
- Embedded software
- Data communication
- Microprocessor/controller systems
- Programming
- Transducers, actuators and sensors
- Mathematical modelling

Personal competences:

- Communication skills
- Analytical and critical reflection skills
- Independent
- Creative and innovative
- Management skills
- Collaboration and process-oriented skills

§4 The profiles of the education:

The study programme is on the master level not divided into semester themes which is the case for the bachelor level. Further, the master of science in Engineering in Innovation and Business has only one specialization (one profile) which will be described below.

§5 Structure and Semester modules

<table>
<tr><td>10.</td><td colspan="30">THS*
Master Thesis</td></tr>
<tr><td>9.</td><td colspan="11">DIN
Dynamics of Innovation</td><td colspan="5">ELC9
Elective</td><td colspan="5">ELC9*
Elective</td><td colspan="5">ELC9*
Elective</td><td colspan="5">MDB2
Mechatronics Design and Build</td></tr>
<tr><td>8.</td><td colspan="11">INV
Innovation in Value Networks</td><td colspan="10">PIN
Participatory Innovation</td><td colspan="5">SMS
Scientific Methods</td><td colspan="5">MDB1 Mechatronics Design and Build</td></tr>
<tr><td>7.</td><td colspan="11">STM
Strategic Innovation Management</td><td colspan="5">ELC7
Elective</td><td colspan="5">BDE
Business of Design</td><td colspan="10">INT
Business or Technology</td></tr>
<tr><td>ECTS POINTS</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td></tr>
</table>

*Students may choose to do a 40 ECTS thesis, in which case work on the thesis begins in the 9 semester, replacing two of the 5 ECTS elective courses.

§6 Description of the 7th Semester

Value argumentation
The 7th semester presents the students to the core disciplines of the education. The purpose of the 7th semester is thus to give the students an understanding within technology, innovation management, design and business. The knowledge provided will enhance the students capabilities within strategic innovation management, business design and prepare them on the technical side for the technical electives and the mechtronics and build course in the coming semesters. This understanding provides the students with the foundation for coping with the courses defined as profile courses in the 8th and 9th semester. The courses on the 7th semester should therefore provide the first steps on a more advanced ladder of knowledge which will be offered in the 8th and 9th Semester.

Students who have graduated as bachelors of innovation and business or external students enrolling with a bachelor containing sufficient business courses already will not be introduced to the business area. These students will follow a technology intro module whereas external students with no business prerequisites will follow a business intro module (both captured in the module INT) .The technology intro offered is IECS, also available in the master of engineering in Mechatronics.

Students coming from other universities lacking the business skills will follow the Business Intro module with the planning units: STRA and BA2.

Competence goals
The competence goals for the 7th semester are the following:

- Be able to understand and apply relevant theory, models, concepts and methods within Strategic Innovation Management, Design , Business and Technology
- Be able to define relevant research problems within the central subject areas such as e.g. innovation management
- Be able to integrate relevant sources when answering research problems
- Be able to apply the gained knowledge on real-life cases
- Be able to present findings and structure a presentation

Modules
The 7th semester contains the following modules:

INT, 10 ECTS-points
BDE, 5 ECTS-points
STM,10 ECTS-points
ELC7, 5 ECTS-points

The modules INT, BDE and STM are constituent modules. The module ELC7 is elective.

Connection
The 7th Semester contains 4 modules: INT, BDE, STM and ELC7.

INT: The Business intro contains the planning units STRA and BA2 (10 ECTS). The technology intro consist of the module IECS (10 ECTS). Whether the student should take the business or the technology intro depends on the prerequisites acquired in their bachelor education. The focus in STRA is on gaining the basic and most fundamental concepts within marketing and being able to solve basic marketing problems. The aim of BA2 is to give the student a basic knowledge in management accounting and to get an understanding of costs and cost behavior. IECS is an introductory project that provides students with basic knowledge and practical skills needed to continue their studies in the following semesters. The scope and contents of the project are determined depending on the background and previous experience of the students.

BDE: The Business Design module has a workload of 5 ECTS. The aim of this course is to introduce collaborative design as a way of approaching the innovation of both product services and the corresponding business models.
STM: The Strategic Innovation Management module has a workload of 10 ECTS. The course will answer fundamental questions such as: What is an innovation? What are the challenges of cross-functional coordination? How does culture support or hold up from innovating? What are emerging trends in innovation management?
ELC7: The Elective module has a workload of 5 ECTS. The student can here chose from a number of technical electives.

§7 Module descriptions for the 7th Semester

Module description for M.Sc.(Eng) in Innovation and Business, applicable for seventh semester students enrolled in September 2009, is available in the Course Database under Course Description autumn 2009.

§8 Description of the 8th Semester

Value argumentation
Innovation by businesses is achieved in many ways, with much attention given to formal research and development for radical innovations. However, innovations can also emerge from less formal learning- by- doing modifications of practice, by combining professional experience and in many other ways. The profiling course running on the 8th Semester intends to discuss the variety of sources that can lead to both radical and incremental innovations seen form a firm perspective. Knowledge on how companies can profit from innovation in value networks is discussed. The value creation that can happen in the complex nature of value networks is thus considered and the variety of sources of innovation are emphasized. Regarding user innovation as one possible source, a great deal of innovation is done by those actually implementing and using technologies and products as part of their every day lives. Further, users may also reveal their innovations, using methods like open source, sharing knowledge within networks of innovation or other types of user communities in order to stimulate and discover new innovation potential. The purpose is thus, to give the students a thorough understanding on an international research level, of the complex nature of how different sources of innovation can influence and mediate innovation processes and how.

Competence goals
The competence goals for the 8th semester are:

- Be able to understand how theoretical perspectives can be used to explain distributed innovation in value networks and how the linkages between these perspectives help to explain how innovation unfolds and can be managed
- Be able to use and apply theoretical and empirical support— both orally and in writing—to explain the sources of innovation.
- Be able to define relevant research problems within the above subject areas
- Be able to understand and analyze advanced issues concerning mechatronics design

Modules
The 8th semester contains the following modules:

- INV, 10 ECTS-points
- SMS, 5 ECTS-points
- PIN, 10 ECTS-points
- MDB1, 5 ECTS-points

The module INV is a profile constituent module. MDB1, SMS and PIN are constituent modules.

Connection
INV: This module INV has a workload of 10 ECTS. It deals with distributed sources of innovation by exploring different aspects of the innovation process that go beyond the boundaries of the firm.

The course will particularly focus on the fact that innovation is result of the combination of knowledge and often requires firms to look outside for sources of knowledge and innovation.

MDB1: The course MDI 1 and MDB2 (5 ECTS each) provide students with an understanding of the Mechatronic Design Process.This involves knowledge about the ability to interface sensors and actuators to computers to provide data acquisition and control of mechatronic systems etc.
SMS: The goal of the course SMS (5 ECTS) is to provide students with knowledge in scientific research methods. It will help the students to go through the theoretical and practical topics affecting the research process from start to finish. Within this course students will learn to provide the information that will allow solving managerial problems.

PIN: The PIN course (10 ECTS) provides an overview of theories and methods in the emerging field of use-driven innovation. Through an innovation project in collaboration with a company, students get concrete experience in studying and involving users and in developing design concepts and business models. The challenges of working in mixed teams of design and engineering students further develops a solid understanding of project management issues and process facilitation.

§9 Module description of the 8th Semester

Module description for M.Sc.(Eng) in Innovation and Business, applicable for eight semester students enrolled in September 2009, is available in the Course Database under Course Description spring 2010.

§10 Description of the 9th Semester

Value argumentation
The purpose of the 9th semester is to present the students to the multidisciplinary field of innovation research. Thus, the students will learn how to orient themselves on the map of innovation research and further understand interconnections, and to creatively apply and visualize the knowledge gained in the course

Competence goals
The competence goals for the 9th semester are:

- Be able to understand the main body of knowledge presented within the field of innovation research and apply relevant theory, models, concepts and methods on specified research problems.
- Be able to understand and analyze advanced issues concerning mechatronics design
- Be able to define relevant research problems within the profiling course and the thesis preparation course
- Be able to integrate relevant sources on an international research level when answering research problems

Modules
The 9th semester contains the following modules:

DIN, 10 ECTS points
MDB2, 5 ECTS points
ELC9, 5-15 ECTS points

The module DIN is a profile constituent module. MDB2 is a constituent module. ELC9 is an elective.

Students may choose to do a 40 ECTS thesis, in which case work on the thesis begins in the 9 semester, replacing two of the 5 ECTS elective courses.

Connection
DIN: The course DIN (10 ECTS) views innovation as a social process where interactive learning between different actors (e.g. suppliers/producers, customers/users, universities, public procurers) is a central element.

MDB2: The module MDB2 has a workload of 5 ECTS. A deeper understanding of some of the issues concerning Mechatronics design is provided than that achieved in MBD 1. In addition there is an increased emphasis on actuators and the role of Smart materials for sensing, actuation and control in mechatronic systems. The laboratories and assignments have elements of a distinctly higher level than those encountered in MBD 1.

ELC9: Each of the elective modules has a workload of 5 ECTS. The student can chose from a number of electives

§11 Module description of the 9th Semester

Module description for M.Sc.(Eng) in Innovation and Business, applicable for ninth semester students enrolled in September 2009, is available in the Course Database under Course Description autumn 2010.

§12 Description of the 10th Semester

Modules
The 10th semester contains:

THS, 30 ECTS-points

The module THS is a profile constituent module.

Students may choose to do a 40 ECTS thesis, in which case work on the thesis begins in the 9 semester, replacing two of the 5 ECTS elective courses.

§13 Module description of the 9th Semester

Module description for M.Sc.(Eng) in Innovation and Business, applicable for ninth semester students enrolled in September 2009, is available in the Course Database under Course Description spring 2011.