DISPUUT TRANSPORTKUNDE PANDORA

NetwerkNieuws.

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From an old Staff member

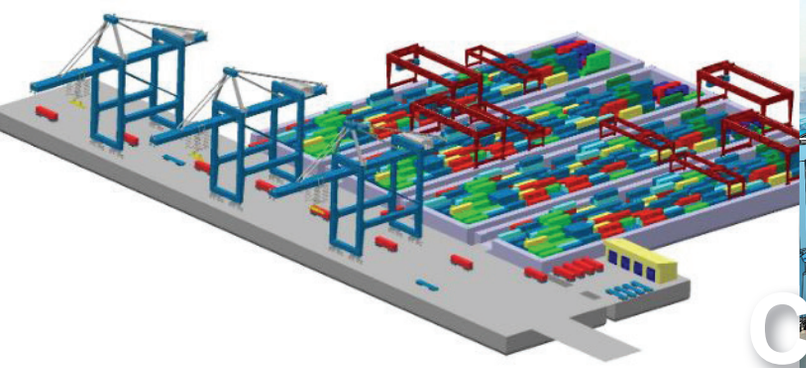
Innovation? Sure…..but quite an effort!

Dreamteam

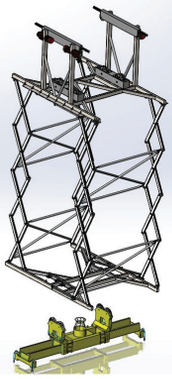
Delft Aerospace Rocket Engineering

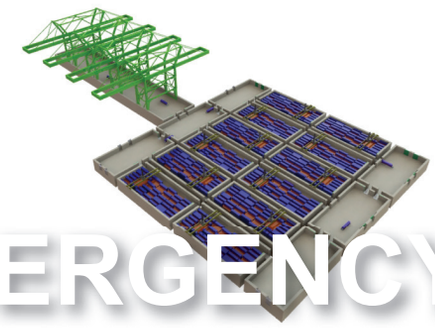
Coronavirus

A Graduation Project in 2020



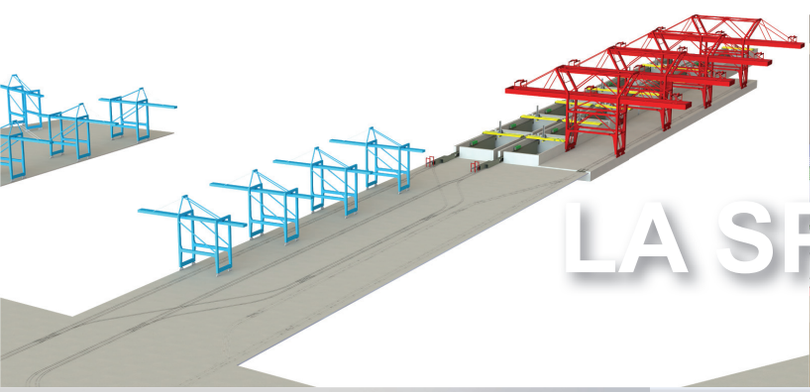
CONSTANZA

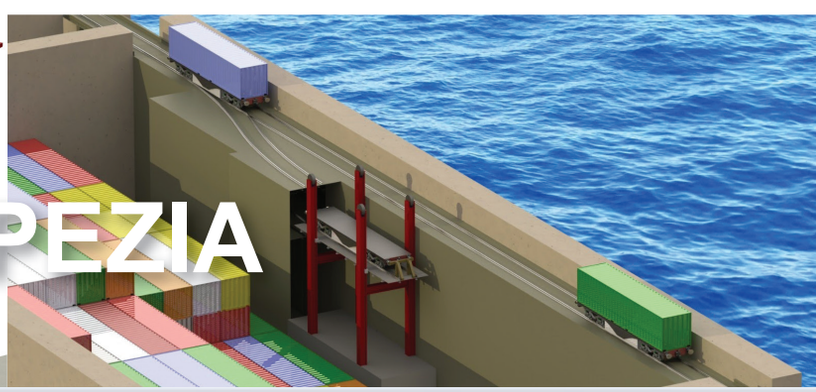




EMERGENCY PORT

These pictures are results from Ir. Wouter van den Bos's course ME 44110 Integration project Multi-Machine system of last year. Project groups of six to seven students would have to make an innovation in transportation on floating ports in the third quarter and in the final quarter of the academic year apply the innovations of them and the other groups on different floating additions to existing ports in Europe. These gave some interesting insights in what the future of floating ports may look like.





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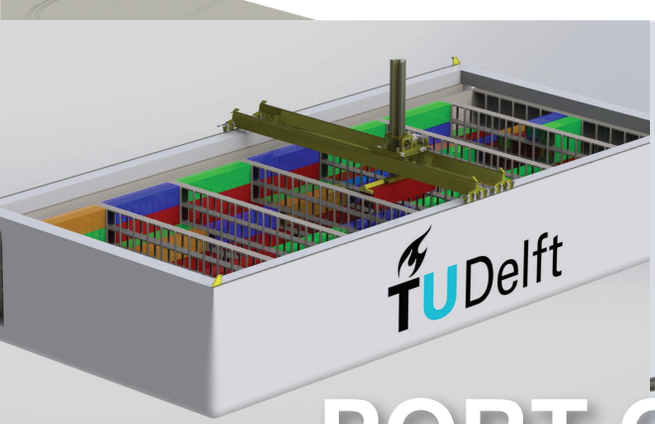
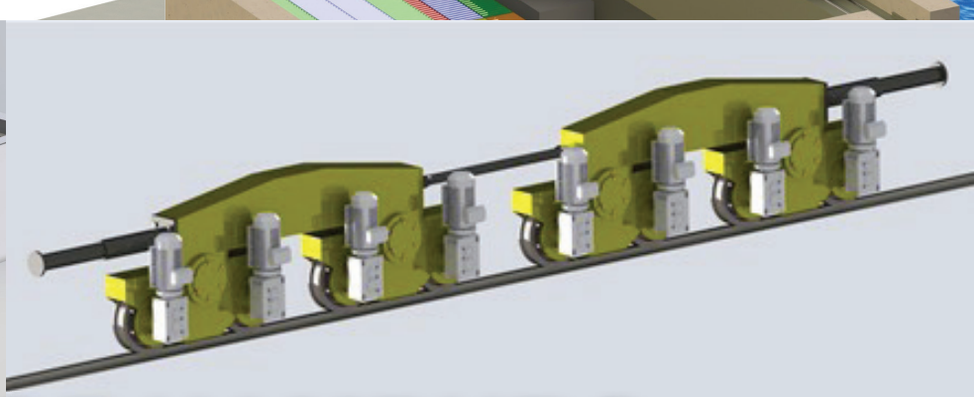
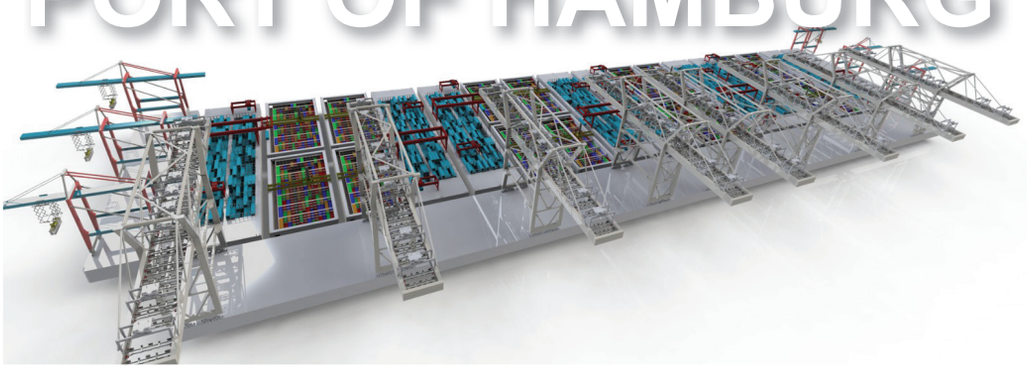




PORT OF HAMBURG



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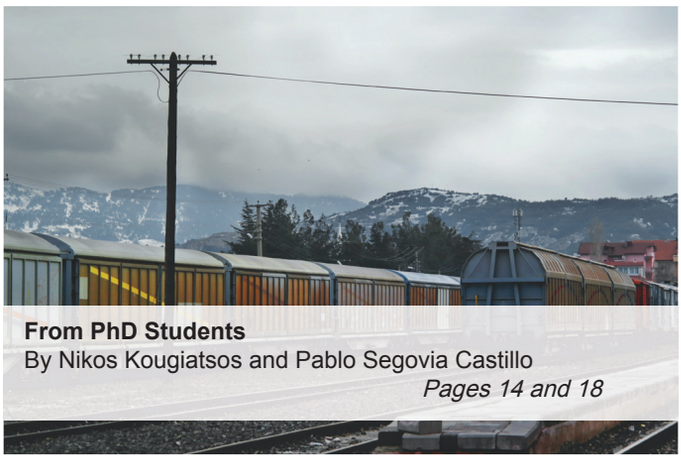

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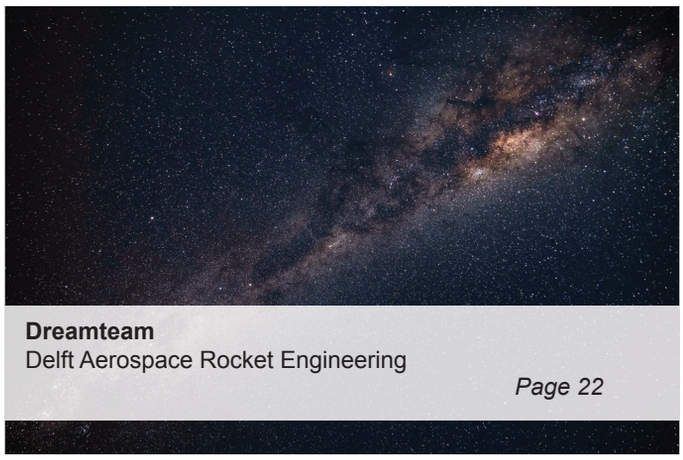

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INTRODUCING: THE NEW BOARD

By: Board 2020-2021

President
Gitte Hornung
voorzitter@transportkunde.nl

My name is Gitte Hornung and the upcoming year I will have the honour of filling the position of president in the board. On my very first day as a Mechanical Engineering student, I went on an excursion to the Rotterdam Harbour. I was deeply impressed by the all the large cranes and from that moment onward I knew that this was what I wanted to do. When looking for a master I couldn't find what I was looking for and thought that maybe there just wasn't a perfect master for me. After half a year of trying my hand at Systems&Control, I decided to start the master Multi Machine Engineering. When during the intro day I heard people enthoustically talking about grabs, cranes and other heavy duty mechanical engineering I knew I was in the right place.

Especially, during this year of online education and uncertainties, it is my aim that we as a board make sure that the students are provided with quality education, contact with companies in the field and above all a good time during their master studies.

Did you know:

If you rip a hole in a net, there are fewer holes in it then before.

Secretary
Koen Kruimer
secretaris@transportkunde.nl

I am Koen Kruimer and I will be the secretary for this year's board. I have wanted to become an engineer and study in Delft since I was very young. At seven years old I asked my father with what type of job I could play around with cars and diggers all day. The answer he gave me was just one word: 'engineer'. To the question where I could become an engineer he replied: 'Delft'. During my years at middle and high school that thought never left, even though I didn't fully comprehend what an engineer was or did. During my bachelor Mechanical Engineering the fascination for the biggest vehicles, cranes and excavators only grew, making the choice for Multi-Machine Engineering also quite easy. I'm not interested in the specifications of a tiny high-tech microsystem, I'd rather talk about machines capable of lifting oil rigs out of the sea all day.

I'm excited to be the first line of contact for the board of Transportkunde Pandora for this year, because you get to come in contact with a lot of different people. The current situation makes it difficult for us to plan trips and visits to companies, but we will do our best to try and still get some amazing events in!

Treasurer
Bastijn Berenschot
penningmeester@
transportkunde.nl

My name is Bastijn Berenschot. I obtained my bachelor's degree in Mechanical Engineering halfway through last year. To get a better idea of which Master I wanted to do next, I did a full-time internship for a half year. During this internship I learned a lot about the working environment, which can not be learned from any book. After this period I chose to do Multi-Machine Engineering because I wanted to do a Master in Mechanical Engineering, and the fact that this Master focuses on the optimization of the logistic and production aspects of a complex process really excited me.

In this year's board I will fulfill the role of Treasurer. This means that I am responsible for the budget of Pandora and the contracts between us and other companies. I will also be closely involved in the organization of foreign excursions. Due to Covid-19 last year's excursion could not take place, so that's the more reason to make it really special this year!

Commissioner of External Affairs
Laurens Pierik
extern@transportkunde.nl

My name is Laurens Pierik and this year I will be Pandora's Commissioner of External Affairs. In 2017, I started my bachelor's degree in Mechanical Engineering at Delft University of Technology, which I completed last year. I felt, however, that the picture was not complete without also taking a master's degree in Mechanical Engineering. Of the various master's degrees offered, Multi-Machine Engineering stood out to me. This as it offers a combination of engineering, logistics and process optimization. Each of these subjects interests me a lot, because in a changing world as a result of pandemics or environmental issues, knowledge of these subjects is very important to solve for example transport problems.

As Commissioner for External Affairs, I will be responsible for the contact between companies and Pandora, for maintaining our relationship with existing partners and I will do my best to bring in new partners. Together with the rest of the board, we will bring these partners into contact with students of Multi-Machine Engineering through, for example, a lunch lecture or excursion, so that the students can get acquainted with different companies in our field and vice versa the companies can come into contact with a new batch of Multi-Machine Engineers. Reaching these contacts will be extra challenging this year, due to COVID-19. However, challenges often only lead to more creativity, therefore I am confident that this year we will again find ways to make good contacts between the students and the companies.

Commissioner of Education
Carolina van Oeveren
onderwijs@transportkunde.nl

My name is Carolina van Oeveren and I obtained my bachelor Mechanical Engineering here at the Delft University of Technology. I chose the Multi-Machine Engineering track because of my interest in logistics and optimization of industrial processes. Combining these aspects with traditional mechanics was the perfect mixture for me. Up until now I'm really enjoying this master and I am looking forward to the future parts of this program.

In this year's board I hold the position of commissioner of educational affairs of Transportkunde Pandora. Due to the pandemic, this study year will be tough for both the students and the university. However, when looking on the bright side, this year might be the start of a new era in online education. It is my aim to accomplish a comfortable and engaging study environment at home for my fellow students and for the professors of Multi-Machine Engineering. This goal will be targeted by evaluating the courses with the help of my fellow students and trying to improve discomforts together with the staff of the faculty. Please don't hesitate to contact me with any queries you may have, I'd be happy to hear from you. •

FROM THE BOARD

By: Board 2019-2020

From the previous board

It's been just over a year since we were asked to take on the prestigious task of being in charge of the master dispute, and boy oh boy what a year it has been. Looking back at such a year is an almost dizzying experience, where it feels like we were on for at least double as long. Still it was an experience none of us would have wanted to miss.

It all started in October 2019, we were just getting to grips with Multi-Machine Engineering and immediately got thrown into the new deep of Pandora. In our first week we continued right where our predecessors left of and hosted a lunch lecture given by Royal Haskoning (granted they set it up, but we got our first taste of fame). It was a funny thing to suddenly be on the other side of the lunch lectures you visited yourself just the year before, and seeing all the normally unseen parts of it, like trying to transport about thirty sandwiches on your bike. The lunch lecture itself was attended nicely and got us all hopped up to continue the good work. We started are weekly meetings and got to thinking what the next activity would be, it landed on an excursion to that same Royal Haskoning. They organised a case day for us which gave us a glimpse into the world of consulting, it was a new experience for everyone who joined, but also a very educational one. Afterwards they hosted drinks and snacks at their office, which led to the general consensus in the group being that:' If all Fridays ended this way at Royal Haskoning we should stop by more often'. The moral within the board was high, we had all had a pretty solid first period study wise and Pandora was doing great. Our next was arguably are favourite to go on from the start, except for maybe the introduction days. It was the Germany trip, a small two-day excursion where we visited Europe's largest brown coal mine and a powerplant. The sheer size of these facilities was mind boggling, and the engineering efforts they made to achieve all of it was immense. To top it all of the Germany trip coincided with the region's popular carnival festivities (almost as if we planned it that way). Everyone had a blast, and even if we started our second day somewhat hungover, the good spirits and sing a longs in the bus quickly took care of that. At this time COVID was starting to break out, but as the thought at the time dictated that was too far away from us to have an impact on our daily lives. So, we could go on with planning our next activities, and there were a lot planned. The first one was another lunch lecture, this time hosted by TBA. Sadly, this was also our last physical event as COVID wasn't so far away anymore. Still we didn't want to sit still and do nothing with the remainder of our year as the board. We tried to look into the possibilities of physical activities but at the time these were a no go. So, we created and hosted an online pubquiz for our members, with some lovely prizes including a dinner coupon for first place, to try and support our local catering industry. There were quite some participants and the online ambiance was great. Even though the online pubquiz was a success, we did have a desire for a physical activity again. As luck would have it the COVID measures softened quite a bit around the time we had our introduction days, so we could and our year with somewhat of a bang. We hosted a networking dinner for all the future Multi-Machine Engineering students, so that they

could start of their hectic and exciting first master year with at least knowing their fellow students. The responses we got were amazing, the students really appreciated the opportunity to get to know one and another in real life rather than behind their computer screens. It was a huge success in our eyes, but one with a sad note behind it, because just like that our year as board was over. The last dead we did was picking the new board. We have a lot of faith that they will keep going, even if these tough times get even tougher and wish them all the luck in the world. That was all from us, thanks for the amazing year –

On behalf of the board,

Evan Tets, Secretary •

Did you know:

The longest distance lift in the world is the one in the Anglogold Ashanti's mponeng gold mine in south africa: 2,283m in a single descent, 4.5x more than the greatest distances of the Burj Khalifa (tallest building in the world) lifts

By: Vasso Reppa

Towards Autonomous Control of Transport Systems

Transport domain envisages the development of autonomous systems in a cyber-physical framework for ships and shipping operations, container terminals, underwater vehicles, air and road vehicles, trains and many more. Autonomy is not a binary situation, either autonomous or non-autonomous. Autonomy is characterized by several levels [1], the number of them varies depending on: (i) the extent of deployment of cyber systems, (ii) the number of human operators, and (iii) the role of both of them in decision-making and control. In a cyber-physical framework, the physical part includes any physical or engineering system, e.g. cranes, vessels, AGVs, container terminals. On the other hand, the cyber part involves modern information and communication technologies (ICT), and sensor technology to implement software agents that execute sophisticated algorithms of automatic control, artificial intelligence and machine learning.

Increasing the levels of autonomy implies that the number of humans needed for the system operation becomes limited, or their role becomes supervisory. However, up to the level where a system will be fully autonomous without human intervention (if we ever reach this level), it is essential that cyber-physical systems and humans interact very well and cooperate fully to guarantee safety. This was the main motivation for recently establishing a new discipline, the **Cyber-Physical and Human systems (CPHSs)** [2]. In these systems, humans can be considered as: (i) supervisors of transport systems (e.g. operators in ships and oil platforms, road tracks, bridge and locks) operators, (ii) control agents in multi-agent systems for e.g. road/waterborne traffic management, port operations and many more, and (iii) part of controlled systems (i.e. human-in-the-loop), like passengers in vehicles.

The primary question that drives my research and teaching activities in the field of multi-machine engineering (MME) is “how to design autonomous control systems in transport?”. According to [3], *autonomous control systems are designed to* ***perform well under significant uncertainties in the system and environment*** *for extended periods of time, and they must be able to* ***compensate for significant system failures without external intervention.*** So, to answer the main research question, two fundamental questions should be addressed.

1. How to handle uncertainty in autonomous control of transport systems?

Handling uncertainty is a crucial issue that can be tackled effectively by first identifying the sources of uncertainty. To limit modelling errors due to large scale and complexity of systems (how to model a container terminal with numerous quay/yard cranes, AGVs, ships, multi-trailers, shuttle carriers etc?!), several researchers in the TEL Section, including me, apply **non-centralized** cyber-physical design. In such design, transport systems are conceptually decomposed in several **interconnected** subsystems, each of them controlled by an agent. The problem then is how to coordinate the interconnected, controlled

RESEARCHLAB AUTONOMOUS SHIPPING

subsystems. A drastic remedy to this problem is designing a multi-agent, multi-level architecture. In the **ResearchLab Autonomous Ships (RAS)**, we have been working on several shipping applications developed using this architecture to coordinate multiple vessels including but not limited multiple tugboats to manipulate a big ship using towlines [4], or multiple Roboats in Amsterdam canals for waste transport [6]. In such applications, the system interconnections that can be physical (e.g. towlines) or cyber (e.g. exchange of information) are the key for coordination. Much more transport systems are studied in the Master course that I teach, **"Multi-Machine Coordination for Logistics"**, investigating how we can make them more intelligent.

Coordination is also prominent for inland waterway transport (IWT). In contrast to open-sea transport, IWT highly depends on the variability of the water depth, as well as the operation of infrastructures (e.g. bridges, locks). How to control the **voyage of inland vessels**? How to control the **vessel traffic in inland waterways**? How to **coordinate them both in space and time**? Vessels should cooperate with bridges and locks in order to reduce waiting times. This exciting challenge we face in the **European project NOVIMOVE**!

Realistically speaking, models cannot capture the actual system behavior accurately due to intrinsic unknown, nonlinear dynamics, as well as unknown effects of external disturbances such as wind, or waves and current in waterborne environments. To deal with this type of uncertainty, I believe that machine learning is a must, and in combination with classical control and estimation methods can be a great asset! I have been working on this method integration the last 10 years, and recently with colleagues in Cognitive Robotics (CoR) Department we obtained promising results on **reinforcement learning** to control autonomous vessels [8]. A different type of uncertainty that complicates autonomous control, and constitutes a difficult hurdle for CPHSs is unknown human behavior. In the **project SCoop** that starts in December 2020, together with the CoR Department we will investigate the design of **cooperative control** algorithms for autonomous vehicles to safely navigate in **mixed traffic**, namely in the presence of human-operated vehicles. The results of this project are expected to significantly contribute to the **safety of autonomous vehicles navigation** in the light of human interaction [9].

2. How to compensate for the effects of multiple faults in autonomous control?

Among the main tasks of human operators is to monitor the healthy condition and operation of systems to perform maintenance. So, when software agents are used to replace or support human operators for the sake of sustainability, cost and system efficiency, autonomous monitoring is essential to guarantee that **unexpected events** are identified and properly handled, and safety-critical tasks continue to be performed as in heavy lift operations for constructing offshore structures [10]. Such unexpected events can be the occurrence of faults affecting system components, actuators, sensors and communication means. Developing CPSs comes at the cost of increasing the number of cyber components. This implies that more components may fail over time during the continuous operation of CPSs. The **faulty operation of sensors** is considered highly critical due to their widespread use for: (i) implementing advanced feedback control loops, (ii) performing situation awareness and state estimation in unknown, harsh environments, (iii) coordinating large-scale distributed systems, (iv) real-time logistics planning in e.g. vehicle missions, (v) condition-based maintenance and (vi) executing safety-critical tasks by operators such as pilots, captains, etc. Can you imagine the consequences of sensor faults?! System instability, loss of information fidelity, disorientation of remedial actions, loss of human lives just to mention a few [10].

Since 2011 I have been working on developing methods for diagnosing sensor faults in complex, large scale systems, and I am teaching in the course **"Operations and Maintenance"**. The great challenge is how to isolate multiple faulty sensors from thousands of sensors used in a large-scale system required to collect Big Data. What is the best way to design such methods? Distributed, decentralized, centralized?! These questions are addressed in my book **"Sensor Fault Diagnosis"** [12]. Multiple sensor fault diagnosis is the key for ensuring the coordination of several systems that share information to cooperate in achieving a global objective. This will be one of the research pillars of the **project SCoop**, to ensure the reliability of sensor information shared between autonomous vehicles. The utmost goal of SCoop is to design a cooperative control scheme for vehicles to handle multiple sensor fault effects autonomously. Diagnosing multiple sensor faults is part of a bigger problem, **diagnosing faults of different type**. This problem can be expressed with questions like "When a sensor in your car raises an alarm, is something wrong with the car (e.g. the engine), or is the sensor faulty?". Distinguishing sensor from system failures in a ship and taking the appropriate remedial actions depending on the type of the fault are among the main problems that will be studied in the context of **project READINESS** [13].

It is an exciting time for me to be a researcher of TU Delft and to work together with a great team in TEL section including Prof. Rudy Negenborn, Dr. Yusong Pang, Ir. Vittorio Garofano, Dr. Pablo Segovia and the PhD students Zhe Du, Nikos Kougiatsos and Anastasios Tsolakis! This team is closely collaborating with TU Delft colleagues in the Ship, Design, Operation, and Production Section and the Cognitive Robotics Department, as well as industrial partners and stakeholders like TNO, CoVadem, Systems Navigator, Royal IHC, Van Oord, Royal Wagenborg, Conoship, and Port of Rotterdam. Among the important collaborators in the aforementioned projects is SINTEF in Norway. Would you like to be involved in this research? Do not hesitate to contact me via v.reppa@tudelft.nl. I would be happy to further discuss these research topics!

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Vasso Reppa is an Assistant Professor in the Maritime and Transport Technology Department at TU Delft. She has obtained her Doctorate (2010) in Electrical and Computer Engineering from the University of Patras (Greece). In 2009 she joined IBM Zurich Research Laboratory (Switzerland) as a student intern. From 2011 to 2017, she was a research associate (now research affiliate) with the KIOS Research and Innovation Center of Excellence (Cyprus). In November 2013, Dr. Reppa was awarded the Marie Curie Intra European Fellowship and worked as a research fellow with CentraleSupélec, University of Paris-Saclay (France) from 2014 to 2016. She has been a visiting researcher at Imperial College (UK) and University of Newcastle (Australia).

FROM AN OLD STAFF MEMBER

By: Em. Prof. ir. Joan Rijsenbrij

Innovation? Sure…..but quite an effort!

Nowadays innovation is a globalized buzzword, frequently mentioned as the key-solution for all kinds of economic threats and challenges. But there is nothing new under the sun because innovation is as old as mankind. However, the rate of innovations accelerated tremendously during the last two centuries: first in machinery, manufacturing, household tools then in electronics, medical appliances, telecommunications and recently information systems, artificial intelligence, and biochemistry.

The still growing world population, globalization and social media remain the drivers for a growing consumption, more wealth and a better quality of life, and that all will encourage new developments.

In this dynamic world with many threats and opportunities, companies must survive and are pushed to grow (shareholders value). Cost leadership is a popular objective, which helps many companies to strengthen their market position. But sustainable quality products, reliable systems and customer-oriented services are increasingly appreciated (value for money). Companies are pressed with market development, launching new products, cost reductions, energy transition, sustainable production, and all this with one magic tool: Innovation!

Companies cannot wait for an all-embracing "Eureka"-moment and so, for many companies/industries incremental innovation (step by step renewal) is the common approach: small improvements, additional functionalities, more cost-effective production methods, etc.

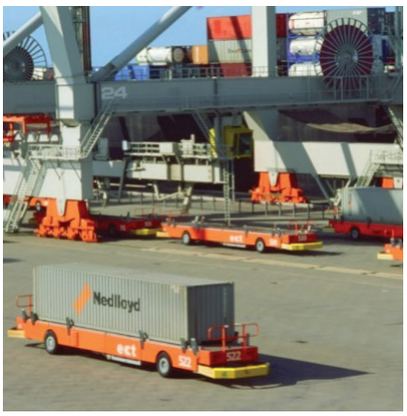
Now and then disruptive innovations are realized as a result of applied new technologies or fusion with other businesses. Such innovations will open new markets and sometimes cause a disappearance of existing players in the market.

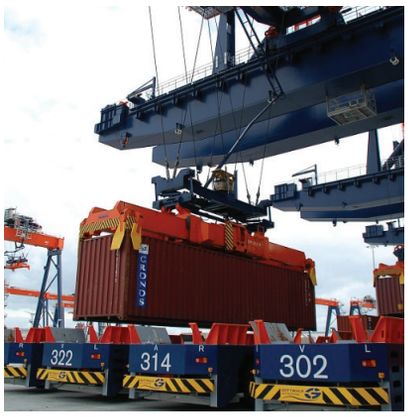
Even more seldom are breakthrough innovations which may cause dramatic alterations in the marketplace. History learned that only a few real entrepreneurial innovators could trigger such breakthroughs in our society (steam engines, telephone, internet, smartphone).

In my 50 years of activities in the field of materials handling, I have been involved in all three of the above mentioned innovation types.

The introduction of the container (first incidentally by some railroad companies and later in the shipping business by Malcolm McLean's Sea-Land) caused a real breakthrough in both maritime and land-based transportation. Many established shipping lines disappeared, and the stevedoring business was completely re-designed with a tremendous reduction in manpower and the introduction of all kinds of new equipment and operating methods.

Various disruptive innovations came along in the container handling industry. The reach-stacker overruled the top lifter (a forklift truck development); the straddle carrier market was for the greater part overtaken by the rubber-mounted stacking crane





and many checking, planning and control jobs were exchanged for information control systems, automated identification and data communication systems.

From the start of containerization a continuous flow of incremental innovations has been seen both in equipment development, planning and control, data communication systems and labor organizations. And this process of improvements and integration of new technologies from adjacent industries continues.

In the first decades of containerization there were both push- and pull-types of innovation: equipment suppliers pushed all kinds of new handling equipment, often exotic, unreliable, and not designed for a 24/7 operation. Pull-types of innovation came from shipping lines and terminal operators who were asking for simple solutions, proven designs, reliable, and suited for their extending operations. Entrepreneurial innovators (Sea-Land, OCL, ECT, HIT) realized successful innovations through partnerships between their operating companies (shipping lines, terminals) and equipment/system suppliers.

The introduction of Automated Guided Vehicles (AGVs) at ECT is a good illustration.

In the 1980s ECT recognized two threats: how to improve the handling performance (demanded by shipping lines to serve their ever growing vessels) and how to maintain a competitive position in North-West Europe. A business analysis (growing volumes, increased buying power from shipping consortia) learned that automation of waterside transport and stacking operations could be attractive. Research showed three feasible concepts for automated horizontal transport: self-driven railcars, an overhead conveyor system and rubber tired AGVs. The latter was the most promising one (technology support from the automotive industry, low infrastructural investment, flexible, expandable) however, for an outdoor application and forty tons payload there were no suppliers. So, ECT decided to develop the AGV themselves, after a thorough investigation of suitable technologies and detailed purchase design specifications.

ECT took the risk of failure, the selected supplier Gottwald accepted a fixed price and after two prototypes and a pilot plant the production series was installed early 1990s. Today the AGV is a proven technology, adopted (copied) by various other suppliers, with more than 1000 AGVs world-wide in operation.

Innovation requires a structured R&D, a team of creative people with some freedom in their approach and sufficient backing (stimulation) from top management. Risk management is helpful (specified functionality, cost control, appreciation in the market, etc.) however some tolerance for failure must be included. Innovations always mobilize virulent antibodies therefore it is important to carefully manage acceptance in the company or (new) market.

The well-selected technologies and tough project management were only part of the success of the innovative AGV. Also, the timing and urgency to realize the first automated terminal (after many years of drawing board concepts and some trials by other terminals) supported the introduction.

Timing is a major topic for a successful launch

of innovations, as I experienced in a promising innovation for city logistics: The City-Box. After some prototypes of the City-Box, detailed designs of city-trucks and logistic centers and a feasibility analysis, many stakeholders expressed their interest and support. However, when it came to a pilot project, former enthusiastic stakeholders withdrew. City authorities were reluctant to realize special permits (e.g. for the use of tramway tracks) and transportation companies doubted the benefits of cooperation. Moreover the required (costly) driving license for a small truck (> 3.5 tons) was a cost increasing element, not acceptable for the city parcel services.

And so, the innovation for more sustainable city logistics failed due to a low sense of urgency by those involved and insufficient acceptance and support from the transportation market.

In the coming decade(s), when city traffic circulation has worsened further and the quality of life must improve, then an innovation of this nature may get a second chance.

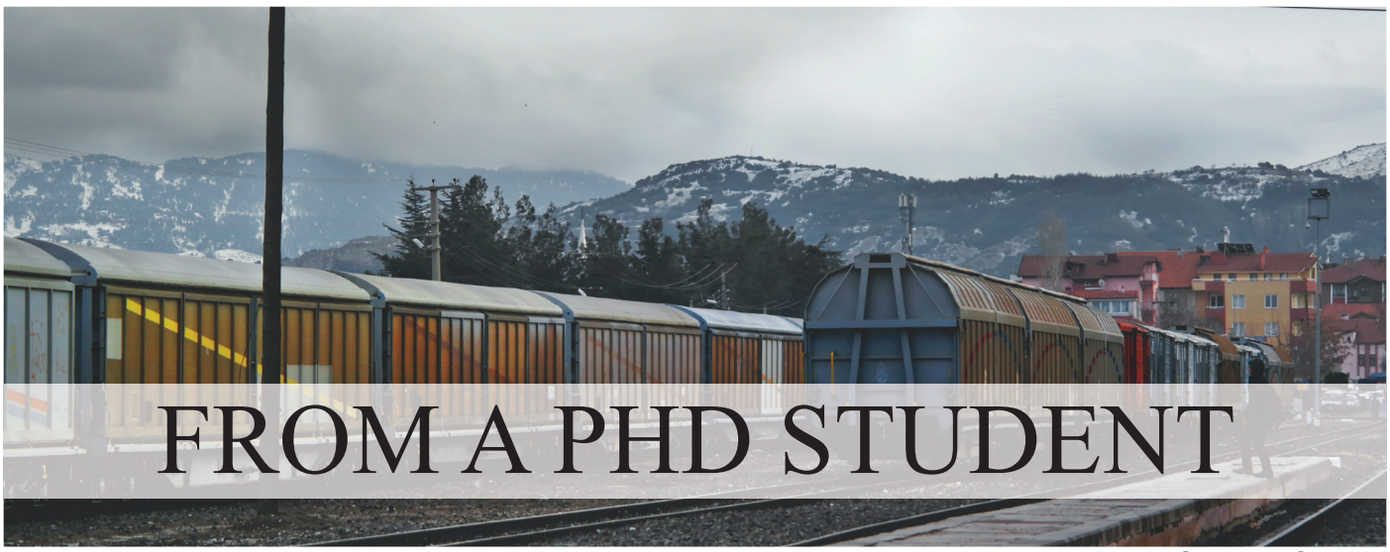
Unfortunately there is no “Handbook for Successful Innovations”, but innovations can be encouraged, managed and implemented when directing attention to the following:

- define the objectives/functionalities for the innovation target
- keep track of technology developments
- support and allow some freedom for creative teams and accept incidental failures
- take a systematic approach with regular evaluations (from outside experts)
- investigate acceptance and involve future users;
- analyze how to create value for the customer, are consumers ready to accept it

I have enjoyed my 50 years of engineering and managing innovations in the materials handling business; the message is: “Inspiration through Transpiration”. •

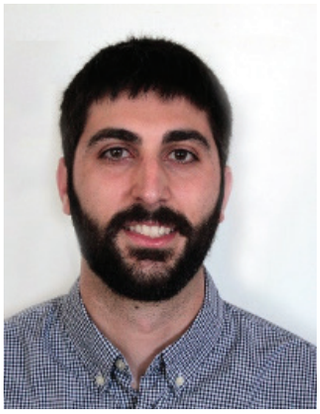
Did you know:

The longest 9 oil or gas pipelines together are longer than the circumference of the earth



FROM A PHD STUDENT

By: Pablo Segovia Castillo



My name is Pablo Segovia Castillo and I was born in Barcelona, Spain. I received my Industrial Engineering degree (equivalent to BSc+MSc) from Universitat Politècnica de Catalunya (Barcelona, Spain) in 2015.

An interesting feature of its academic curriculum is that it covered a vast number of different areas, e.g., automatic control, electronics, materials and thermodynamics, during the first years. This allowed me to find out that automatic control was the topic I fancied the most, and which I chose for my specialization. Moreover, I did my MSc thesis within the Automatic Control department in collaboration with Ingenia Motion Control, a Barcelona-based company, on modeling and control of a voice-coil motor for industrial applications. This first research experience made me realize that I wanted to pursue a career in academia, as I enjoyed investigating existing approaches and adapting them to the particularities of the problem that I wanted to solve.

A few months after my graduation, I was offered a PhD position in a co-tutoring agreement between UPC and IMT Lille Douai (Lille, France). The main goal of the PhD was to develop optimal water level regulation approaches for inland waterways, aiming at ensuring the navigability of the network. To this end, I first worked on modeling to obtain a simplified network model that was suitable for control purposes. Then, I looked into predictive control and state estimation strategies to fulfill the operational goals of the system using both centralized and distributed approaches. Finally, I tackled the topic of fault diagnosis, as the presence of sensor and actuator faults can lead to an inefficient system management.

Some months before my PhD defense, which took place in June 2019, I was offered the possibility to take part in an upcoming French regional project as a postdoctoral researcher, also at IMT Lille Douai. The project aimed at using the water volumes that are released with every lock operation to feed turbines that would generate hydroelectricity, and at the same time regulate the water levels using ON/OFF pumps. Aside from using the knowledge I had gained during my PhD, I also investigated hierarchical and multi-layer approaches, which allow to decompose the original task into a sequence of simpler and structured subtasks.

Since September 2020, I am with the Maritime & Transport Technology Department at TU Delft. I work as a postdoctoral research in the context of the NOVIMOVE project, which is an H2020 program funded by the EU. The main goal consists in addressing the current inefficiencies in the IWT logistics system, namely the time lost due to sub-optimal navigation on rivers and waiting times at bridges and locks, and the low load factors of containers and vessels, which result in an unnecessarily high number of containers and trips. In particular, I am involved in work package 3 (WP3), which deals with the operational aspects and systems for river navigation. The main goal of

WP3 is to develop and validate a coordinated scheme for a smart navigation system, which will be installed on vessels, and a dynamic bridge and lock scheduling system, which will make use of real-time traffic flow information. The coordination of these two innovative systems aims to optimize the voyage plan of the vessels with respect to fuel consumption and voyage duration, and to minimize the waiting times of vessels at bridges and locks.

All in all, I am very excited to join the M&TT department, where top-notch research is carried out and where I believe I will be able to grow both personally and professionally. Furthermore, I would like to take this opportunity to encourage students who would like to do an assignment, e.g., literature assignment, research assignment, graduation project, in a topic related to NOVIMOVE's WP3 to contact me (P.SegoviaCastillo@tudelft.nl) or Dr. Vasso Reppa (V.Reppa@tudelft.nl). Possible topics include, but are not limited to, modeling and control of traffic flow networks, inland waterways guidance, navigation and control, coordination of transport systems, human-in-the-loop control of inland waterways and optimal system partitioning for coordinated transport. •

Did you know:

The world's large ships can hold 745 million bananas in nearly 22,000 containers. Converted that's 1 banana for every European and American.

MME NETWERKBORREL

A couple of weeks ago study association Transportkunde Pandora hosted its annual introduction days. Normally this is a two day event where multiple companies are visited and an overnight stay in Rotterdam is accompanied by a couple of drinks.

Sadly due to the COVID-19 situation this was not possible. But we still wanted to provide the first years students with the opportunity to meet each other in real life. To do this we booked a whole beach club so the corona measures could be enforced.

At the beach club we had a dinner and two pubquizes. The first one was given by Nemag. For most of the first year students this was the first acquaintance with a real Multi-Machine Engineering company. The second quiz was hosted by our very own Wouter van den Bos and really got people excited.

At the end a lot of the first year students were happy to have met each other physically rather than online, and said they were delighted to start their year of the way they did.

MME Netwerkborrel

BURCHARDKAI
RCHARDKAI
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MOL

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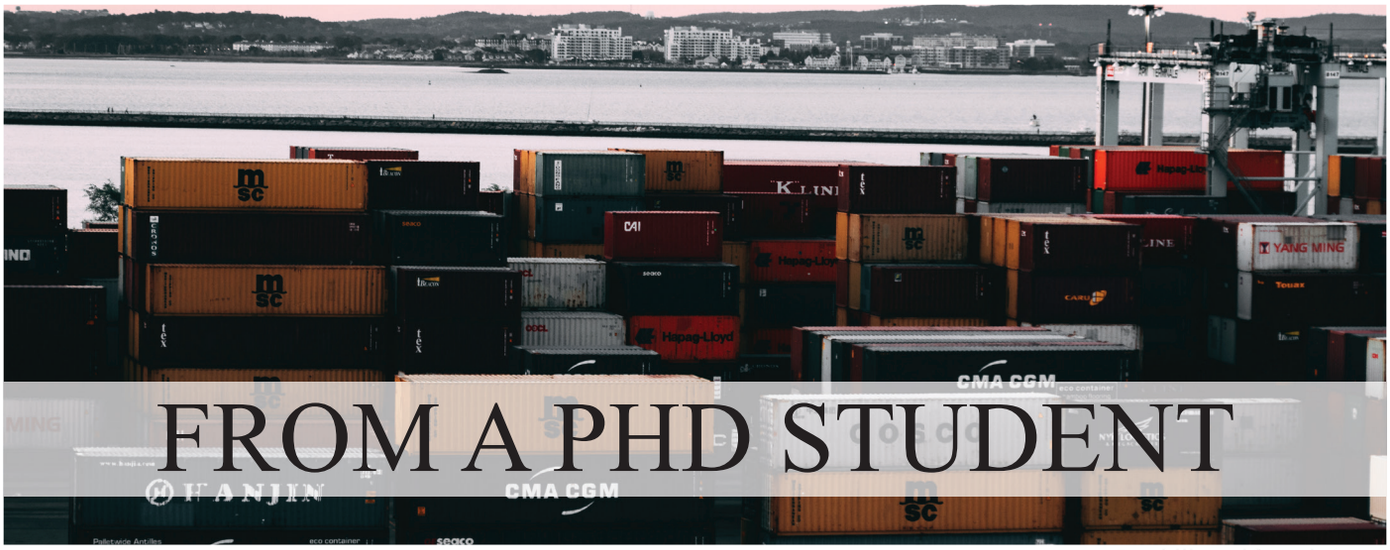
A S C



FROM A PHD STUDENT

By: Nikos Kougiatsos

I am Nikos Kougiatsos and I am a new PhD Candidate at the TEL section of the MTT department. Originally from Greece, I majored in the field of Naval Architecture and Marine Engineering by following the integrated Bachelor and Master's Degree program of the same name offered by the National Technical University of Athens.

What drove me throughout my studies was my keen interest on modelling a ship's behavior starting from first principles, studying how well the derived model fairs with respect to the real vessel and designing the needed automations. During my Master's degree, I have carried out projects on both design and automation, the later by working alongside the staff from the Laboratory of Marine Engineering. My diploma thesis was titled "Dynamic Positioning of an EERV Vessel using Neural Networks". This work was part of a European funded project called **"Lean Innovative Connected Vessels (LINCOLN)"** [3]. The main goal was to automate an Emergency Response Vessel using a novel thruster system, comprised of a central pump, six nozzles fitted on the ship's hull and three valves (see Figure below), in order to keep its locked position in the presence of sea disturbances. To accomplish this task, a Reinforcement Learning Approach was followed, using a Deep-Q Network (DQN) Architecture [2].

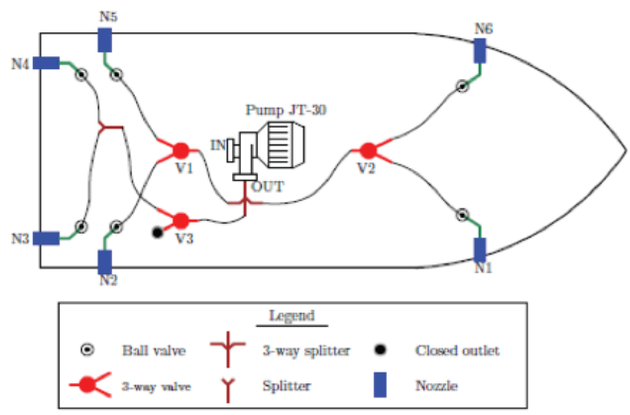


Figure: "LINCOLN" EERV Vessel Thruster System Layout [2]

I started my PhD in October 2020, working towards the project **"Robust, effective and adaptable ship designs for uncertain transition paths (READINESS)"** funded by NWO. With ships designed to operate at least for 30 years, it is inevitable that the onboard systems will eventually need to be replaced either due to errors or because they have become obsolete and new equipment will have to be installed. The concept of Maritime 4.0 [1] and the strict regulations imposed by the IMO for the required energy efficiency and emissions control for sea vessels demand that ships be designed keeping both robustness and adaptability in mind. In other words, new marine vessel designs need to take into account uncertain future modifications in order to stay competitive. However, no one can guarantee that the new or replaced subsystems will be compatible and work seamlessly as part of the greater integrated ship automation system. In particular, my work actually focuses on the aforementioned automation transition path that the ships will undergo in the years to come.

Although vast and demanding, the problem can be analyzed onto four distinct subproblems:

Scalability:

In case that a new subsystem should be added, it must tie in well with the other installed on-board equipment. Unfortunately, most vessels operating today use unscalable control architectures, meaning that adding new components would require resetting the whole automation scheme. This, however, could be avoided if we were to employ scalable model-based control architectures like a hierarchical distributed control scheme [5].

Modularity:

In case we want to replace an existing subsystem in the future, how could we be sure that the new piece of equipment would behave just like the older one? In this regard, we will be investigating non-centralized control architectures with plug-and-play capabilities. Moreover, the needs of Maritime 4.0 require the modular integration of IoT Sensor devices and other wirelessly connected embedded systems in the future autonomous and semi-autonomous vessels. However, each different sensor has its own characteristics and faults that need to be considered in order to get the correct measurement information displayed in the respective monitoring unit. This problem can be tackled using a concept called Semantic Mediation [4] that sums up in creating a knowledge database where all the sensor information is stored. This database can be later used to resolve all measurement-related issues before displaying the values to the end-user.

Fault tolerance:

But what would happen in case a sensor begins malfunctioning during operation? How can we possibly tell if there is indeed a sensor attributed fault or our system displays abnormal behavior? Also, how will a sensor fault be handled onboard the vessel? One quick answer to those questions would be redundancy. For example, if we had two sensors measuring the capacity of the engine's cylinder oil tank and both report a below-minimum value, then probably we would trust the measurements. In contrast, if only one of the sensors reported a below-critical value, then the error would most probably be attributed to a faulty sensor. In both cases, we are uncertain about what actually happened and as a result in what action we should take. If we were to immediately stop the engine(s) in the first case and we were wrong in our assumption, then the ship would find itself in a rather difficult situation especially in the presence of bad weather. This was the case of the Viking Sky incident (2019). In addition, if we were to continue operation in the second case or if we were bold enough to do so in the first case, then the outcome could be far worse if the cylinders indeed were not well lubricated. Upscaling the number of sensors would give as better confidence but the complexity of the system would increase gravely. What we truly need and what I will be investigating is the employment of a cognitive decision-making logic that would consider the possible propagation of fault effects through both physical and cyber interconnections [6]. To further enhance the approach, multisensory schemes will be employed to improve redundancy, but in a moderate manner.

Verifiability:

As with every well documented research and especially the ones that are Industry-related such as this one, the verification of all designed algorithms, control architectures and systems' stability and robustness is of the utmost importance. To this end, extensive simulations and/or case studies will be carried out.

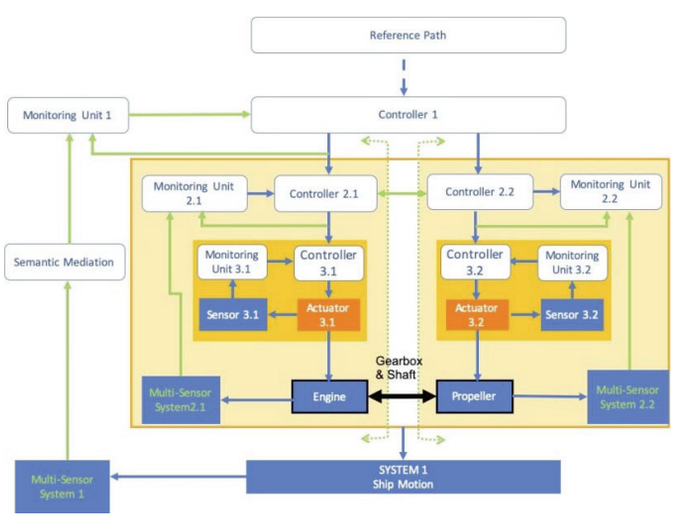


Figure: Hierarchical distributed fault-tolerant control [example for propulsion]

Sea vessels must be ready to cope with tomorrow's challenges and I am glad that I can work towards such an exciting project. I really look forward to collaborating with my colleagues at the TU Delft university and working together with prospective

students. If a student finds any of the above subproblems interesting and would like to work with me, then keep an eye for future Master assignments published by my supervisor Dr. Vasso Reppa. I will also try to post the links on my TU Delft personal page. •

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[2] Kougiatsos N. (2020). Dynamic Positioning of an EERV Vessel using Neural Networks, School of Naval Architecture and Marine Engineering, National Technical University of Athens, URL: https://dspace.lib.ntua.gr/xmlui/handle/123456789/51370

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[5] Panagi, P., & Polycarpou, M. M. (2013). A coordinated communication scheme for distributed fault tolerant control. IEEE Transactions on Industrial Informatics, 9(1), 386-393.

[6] Reppa, V., Polycarpou, M. M., & Panayiotou, C. G. (2015). Distributed sensor fault diagnosis for a network of interconnected cyberphysical systems. IEEE Transactions on Control of Network Systems, 2(1), 11-23.

Did you know:

The earliest known public bus service was introduced by the French mathematician and philosopher Blaise Pascal in 1662.

Did you know:

The annual beer consumption in the Netherlands is equivalent to 2 times the capacity of the largest oil tanker that ever sailed.

Did you know:

If you stacked all trucks currently in the United States end-to-end they would reach the moon.

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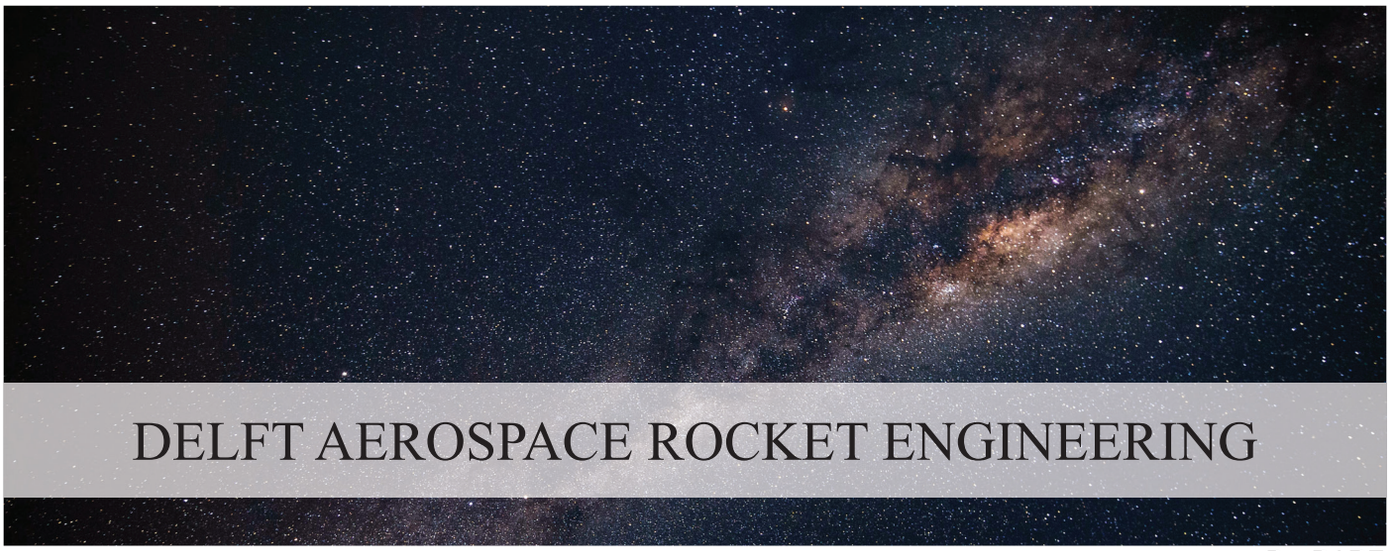


DELFT AEROSPACE ROCKET ENGINEERING

By: DARE

Delft Aerospace Rocket Engineering, also known as DARE, is an amateur student rocketry team in Delft. Foremostly a society, with an active member count just short of 200, the interest of rocketry spans far and wide between her members, which DARE accommodates with its numerous projects. These projects range in scale, with some having only a handful of people and aiming to lay the groundwork R&D, others developing specific subsystems, or aiming to combat natural disasters, all the way up to its two flagship projects with 50+ enthusiastic engineers.

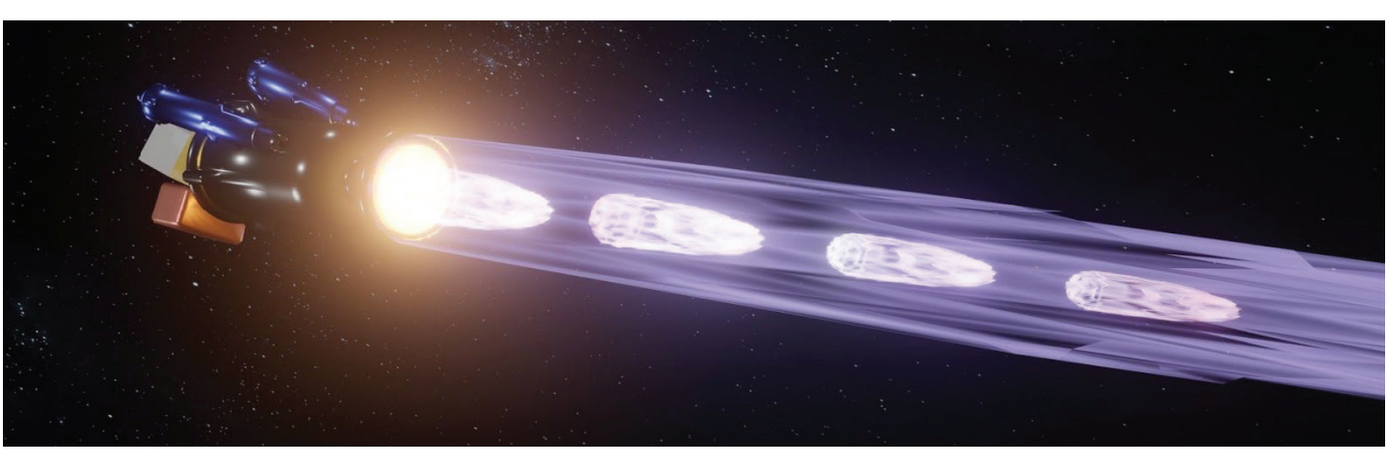
Project Stratos

Starting with Stratos I in 2009, Project Stratos is DARE's longest-running flagship project, always aiming further, higher and better. With Project Stratos, DARE has broken the European Student Altitude record twice, and made leaps in both technological capability and our capability to work with many members on many parts, resulting in one great rocket.

Now the team is in the stages of finishing, and launching, the latest record-breaking rocket, Stratos IV. This project started after the mid-flight anomaly of Stratos III, and aims to beat the current European altitude record of 41km, and to even exceed 100km, known as the Karmen line and the official boundary of Space.

With Stratos IV DARE will take a shot at the stars, to become the first student team in space, showing that space is closer, and more reachable, than you might think.

The biggest difference between its previous generation is the newly introduced roll control system. The in-flight anomaly of Stratos III was caused due to the complex phenomena of roll-pitch coupling, where a constructive interference of Stratos III's roll and pitch natural frequency caused the rocket to break up at T+22 on 26th July 2018. Beyond this all systems have been revised, improved and made lighter. Stratos IV is planned to be launched in late Summer 2021.



Project Sparrow

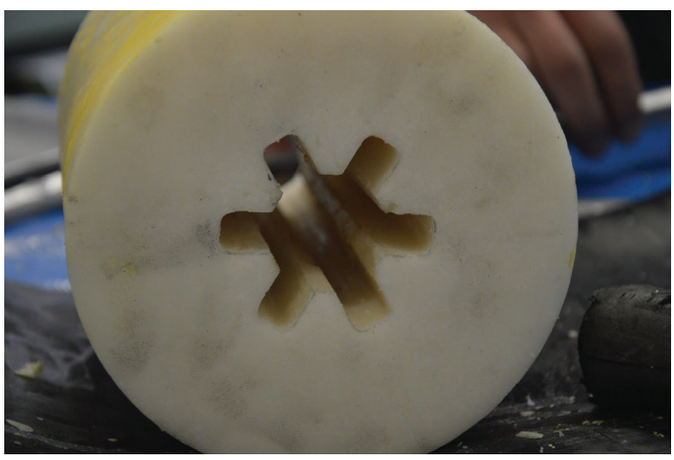
Project Sparrow is a new project within DARE that was founded in May of 2020. The goal of the project is to design, build and test a liquid rocket engine which will be thrust vector controllable. This is being done as part of our greater vision of democratizing space. We show that not only governments and large companies but also students can innovate in cutting edge aerospace technologies. With this project in particular, the team aims to elevate DARE's technology readiness level for both liquid rocket engines and thrust vector controllability. Our long term vision is to eventually be able to design and build an orbital capable rocket engine.

The team working on Project Sparrow is a multidisciplinary team consisting of both full time and part time students. Many have international backgrounds and even come from different universities. All brought together by their common passion for rocketry, they aim to lay the foundations for future DARE flagship projects to build upon.

Solid Propulsion Team

The solid propulsion team is one of the oldest teams in DARE. It was founded in 2009 and has provided all the engines for the smaller scale rockets used by the society. Currently the solid propulsion team is developing the largest student built solid rocket engine in Europe, the DXS-Icarus. This engine will power the Aether rocket; a modular supersonic test platform developed in collaboration between different DARE teams. The Icarus comprises 40kg of potassium nitrate sorbitol, provides a peak thrust of at least 9kN and will burn for approximately 6 seconds. The fuel is split into 7 separate grains stacked on top of each other inside the engine.

These grains have a star shaped port hole in the centre. This shape creates a larger burning surface area at the start of burn; creating the high thrust that is required to clear the launch tower with sufficient speed. In the past years, the team has successfully completed a series of smaller tests. First using only one grain, then scaling up to three. This year the team will be conducting a series of full-scale motor tests using all seven grains. Initially in a so-called battleship configuration; an engine with a thick metal casing with a higher safety factor. Then finally the flight version, using a lightweight composite casing and flight optimised nozzle.



PRG

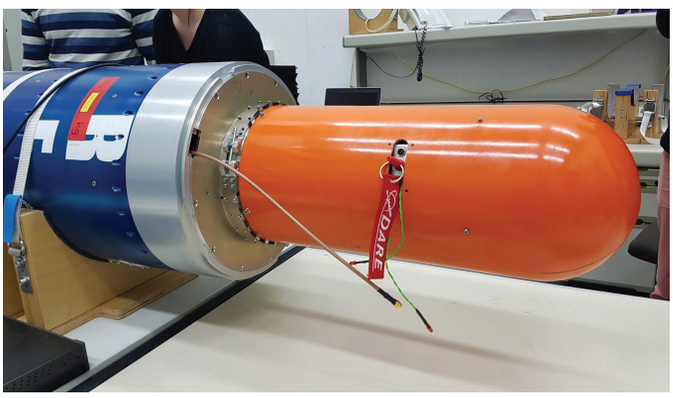
As one of the most versatile teams in DARE, the Parachute Research Group (PRG) does everything from sewing parachutes, sanding carbon fibre heat shields, manufacturing deployment devices and even creating simulation tools - all to recover the precious payload that we fly into the skies! After this hands-on production work, we test, test and test again.

In the past academic year PRG has not only conducted a series of low speed wind tunnel tests in the Open Jet Facility (OJF) of TU Delft but also various thermal and vibration tests to reiterate and improve our recovery systems.

Following testing, the progress is tracked and extensively documented as PRG literature, some of which are now published articles! Currently housing bigger mission projects such as SPEAR and Stratos IV, PRG is also working to test new concepts such as reefing and steerable parachute recovery systems and consistently exploring different ideas through research and development projects.

SPEAR 1

The Supersonic Parachute Experiment Aboard REXUS, or SPEAR, is a relatively young team. The SPEAR missions aim at testing parachute recovery systems in-flight to validate their performance. SPEAR 1 centers around a supersonic capable parachute; the Hemisflo ribbon drogue parachute. Over the last year the team has finalized the preparations for flight, including integrated testing with the REXUS28 rocket. It will be launched in February 2021 from Kiruna, Sweden. From this flight the team can confirm whether the drogue parachute is suited to fly on Stratos IV and/or other future DARE missions.



Education Group

Seeing the smiles on faces of kids who learned more about your passion is incredible. In the Education Group, DARE works to offer fun workshops to children and youth about rockets, but, fundamentally, this is also teaching that you can do anything by making. Using your hands and your ideas the future becomes yours to control. Bringing this idea in a fun way brought us to 'de Raketbouwers' where we let children and youth build paper rockets and shoot them off an air cannon. Integrated with a bit of theory about what rockets are as well as space, and what DARE and her members have done so far in their lives. The end result is one of many more workshops that have brought us closer with many partners in institutions and the industry. Make the future.

Project Bloom

Globally, natural disasters like floods and storms claim a huge number of lives and are responsible for large economic losses, especially in the global south. The severity of subsequent disasters can be decreased by introducing soil-fixing plants into areas at-risk for soil erosion and future disasters. In order for this measure to have the best possible effect the plant seeds need to be deposited as soon as possible after a disaster. A cheap, simple and biodegradable rocket dispersing seeds at high altitude might offer a solution where "conventional" methods fall short. The Bloom team is developing this rocket based on flight heritage hardware and expects to test

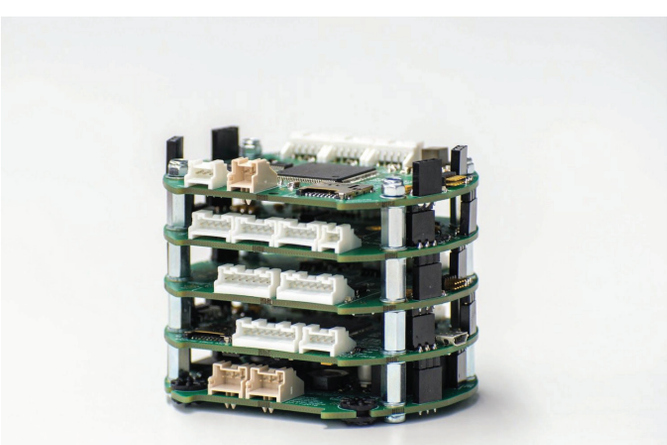
the first systems towards the end of this year. Long-term we think of Bloom as an approach to enable at-risk communities to safely combat future disasters themselves.

SRP

While with the Education Group children and youth learn about rockets, the Small Rocket Project (SRP) is the next step. SRP is a program where a group of around 20 students, all first-year bachelor students at the TU Delft, design, build and launch a small rocket containing a raw egg to an altitude of 1500m, with the goal of also successfully recovering the rocket with the egg still intact.

Electronics

Why do we have an Electronics team? Because without electronics, we would just be shooting fireworks. Every rocket in DARE has some form of electronics which we use for actuation (e.g. deploying parachutes), sensing, telemetry and sometimes even active control. For our biggest project, Stratos IV, we also integrated a flight termination system, GPS and a radar transponder used for measuring altitude. The flight computer consists of 7 custom designed, custom-built circuit boards that are stacked on top of each other. Next to the big projects we also make electronics for smaller rockets. One such development is our modular electronics stack. It is a flight computer meant to be usable for the average rocket, where additional needs like telemetry and attitude sensing can be met by simply adding the relevant modules to the stack. Currently the Electronics team is trying to finish the electronics of Stratos IV, and we are getting started with Project Sparrow.



Project Daedalus

As DARE has reached higher and higher with its big projects it has not forgotten its roots in building small rockets for learning and fun. Project Daedalus is a push to fly an experimental solid rocket motor developed by the solid propulsion team. To do this the team has had to rethink and scale down some vital technologies that are commonly used in space flight. The best example of this is the parachute reefing system that allows us to recover the rocket in one piece without causing excessive forces on the rocket. •

Interested in following (one of) the aforementioned projects?

Check out the DARE website at

www.dare.tudelft.nl and keep an eye out for interesting updates and footage in the following extensive social media links:

https://www.linkedin.com/company/daretudelft/

https://www.instagram.com/daretudelft/

https://www.facebook.com/daretudelft/

https://www.youtube.com/user/lrdare

https://www.twitter.com/daretudelft

DARE is also always contactable at board@dare.tudelft.nl.

JOINT INTERDISCIPLINARY PROJECT

By: Judith Claassen

The JIP program is a well used alternative for the research assignment of students in the second years of their master studies. Multi machine engineering is one of the present tracks in this program, but what is this program really about, and what do companies or student get out of it? Former participant and current student assistant of the project explains:

Joint Interdisciplinary Project: Real business cases, real experience

Curious about interdisciplinary team work? Ready to start having an impact in the real world? Eager to show leading companies what you are made of? Keep reading!

In the past, engineering has often been viewed as a mono discipline. Yet the truth is, even within a top-notch technical university like TU Delft, faculties such as Aerospace, Civil and Mechanical Engineering are each defined by their own work ethic as well as their separate building on campus, segregating the disciplines. Staying within the disciplines was so ingrained within the education system, especially within a master where you are expected to emerge yourself deeper into a speciality, a paradigm shift was required.

Aldert Kamp, former Director of Education for TU Delft Faculty of Aerospace Engineering, recognized that education is no longer complete when students have acquired a deep knowledge on abstract theories and concepts without knowing how to act on that knowledge in the outside world or take multiple perspectives into account. Educating the students on the latter required a program with intensive collaboration between the world of education and parties in the field, including companies, governmental organisations as well as the wider public (Aldert Kamp, 2020). Hence Aldert, with his knowledge and his status, was the perfect insider to drive this change at TU Delft.

Together with Hans Hellendoorn, Birgit de Bruin, a team of rebellious faculty members and companies, without going through the official procedure and having all the proper permission, a student project pilot was set up to bridge the gap between distant faculties. For the development of this project, funded by 4TU.CEE (Centre for Engineering Education), they obtained interested companies to host 13 students put into 4 interdisciplinary teams that worked on a challenging business case study. In Q1 academic year 2018-2019 the Joint Interdisciplinary Project (JIP) was born.

Albert Kamp

The Pilot was so successful that two years later, JIP is an official 15EC second year master course, counting 150 participating students, working with leading companies such as Van Oord, Airbus, and Arcadis.

Throughout JIP the full 10 weeks of Q1, interdisciplinary teams focus on a company case study on technical innovation 'in the niche' to create lasting innovative impact. As a JIP team member, students are required to think beyond their field of expertise, deepen their analytic and creative skills all the while sharing their own obtained disciplinary knowledge from the first year of the master.

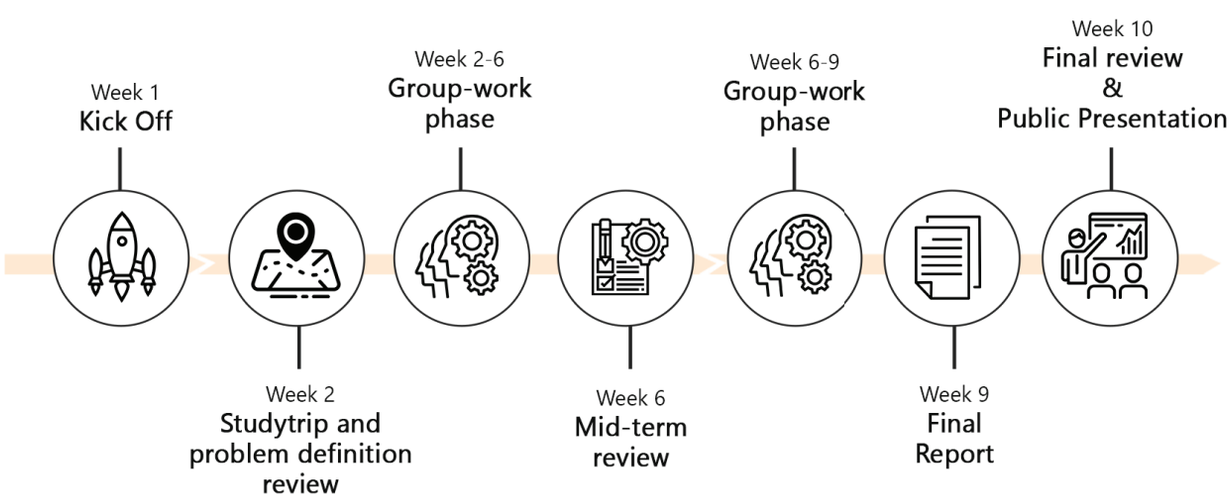
The program

In April the participating companies are announced during the company pitch event. Here, the company coach will present their business case study to the interested students. Students are then able to discover which case study piques their curiosity. Following the pitch event, application opens up where students are required to upload their top case study choices and a motivation letter. Based on the applications the JIP core team will construct interdisciplinary teams of 4 to 6 students.

In week 1 all students participate in the Kick-off. Here, they get to know their fellow team members and company coach through exciting workshops and games. Students will be immediately triggered to explore their inner creativity while building with Lego, or discover more about themselves as they obtain a deeper understanding of "engineering roles". Throughout the first week the tools will be handed to the teams to tackle the first challenge of JIP, the problem definition.

Week 2 is centred around defining the problem definition. The JIP company cases are set up relatively broadly, leaving a lot of freedom for the team to fully narrow down exactly what problem they are going to tackle based on the unique interdisciplinary nature of the team. teams will also watch other problem definition presentations from teams with similar topics in order to give/receive constructive feedback from/to fellow students. JIP encourages communication between teams to incorporate an additional social aspect to JIP, becoming one big JIP family.

Week 2-6 are filled with refining the problem statement, company visits, and making new connections. In this time, the teams will reach out to specialists in the field, from TU staff to experts across the globe, to obtain the best understanding of the topic. This is an opportunity for the students to develop network skills by discovering the best



methods to get in touch with professionals (tip: LinkedIn is your friend).

Week 6 is known as the midterm review week. Here the teams present their findings so far, alongside a 4-page summary to guide the audience. The audience, composed of the company coach, The JIP core team and invited members of the TU Delft staff provide constructive feedback to help guide the teams through the final weeks of JIP.

Week 7-9 is the final sprint to the end. Refining the findings and writing a report. An exciting period to finalize, make last changes and submit the result to the university as well as the company.

Week 10 the final week is the moment that teams defend their work in front of a committee, much like students are going to have to do for their thesis defence, making it a good preparation moment for the future. The committee will again be a combination of the company coach, the JIP core team and members of the TU Delft staff. Following the defence, the students showcase their work to a greater audience during the pitch event. This event serves as another opportunity to see what the fellow students have been up to, inspiring each other for future adventures. Together, celebrating the end of JIP and the bright future ahead during the (virtual) drinks.

What makes JIP special?

In 2019 I participated in JIP myself for the Royal HaskoningDHV project. Today I am a student assistant for the 2020 group, frequently speaking to the students on a weekly basis. Hence, I can say with confidence that JIP is more than just a course or a research project, it's an adventure. An experience where I have learned skills, which could have never been obtained in my other master courses. Firstly, I discovered more about myself through personal and team reflections, shaping what kind of team player I want to be in the future. Secondly, I further developed my communication skills though the numerous presentations as well as interactions with professionals who have different backgrounds. The realization moment that not everyone speaks your "language" can be frustrating at first as it can hinder communication within the team. But it is also an opportunity to better learn from various perspectives

Judith Claassen

and create common understanding with people. Throughout JIP I truly got a taste of both success and failure which made me resilient in the face of obstacles, a skill that until this day I still greatly benefit from. As the weeks went by, I felt myself become more confident to speak up, reach out to strangers and explore beyond my comfort zone. I learned to be bold, just like the founders of JIP.

Having worked in close contact with the core organizing team of JIP in the past two years I have first-hand experienced the energy, care and personal attention that they put into JIP. Continuously they aim to improve the program and ensure the most value for TU Delft, the companies and above all the students. The growing numbers of participating students and companies represents JIP's success. We invite you to become part of that success, as a participating student (or company). Stay up to date by following us on Instagram (jip_delft), facebook (JIPDELFT), or you can also check out our website for more information

https://www.jointinterdisciplinaryproject.nl/.

Let's innovate together! •

Reference:

Aldert, K. (2020). Navigating the landscape of higher engineering education: Coping with decades of accelerating change ahead. Retrieved from https://repository.tudelft.nl/islandora/object/uuid%3Adf7883b5-919d-4479-a105-15f3c0605e25

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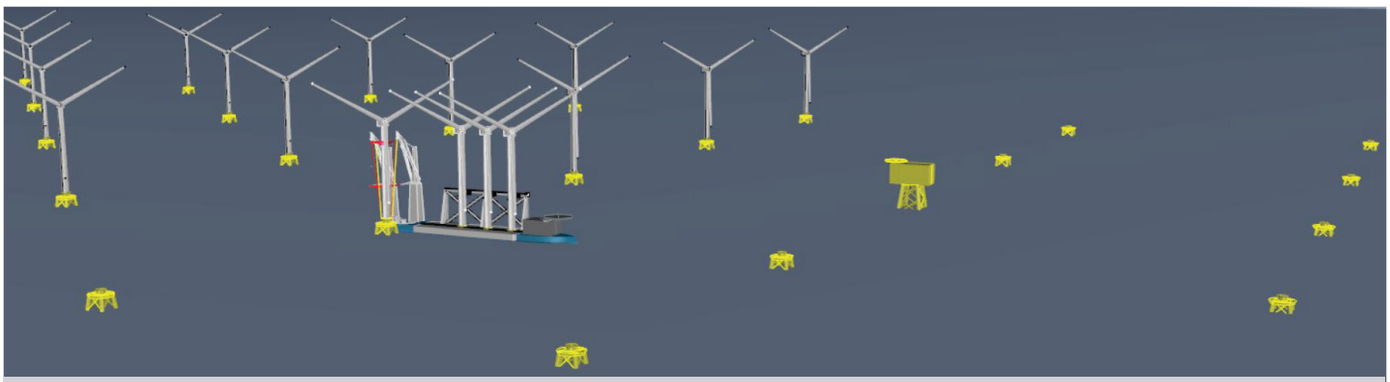


A GRADUATION PROJECT IN 2020

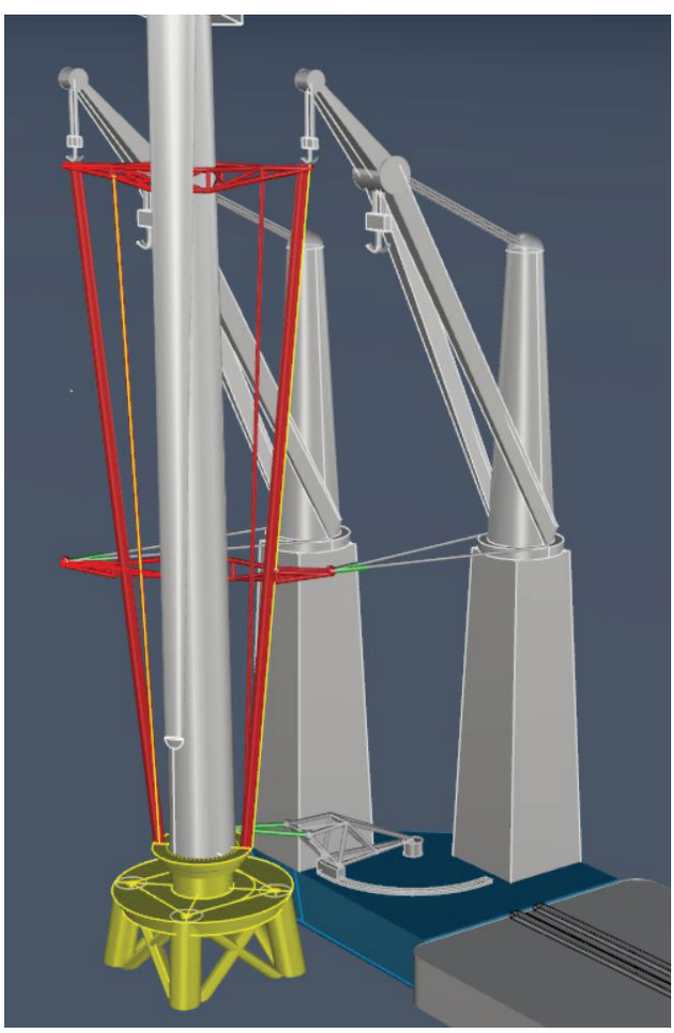
By: Ir. Gerben Hoogendoorn

The pandemic has influenced the way of studying in 2020 a lot. In this article, I will tell you my story about the finalization of my master and my work during the graduation project.

My name is Gerben Hoogendoorn and I'm 23 years old. I finished my bachelor in 2018 along with a Honours Programme Bachelor. During the bachelor, I have been working for Mammoet and I got introduced in the world of large cranes (capacity of over 1,000 metric tons). Furthermore, I have been working on the Delfia project in a group at the department TEL for my final bachelor project. Due to my interest in transportation and cranes, the (former) master Transport Engineering and Logistics was the perfect fit for the follow-up of the bachelor. Last year, I got in touch with Ir. E. Romeijn from Huisman Equipment for the research assignment (about cranes) via Dr. X. Jiang and Dr. H. Polinder. During my first meeting with Huisman both the research assignment and possible graduation project were discussed. At the 2nd of March, I started my graduation project within Offshore Wind Installation at Huisman due to my interest in cranes and transportation.

In the beginning, I started my project at the office. The start gave me a good impression of the company and the interesting work they perform. The colleagues were helpful and helped me on track. However, after two weeks working from home became the way of working due to the intelligent lockdown of the Dutch government. Luckily, I could do the work at home, since I still was working on the plan and literature part of my project. It helped to set-up a plan up to finalization of the project to guide myself through the process. I kept sticking to the plan and it worked out well. At home, I became creative and generated lots of ideas within my research question:

In which way is it possible to install pre-assembled large offshore wind turbines in a scalable, flexible way using a floating installation vessel equipped with one or multiple cranes?



In April and May, I worked on finding solutions for fully assembled wind turbine installation using cranes. At one moment, I came up with a new crane configuration which influences the flexibility of a crane vessel significantly. The different solutions were combined into one vessel. This PWT installation vessel (Parallelogram Wind Turbine installation vessel) was described in the report, but something was still missing. The idea behind the PWT installation vessel was not yet clear. Therefore, I decided to work on the explanation of the benefits of my idea by generating a complete 3D model. This 3D model helped explaining the advantages and disadvantages of the idea and the model gave me the opportunity to zoom into different components and address potential for further research. All the work could be done within the limitations of working at home. Sometimes it was hard to continue working since there was different contact at home than at the office. However, together we managed it well and the finalization of the project was planned end of summer 2020. First, I delivered the report to explain all the details of my project. After the report, I took my summer holidays to relax a bit before the finalization of the master. After the holidays, I worked on the final presentation which I gave both at Huisman and at university. I was content with the solution to perform my defense under Corona circumstances at university (with a limited amount of visitors). The result is a master degree in Mechanical Engineering cum laude.

In my graduation project, the following quote was central:

Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world. *– Albert Einstein*

The final result of the project was a tangible solution to install wind turbines in a more flexible way. The vessel could perform many other activities besides wind turbine installations such as foundation and offshore substation installation without a need for an additional fleet. During the project, it became clear that there is an interest in the proposed solutions of my project and the question arose 'what is next?'. Since I still have an interest in development of cranes and transportation, I decided to continue working on the solutions of the concept of my graduation project.

In November, I will start working at Huisman. Part of my work will be setting up a plan for a PhD trajectory related to my graduation topic. Due to the pandemic, I could develop this novel idea although the overall process was different. The first two weeks at the company were very important. The original plan could be followed throughout the project although some meetings or conversations were held differently. What I have learned is that if you have set up a good process and you follow it, it is possible to continue although a pandemic can influence your way of working. A good process consists of a balance between working and relaxing to maximize your overall performance. Important in these times is to not hesitate to ask questions, although digital conversations are different from the face-to-face contacts at the office (or university). •

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