# NTNU The Global Manufacturing Management Programme:

*Trondheim, Norway*

## A master's degree programme with a global focus and close connections to the industry

# General Information

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| **Title** | NTNU The Global Manufacturing Management Programme |
| **Pitch** | A master's degree programme with a global focus and close connections to the industry |
| **Organisation** | Norwegian University of Science and Technology (NTNU) |
| **Country** | Norway |
| **Author** | Pierre Lindman (Technopolis Group) |

**Nature of interaction**

- ☐ Collaboration in R&D
- ☑ Commercialisation of R&D results
- ☐ Mobility of staff
- ☐ Academic entrepreneurship
- ☐ Governance
- ☐ Lifelong learning
- ☐ Joint curriculum design and delivery
- ☐ Mobility of students
- ☐ Student entrepreneurship
- ☐ Shared resources

**Supporting mechanism**

- ☑ Strategic
- ☑ Structural
- ☑ Operational
- ☐ Policy

**Summary**

NTNU is very successful in the education of manufacturing and logistics and, following a strategic investment where globalisation was one of the priority areas, a two-year master's degree programme in Global Manufacturing Management (GMM) was created. The university's main objective with the MSc programme in GMM is to provide students with practical skills of logistics in a global perspective. These skills are necessary to take active part in the development of future technologies and sustainable solutions for global enterprises. The students are provided with opportunities to close cooperation with industry by taking part of joint research projects and by networking in various form.

# Introduction & Overview

## 1. BACKGROUND

The Norwegian University of Science and Technology (NTNU), located in Trondheim, is the main technological higher education institution (HEI) in Norway, including Norway's premier institution for education of engineers. In January 2016, NTNU became the largest university in Norway after a merger with three university colleges, the University College of Sør-Trøndelag, also located in Trondheim, the University College in Ålesund, and the University College in Gjøvik. This has all in all created a large academic environment in Trondheim with several campuses around the city, plus the campuses in Ålesund and Gjøvik, which are smaller towns outside Trondheim.

NTNU consists of nine faculties with a total of 56 departments. The university holds about 39,700 students and employs 6,900 people. It has an annual budget of NOK8b (€870m). NTNU offers several programmes and a broad curriculum in technology, natural sciences, social sciences, teacher education, humanities, medicine and health sciences, economics, finance and administration, as well as architecture and arts. NTNU also offers a variety of international student exchange programmes and cooperate with 60 universities worldwide.

Many of the research communities at NTNU have well-developed collaboration and partnership with the world of business. Effective communication and teamwork with external partners provide motivation for further development of research and education. NTNU emphasises creating a reliable and predictable framework for collaboration with external research and industrial partners. NTNU's aim is that their partners get the rights they need for commercial utilisation in their own operations.

In recent years, many business networks have been established at faculties, departments and programmes at NTNU. The main purpose of these forums for collaboration is to involve partners from business, industry and government administration in fruitful cooperation to strengthen the educational activities at the university. Most collaboration linking business and the public sector with NTNU is anchored in the academic communities at the various departments and faculties. These communities of experts have a wealth of knowledge on making the most of partnerships to provide professional benefits for all parties. Businesses and others can buy laboratory services at NTNU.

NTNU has a strong position in the Norwegian job market. Many employers start seeking out students long before they graduate. There are many opportunities for short- and long-term projects, and for recruiting current students who become the company's new employees. Academic collaboration is a good way to get to know students and academic environments. The aim of academic collaboration is solving a challenge relevant to a particular subject. The ultimate goal must be new knowledge for all the parties involved. The companies will get to know

the student and his or her skills, which could create a foundation for future recruitment. Students gain valuable experience through projects of interest to their discipline in a real-life work environment. In order for a company to initiate an academic collaboration they must have a clear idea of the issues that need to be solved, so the academic staff can assess whether they are relevant to students in the discipline.

Among its many reputed teaching areas, NTNU is very successful in the education of manufacturing and logistics. Following a strategic investment where globalisation was one of the priority areas, a two-year master's degree programme in Global Manufacturing Management (GMM) was created. This programme serves as one good example of the cooperation that NTNU has with the regional and local industrial sector. The GMM programme is hosted by the Faculty of Engineering and is a collaboration between the Department of Mechanical and Industrial Engineering and the Department of Industrial Economics and Technology Management.

Due to intensified competitive challenges and global production, the market calls for an understanding of how strategic improvements can be made along the supply chain, within enterprises and on operations level. The two-year master's programme's main goal is to provide the students with analytical skills and a theoretical foundation to handle these challenges effectively. During the master's programme, the students will acquire a set of capabilities combining engineering and management competences with a global perspective.

The globalisation approach of the programme provides the students with economic, technological, cultural and political knowledge. In order to lead international projects, knowledge within these areas is important. The key knowledge is related to strategic management. By a combination of this knowledge and technology and engineering, the students also obtain competencies to become leaders within the business sector. The GMM programme provides the students with an understanding of how to develop competitive advantages in the global market, highly important to a company's strategic position.

**NTNU Collaboration with SINTEF**

NTNU is the university in the world that produces the highest proportion of the research in collaboration with a single partner from industry, SINTEF, which is one of the companies involved at GMM.

SINTEF is an independent, not-for-profit research institute and as such the largest independent research organisation in Scandinavia. SINTEF conducts contract R&D as partner for the private and public sectors, and are among the four largest contract research institutions in Europe. Its strategic focus areas are:

- Renewable energy, climate- and environmental technology
- Oil and gas
- Ocean space technology
- Health and welfare
- Enabling technologies

NTNU and SINTEF have worked closely ever since 1950, and have conducted many projects together. NTNU personnel work on SINTEF projects, and many SINTEF staff teach at NTNU. The collaboration involves extensive joint use of laboratories and equipment, and more than 500 people are employed by both NTNU and SINTEF. NTNU also manages more than 120 large and small laboratories, independently or in cooperation with SINTEF. NTNU and SINTEF joint production accounts for 9.1 percent of NTNU's total research output.

One of the institutes in the SINTEF family is SINTEF Technology and Society. Its main goal is to integrate social sciences with national technology projects and to strengthen the interaction between technology, organisation, people and society. SINTEF Technology and Society strives to encourage better solutions and increased innovation in industry, business and the public sector. The institute has six departments, addressing the major challenges facing society, through technological and social science research in areas as employment and industry, energy and climate, health, demography and welfare, smart transport solutions and safe and secure societies. SINTEF Technology and Society is particularly relevant as partner to the GMM programme, and as a potential employer for the students once they have completed their studies. Students of the GMM programme are given the possibility to participate in joint research projects with SINTEF. An example of such a project is SINTEF Operations Management, where students are offered experience within the research fields of logistics and business development.

## 2. OBJECTIVES AND MOTIVATIONS

NTNU is motivated by providing their students with the best possible education within the fields of engineering and management. The university's main objective with the MSc programme in GMM is to provide students with practical skills of logistics in a global perspective. These skills are necessary to take active part in the development of future technologies and sustainable solutions for global enterprises. Considering this, NTNU expects that all their MSc GMM students receive qualified job offers, during the studies or after having graduated.

This is achieved through close cooperation with the industry. NTNU aims to provide the industry with the best possible graduates and the Department of Mechanical and Industrial Engineering aims to provide Norwegian industry and public administration with access to expertise and knowledge on an international standards level. By maintaining a high quality of their graduates, NTNU strengthens its links with industry and makes the GMM programme an excellent forum for recruiting new talents.

The objective for industry to cooperate with NTNU in the MSc GMM is to exchange knowledge between experienced employees and students. Industry cooperates with NTNU in order to strengthen research and innovation that might be beneficial to them. Industry wants to recruit the best talents available and by cooperating with the GMM programme is given an opportunity to present their companies and what they do in order to gain interest from the students. The MSc GMM programme serves as a pool of potential recruits for the industry.

## 3. STAKEHOLDERS

The primary stakeholders of the GMM programme include:

- Industry, either factories that are part of international consolidated companies, or consolidated companies based in Norway. Some examples of partner companies include Statoil, Elkem, Hydro Automotive and Kongsberg Automotive. These companies commonly employ graduates from the GMM programme. All of them are relatively large Norwegian companies, and Statoil and Hydro Automotive are very large companies that operate on global level. Statoil is the primary Norwegian oil company, and since 1972 it has explored, developed and produced oil and gas on the Norwegian continental shelf, where it is a leading operator. Statoil has around 20,000 employees and operations in some 30 countries. Hydro Automotive is part of the larger group Norsk Hydro, which is a global aluminium company with production, sales and trading activities throughout the value chain, from bauxite, alumina and energy generation to the production of primary aluminium and rolled products as well as recycling. Based in Norway, the company has 13,000 employees involved in activities in more than 40 countries on all continents. NTNU has extensive cooperation with all these companies (and many others), both regarding research and education. With reference to the GMM programme, these companies provide projects for the students' master theses, and have a dialogue with the responsible professors at the programme regarding its content, in order to secure relevance of the curricula and employability of the students.
- The Department of Mechanical and Industrial Engineering has a broad interdisciplinary knowledge of logistics, machine design, product development and

materials science. The department focuses its research on developing, optimising and improving production systems and industrial processes.

- The Department of Industrial Economics and Technology Management provides students with challenging educational programmes and research projects in the multidisciplinary field of technology management. Students are educated in how to develop and manage technologically based organisations.
- The Faculty of Engineering offers doctoral and master's level engineering programmes within the fields of science and technology. Students can choose from more than 30 programmes and several specialisations.

# Implementation

## 4. INPUTS

The GMM programme has a rather small marketing budget of NOK 60-70,000 (€6000-7000) at their disposal annually. The Department of Mechanical and Industrial Engineering uses its marketing resources in order to attract more applications from students. As part of marketing the GMM programme, the department organises some events on campus, to attract students and increase their knowledge about the programme. Besides the teaching staff, the department has employed a sales manager that is in charge of marketing the GMM programme.

The GMM programme receives half of its applications from Norway and other Scandinavian countries, a quarter from students outside of the EU and one quarter from students inside the EU. Competition is intense amongst students to be admitted to the programme since NTNU only has the capacity to admit 20 students per year. Admission to the GMM programme requires a Bachelor's degree in Technology or Engineering, or equivalent. NTNU charges no tuition fees (it is not allowed to charge tuition fees in Norway), but all international students who are not citizens EU/EEA/EFTA countries must document that they have a certain amount of money to live in Norway. For 2017, the amount is NOK 103 950 (€11,300). International students admitted to the GMM programme will be asked to transfer the stipulated amount to a deposit account.

## 5. ACTIVITIES

The GMM programme starts in August every year. During the GMM programme, students can specialise in either Production Management or Purchasing Management. Regardless of which specialisation students choose, there is a number of compulsory courses at both specialisations. During their fourth and last semester, students write their master's thesis based on their specialisation. The academic content must include a scientific investigation of a subject related to globalisation of technology. The master's thesis should also apply theoretical understandings to solve industrial challenges within the following areas:

- Project Management
- Supply Chain Management
- Production Strategy
- Operations Management
- Technology and ICT Management

NTNU and the GMM programme have a close collaboration with industry and the education focuses on acquiring experience and manage real life industrial challenges in global enterprises, such as participating in SINTEF Operations Management, a joint research project where students can gain experience within the research fields of logistics and business development. Knowledge of business models and strategy is an important premise for the development of

holistic logistics solutions. Manufacturing logistics is about the transformation (production, assembly etc.) and delivery (inventory, distribution etc.) of products throughout the supply chain, performed according to customer requirements and as efficiently as possible. Business development is about identifying, analysing, evaluating and introducing new business and product ideas. The students of the GMM programme can participate in so called Smartlog activities. Smartlog is an interest group for supply chain management in Norway. The Smartlog Network includes several Norwegian production companies and is organised by the NTNU Production Management Research Group. Smartlog aims to create competence through the dissemination of results to the business community. Through a Smartlog membership businesses of Norwegian industry join this national competence network in logistics and by that get opportunities to make contacts and build their own networks. In addition, members are invited to provide input on relevant topics they want illuminated through such research activities and seminars.

Smartlog started in the year 2002 as research partnership between the Norwegian industry and the research institutes MARINTEK, SINTEF and NTNU. The environment generates business-oriented research and undertakes research and development activities in a wide range of issues, and interdisciplinary approaches and solution methods. Since the beginning, researchers and PhD students in Smartlog have worked with the industry to reach Smartlog's overarching objective, which is to increase Norwegian industry competitiveness through developing and disseminating knowledge and expertise on logistics dynamic value chains.

Based on cases from Norwegian and international companies and research projects, students get to exemplify and discuss theoretical subjects. During their time at the GMM programme, students may participate in ongoing research projects, both internally at NTNU and in projects undertaken in cooperation with industry. NTNU makes it possible because of its strong brand and its long-time collaboration with industry. An important part of the education is networking with companies and representatives from the industry, which can be done during summer jobs, through specialisation projects during the third semester, and along the course of working with the master’s thesis. The student organisation Teknologiporten acts as corporate contact for the faculty and organises company presentations each semester. Teknologiporten has a goal of creating interests and opportunities in business for technology students at NTNU. Other student organisations such as Bindeleddet and IASTE host company presentations available for all engineering students at NTNU. Participation in events and presentations are ways of meeting future employers and all these networking activities provide the students with opportunities to receive job offers by the time they graduate.

As a link between university and industry, a number of business networks are available through faculties, departments and programmes of study at NTNU. The main purpose of these forums for collaboration is to involve partners in business, industry and government administration in fruitful cooperation to strengthen the educational activities at the university.

## 6. OUTPUTS

A majority of students graduating from the GMM programme will receive job offers shortly after graduation or even during their studies. During the recent years, relevant companies operating in the manufacturing industry have employed all Norwegian students and also many foreign students who speak the Norwegian language. Due to the recent decline in the oil sector in Norway, international students who have not learned the language have normally had to apply for jobs outside of Norway and a majority have received job offers elsewhere. Technology students graduated from any of the programmes that NTNU offers are in high demand by the industry.

The main output for industry in cooperating with NTNU and the GMM programme is that they can choose the best talents graduating from a programme that is adapted to their business area. The graduates are well educated after studies at the GMM programme. Another major output for the industry is the amount of research being done in cooperation with NTNU and the GMM programme. It is a beneficial arrangement for both students and industry as the students gain experience and the industry receive new and fresh ideas to real challenges.

## 7. IMPACTS

NTNU and the GMM programme have always collaborated in one way or another with industry. Both the university and the industry are dependent of each other; the industry needs the GMM programme to recruit students and the GMM programme needs the industry so that the staff can continue with applied research projects, with a potential for industrial co-funding. The industry often participates in the research projects and sometimes its collaborating staff act as project leaders. The GMM students often get the chance to participate. During the third semester, students can choose to participate in a specialisation project instead of studying a regular course. The specialisation project is linked to NTNU's cooperation with industry, regarding a topic relevant for globalisation.

# Support & Influencing factors

## 8. SUPPORTING MECHANISMS

The Department of Mechanical and Industrial Engineering and the GMM programme is collaborating with industry and the collaboration keeps strengthening the relationship between them. Collaboration with industry is a key element in developing the curriculum.

NTNU uses a platform called NTNU Bridge that links students with the working world for partnerships on assignments, internships and jobs. On that platform companies can find students with the educational background they need. Another supporting mechanisms is NTNU Technology Transfer AS, the technology transfer office of NTNU. It supports links and collaboration between NTNU and the surrounding society, including industry. The ambition is to create value of research results and turn good ideas that comes out of NTNU's work into innovations, so that results and ideas eventually can reach the market in form of new products or services that benefit society. NTNU Technology Transfer reviews the potential of the research and ideas and is actively involved in obtaining financing, ensuring patent protection, developing ideas, performing market analyses and establishing license agreements. NTNU Technology Transfer supports projects from start to an end.

## 9. BARRIERS AND DRIVERS

One of the barriers the GMM programme needs to handle is the fact that it is an international programme but can only admit a small number of students. Because of the low admission rate, only 20 students per year, the programme receives less attention from the faculty than larger programmes. One of the reasons for a limit of 20 students is that there are no tuition fees in Norway. Instead, the cost of study places at all Norwegian universities and university colleges are covered by the direct government appropriations for education that is the state funding for providing education. The total sum that NTNU receives need to be shared among all teaching programmes at NTNU. Consequently, there is an internal distribution model in place which distributes the resources from the central level down to the faculties and further down to the departments. This order results in annual negotiations both at faculty level and at department level.

The GMM programme has an annual intake of 20 students and for the current academic year the programme received 346 applications. In theory, these figures indicate a highly competitive selection process among the applications. This would mean that the selected applicants should represent the top 20 skilled individuals. At the same time, the Department of Mechanical and Industrial Engineering considers some parts of the recruitment process to be a barrier. Although the students are typically good, they could be even better. As of now, the admission requirements are not high enough to attract the very best students. The department mentions that there is a problem with the competence level of some of the students admitted to the

GMM programme. They simply do not have sufficient knowledge in production and logistics as they start their studies. The industry only wants to have the best students participating in the research projects, therefore students that are not good and qualified enough are left out. The Department of Mechanical and Industrial Engineering is trying to develop and increase the quality of all its students so that as many as possible can be involved in research projects. At the last annual intake the GMM programme had 346 applications of which 117 were from Norwegians applicants and 229 were international. Despite the fact that there is tough competition to be admitted to the programme, the popularity of the GMM programme needs to increase in order to compete with other comparable master's degree programmes, according to the staff. If the popularity of the programme increases, so will the admission requirements.

According to the department, the GMM programme is not a sufficiently visible option for those who want to have a master's degree in logistics. The name of the master's programme itself acts as a barrier as well; it is not considered attractive enough. The department members did not get to choose the current name and they would like to change it to Industrial Logistics, which according to them would be much more suitable.

Staff members also perceive that the smallness as such of the programme means less attention and visibility, both from industry and internally at NTNU. The education is furthermore affected by difficult times for production and logistics businesses. One result is that international students have not learned Norwegian and they have hard times receiving job offers from companies located in Norway.

The fact that a variety of different companies are interested in the GMM programme is considered a driver as it gives the students the opportunity to get acquainted with companies that may be future employers. A good way to possibly attract new applicants and strengthen the programme could be to show future applicants that the majority of GMM graduates have been employed by either Norwegian or international companies. It can also be seen as a driver from the companies' point of view that they keep employing students from the GMM programme.

## 10. FUTURE CHALLENGES

The department aims at making the GMM programme the natural choice of education for students who seek a five-year long education in logistics at NTNU. To achieve that, a clear and profiled bachelor's degree in logistics need to be established, followed by the GMM programme as the two final years. The GMM needs to cooperate with bachelor's degree programmes that have a relevant profile. Through such cooperation with bachelor's degree programmes, the department aims at increasing the knowledge and competences of students who are admitted to the GMM programme.

A challenge is to make the admission rate higher and increase the grade average of the programme. The department also strives to reduce the number of dropouts. The figure is not unusually high but with a relatively small number of students participating in the programme each year, there is good reason to pay attention to each student and try to minimise dropouts.

To handle future demands from the industry, the Department of Mechanical and Industrial Engineering wants to establish a new speciality for the students to choose, Supply Chain Management analytics, within the GMM programme.

## 11. CONTEXT

Norway has seven universities, nine specialised university institutions, 22 university colleges, two national colleges of the arts and several private institutions of higher education with either institutional- or programme accreditation. With the exception of some private university colleges, all higher education institutions are state-run. In general, tuition is not required for study at Norwegian higher education institutions, although fees may be imposed for certain professional education programmes, further and special education programmes and studies at private institutions. In addition to their teaching activities, all the higher learning institutions, and particularly the universities, are responsible for conducting basic research as well as researcher training, primarily by means of graduate-level studies and doctoral degree programmes.

## 12. KEY SUCCESS FACTORS

Key to the programme's success is the long-lasting collaboration with industry and the fact that the Department of Mechanical and Industrial Engineering can present their students with opportunities to be a part of real life industrial research projects. Another key success factor is the fact that almost all students graduating will receive job offers, and some of them even receive offers during the education.

# Further Information

## 13. MONITORING AND EVALUATION

Each year, the head of each department at NTNU conducts a quality report, which is sent back to their associated faculty. Students at the GMM programme are requested to answer a national survey. Besides the national survey, the Department of Mechanical and Industrial Engineering conducts their own survey amongst students that targets following issues:

- The academic environment in the programme
- The social environment in the programme
- Administration and information
- Teaching
- Feedback and advising
- Work life relevance
- Learning outcomes
- Assessment of exercises
- Assessment of exams
- Degree to which the programme is stimulating and challenging
- The students' opportunity to influence the programme

## 14. LINKS

NTNU main page http://www.ntnu.edu/

NTNU Global Manufacturing Management http://www.ntnu.edu/studies/msgloman

NTNU Collaboration with industry http://www.ntnu.edu/studies/msgloman/collaboration-with-industry

## 15. CONTACT PERSON

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