IAC-24-E5,5,7,x81175

"RUMREJSEN" (THE SPACE JOURNEY) - A NATIONWIDE COMMUNICATION AND COLLABORATION PROJECT LINKED TO THE HUGINN MISSION OF THE DANISH ESA ASTRONAUT ANDREAS MOGENSEN

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Abstract

The Danish ESA Astronaut Andreas Mogensen began his six months Huginn mission to the International Space Station (ISS) in August 2023. Already back in 2020 the partnership Space Exploration Danmark had started working on two themes related to the Huginn mission in order to get more parties involved and establish a nationwide communication and collaboration project. One theme was about collecting ideas for Danish experiments that Andreas Mogensen could work on during his mission. The other theme was about creating a plan for STEM related activities before, during and after the Huginn mission. This led to the establishment of the project 'Rumrejsen' (The Space Journey) consisting of four signature projects, each with a certain focus: 1. Spacemission Live focusing on events, 2. Space in business - focusing on education, career and jobs, 3. The next generation space station - developing education materials, 4. On mission with Andreas Mogensen - developing an exhibition. More than 15 different partners participated in the project and we here present the results from the project, sharing experiences, ideas and lessons learned.

Keywords: Rumrejsen, Huginn-mission, Andreas Mogensen, Denmark, STEM, ISS, ESA Astronaut

Acronyms/Abbreviations

International Space Station (ISS), Science Technology Engineering Mathematics (STEM), European Space Agency (ESA), European Space Education Ressource Office (ESERO)

1. Introduction

The Danish ESA Astronaut Andreas Mogensen (see Fig. 1) flew on his second mission - the Huginn mission - from August 27th 2023 to March 11th 2024.
In Denmark the mission was followed with excitement and big interest by the whole nation and many different acitivities took place in relation to the Huginn mission.
The objective of this work is to give an overview of the different activities that took place in Denmark before, during and after the mission with a focus on the nationwide communication and collaboration project "Rumrejsen" (The Space Journey). The project involved partners from museums, science centers, voluntary organizations, universities and schools as well as industry and professional media institutions. The project period was from January 1st 2023 to June 30th 2024.

1.1 Structure of the Paper

Section 2 provides background knowledge about the project. Section 3 is about signature project 1: Spacemission Live. Section 4 is about signature project 2: Space in business. Section 5 is about signature project 3: The next generation space station - developing education materials. Section 6 is about signature project 4: On mission with Andreas Mogensen - developing an exhibition. In section 7 we dicuss the results of the projects and share ideas and lessons learned. Section 8 sums up the conclusions.

2. Background Knowledge

In 2020 Space Exploration Denmark [1] was established as a national partnership for Denmark's participation in manned and unmanned research of space. The partnership consists of partners from industry, universities, non-profit organizations and individuals and was coordinated by the Space Office in the Ministry of Higher Education and Science. The partnership started up work on several themes, and among these two of the themes were directly connected to the upcoming mission of the Danish ESA Astronaut. They are briefly described below.

2.1 The ten Danish Experiments

One theme focused on a building up a campaign to collect ideas for Danish experiments for the mission. Assuming that the mission would be long (6 months), it would be a good opportunity for including also Danish experiments. IDA Space [2], a technical network at The Danish Association of Engineers, established a series of webinars in order to inform about the call. A brutto list of ideas was created and from this list ten ideas were seleceted that would develop to concrete experiments (see Table 1). The ten Danish experiments were met with very big interest by the Danish media up to the mission and they also served as inspiration for activities in the Space Journey project.

Table 1. Danish Experiments in the Huginn mission [3]

Name	Description	Category
Thor-Davis	Photos of giant lightening	Earth and Space Science
Aquamembrane	Water cleaning in space	Technology Demonstration
Earthshine	Photos of the moon used in climate research	Earth and Space Science
Circadean Light	Varying lights	Technology Demonstration
VR for Mental Care	Mental health during missions	Human Research
Sleep in Orbit	Measurements of sleep	Human Research
SpaceWear	Measure medical parameters	Technology Demonstration
VR for Exercise	Increase motivation to exercise	Technology Demonstration
Metal 3D Print	3D metal print	Technology Demonstration
LEGO Spike Prime	Learn to program	Education

2.2 The four Signature Projects

The other theme that the Space Exploration partnership worked with had the purpose to create a STEM dissemination campaign in relation to the mission. A list of ideas to activities was collected by the partners in this theme and eventually after a number of meetings the project Rumrejsen/Space Journey took shape. The project was divided into four signature projects that each had a certain focus as seen below with the project owner shown also:

- Signature project 1: Spacemission Live focusing on events (Experimentarium) [4]
- Signature project 2: Space in business (Naturvidenskabernes Hus/House of Natural Sciences) [5]
- Signature project 3: The next generation space station – developing education materials (Astra) [6]
- Signature project 4: On mission with Andreas Mogensen - developing an exhibition. (Danish Technical Museum) [7]

2.3 Organization of the Project

The Space Journey project was established to enhance interest in STEM (Science, Technology, Engineering, and Mathematics) in Denmark in connection with the mission. The project secretariat was located at the Technical University of Denmark (DTU) [8], one of the partners in the project.

The secretariat coordinated efforts among several key institutions, including Danish educational and space research institutions, Astra, ESERO Denmark, the Confederation of Danish Industry (DI), the Ministry of Higher Education and Science, and several experience and learning centres. The secretariat also coordinated content for the digital homepage of the project, www.rumrejsen2023.dk [9].

2.4 Binding the Project together visually

A logo was created for the project (see Fig. 2) in order to bind the project together visually and the logo was shown on all activitites related to the Space Journey project.

The logo contains the mision patch of the Huginn mission. The mission name "The Huginn mission" was chosen out of a number of a suggestions made by the public. The name Huginn, originates in Norse mythology. Huginn and Muninn are two ravens who symbolise the human mind. Huginn represents thought and Muninn, memory. Norse mythology tells the tale of two ravens who flew into the world every morning and gathered information from the farthest corners of the world to bring back news to the god Odin.

2.5 The Vision of the Project

The vision of the Space Journey project was the following:

· *To use the 2nd space mission of the Danish ESA Astronaut Andreas Mogensen as a unique opportunity to reach children and young people and create greater awareness in society of the importance of research and technical science.*

· *To involve the whole of Denmark in the mission, strengthen interest in STEM among children and young people, and focus on the possibilities of space and the research behind it.*

How could we turn this vision into a plan? And how did we make that plan a reality? In the following sections we will dive further into that.

Fig. 1. The Danish ESA Astronaut Andreas Mogensen before for his second mission to the ISS. Credit: ESA

Mission Facts:
Expedition: 69/70
Spacecraft: SpaceX Crew Dragon, Endurance
Launch site: Kennedy Space Center, Florida, USA
Launched: 26 August 2023
Docked: 27 August 2023
Undocking: 11 March 2024
Landing: 12 March 2024

rumrejsen
– du kommer langt med viden om natur og teknologi

huginn

Fig. 2. The logo of the Rumrejsen/Space Journey project, which also shows the mission patch of the Huginn mission. The text says: - you will get far with knowledge about nature and technology

3. Signature Project 1: Space Mission Live

Signature project 1 will be described here. The responsible partner was Experimentarium, a large Danish Science Center for STEM education and outreach situated in Hellerup, north of Copenhagen.

3.1 Materials and Methods

The aim of Space Mission Live has been to create attention, a sense of togetherness, knowledge and dialogue about space and space travel. This has been done via events and activities all over Denmark at science centres, museums and similar organizations.

This initiative has specifically focused on the Danish ESA Astronaut Andreas Mogensen's space mission and his activities on the International Space Station. Furthermore, the focus has been on the motive to travel into space as well as on the diversity of STEM subjects and professions needed for the development of space travel and the exploration of space.

The methods used have been a variety of STEM communication methods and materials created have focused on materials/exhibits/posters and similar to highlight and better communicate and reach the public during events. Materials for schools have been developed by Astra, the national centre for science education and ESERO Denmark.

3.2 Partnership

The partners in Space Mission Live are Danish STEM (Science Technology Engineering and Mathematics) learning institutions; science centres, museums and universities, that provide professional STEM dissemination to schools, families, children, young people and adults. The partners are from all over Denmark.

Through this joint initiative, we have achieved joint branding, greater (national) visibility, a strong outreach and impact. Furthermore, the partnership has enabled us to develop activities together, inspire each other and share knowledge and experience.

As project manager Experimentarium has had the coordination role in relation to developing and hosting events.

3.3 Events

As mentioned already events have taken place all over Denmark. Science Museums in Aarhus (in Jutland) developed a 2-hour ‘Astronaut for a day’ workshop for middle school pupils and ‘On a mission on the ISS’ for older primary school pupils. The first workshop was about ‘every day life’ on the ISS and the second workshop was about the experiments that ESA Astronaut Andreas Mogensen conducted on the ISS. Events started with kick-off and launch events celebrating the start of the Huginn space mission.

Following the launch all partner institutions have hosted several events focusing on space and the Huginn mission and conducted experiments on board. The events have invited a mix of the general public and schools as well as university students.

The main event was our In Flight Call with ESA Astronaut Andreas Mogensen in December which is explained in more detail hereafter.

3.3.1 In Flight Call

On Monday 4th December 2023, Experimentarium hosted an In Flight Call to ESA Astronaut Andreas Mogensen (see Fig. 3). Experimentarium, in collaboration with ESERO Denmark and ESA, was responsible for the event being streamed to all of Denmark and Europe.

In addition to the In Flight Call, the participating school classes could experience a huge space-themed day with a rocket workshop, micro:bit and stargazing in an inflatable dome. Astra, The House of Science, the Observatory in Brorfelde, DR (the national Danish television) and ESERO Denmark physically participated in the event with workshops and recordings. DR Ultra was there all day and covered the event.

600 school pupils and teachers as well as more than 1,000 guests followed the event from Experimentarium. A minimum of 10,500 guests streamed the event from home. In addition, the In Flight Call went out to the entire Nordic region, and students and teachers gathered in Sweden, Norway, Finland and Denmark to hear ESA Astronaut Andreas Mogensen talk about space technologies.

Several partners in the Space Mission Live project set up events to follow the In Flight Call. Naturama in Svendborg and Steno Museum in Aarhus invited school children and set up a big screen, on which they streamed the entire show from Experimentarium.

Fig.3. In Flight Call with ESA Astronaut Andreas Mogensen during his Huginn mission on the International Space Station. Credit: Experimentairum

In advance, it had been possible to submit questions to ESA Astronaut Andreas Mogensen, which he would answer during the In Flight Call - two questions from each country (Sweden, Norway, Finland and Denmark). Lukas and Liam from Denmark asked which gadget ESA astronaut Andreas Mogensen thinks is the coolest on his space suit - and what he actually does if it itches under the space helmet. Will of nine years old wanted to know how it was to sleep in space. The three boys all agreed that it was mind-blowing that they had been allowed to ask Denmark's only astronaut a question.

It was great to experience ESA Astronaut Andreas Mogensen live from the International Space Station. A gasp went through the audience when ESA Astronaut Andreas Mogensen appeared on the screen. It really meant a lot to children – and adults – to have a role model in the form of an astronaut who comes from Denmark. ESA Astronaut Andreas Mogensen is fabulous at communicating research in space, so that it brings both children and adults together.

3.4 Results and Outcomes

Participating partners have experienced a huge interest in space and ESA Astronaut Andreas Mogensen's Huginn-mission as well as in the exhibition and activities that have been developed in the framework of the Space Mission Live project.

All 12 partners within the Space Mission Live project have held events communicating space and the Huginn mission with ESA Astronaut Andreas Mogensen. These events have reached thousands of children, young people and adults all over Denmark and have taken place in the University of Technology, in schools and libraries, in informal science learning institutions such as science centres and museums and several more places.

The Danish Astronautical Society has also been part of the Space Mission Live initiative and has developed 2 special editions of the magazine "Dansk Rumfart" (Danish Spaceflight) that has followed ESA Astronaut Andreas Mogensen's Huginn space mission and specifically communicated the work done within the Space Mission Live communication initiative. The magazines have been distributed via partners in the Space Mission Live project, via libraries throughout Denmark as well as via libraries in Greenland and the Faroe Islands.

Coding Pirates have developed coding workshops, courses and activities that can be used by "coding pirates" all over Denmark. Participants have built and programmed space mission robots, created animations, coded space websites, designed space-themed games, built 3D moon bases and space stations, composed spacey music, experimented with gravity, and launched small demonstration rockets.

SoMe posts on the space mission within the Space Mission Live events have reached out to more than 300.000 people which is a huge reach for a small

country like Denmark and a huge reach for STEM communication to the general public.

Having ESA Astronaut Andreas Mogensen as a role model has definitely had a huge impact on the positive interest and curiosity we have seen throughout Denmark. He was was welcomed home at a Welcome Home event in April 2024 in Experimentarium (see Fig. 4 and Fig. 5).

Fig. 4. Welcoming ESA Astronaut Andreas Mogensen to Experimentarium following the end of the Huginn mission. Credit: Experimentarium

Fig. 5. Celebrating ESA Astronaut Andreas Mogensen at a homecoming event in the Danish science center, Experimentarium. Credit: Experimentarium

4. Signature Project 2: Space in Business

Signature project 2 will be described here. The responsible partner was Naturvidenskabernes Hus/House of Natural Sciences.

4.1 Material and Methods

The objective of signature project 2, Space in Business, was to enhance visibility of education and career opportunities within space related jobs on the academia level and vocational area, emphasizing the diverse expertise required for a space mission.

The project aims to foster collaborations between schools and space-related industries, engaging children and young people in practical, hands on and inquiry-based space activities across Denmark. Content produced are issued at esero.dk, the European Space Educational Resource Office in Denmark, ESERO Denmark [10].

The main collaborators:

- **Videnskab.dk**: Science Media channel. Contributes videos, articles, and podcasts.
- **Industriens Uddannelser / Educations of the Industry, Dansk Metal and SkillsDenmark**: Educational institutes for the vocational and industry area of expertise. Supply professional content and activities at Skills competitions. SkillsDenmark is the National team in the vocational Skills-competition.

The lead contractor:

- **House of Natural Sciences/ Naturvidenskabernes Hus, hereafter HNS:** National Institute of School-Industry-Collaborations. Managing the project and facilitation collabs.

Main goals:

- Highlight education and career opportunities within space related jobs on the academia level and vocational area.
- Showcase rolemodels and the expertise that enable space missions..
- Promote the Danish space industry.
- Facilitate collaborations between schools and space-related companies: School-Industry-Collaborations.
- Engage children and young people in practical, hands on and inquiry-based space activities.

Target audience:

- Primary schools (elementary, middle, and high school levels).
- Secondary education (high schools and vocational schools).

4.1.1 Key Activities and Deliverables:

The key acitivities and deliverables are the following:

1. Mapping an overview of Space related Education and the cross disciplinary Danish Industry within Space: By structuring an overview, we aim to utilize the fascination with space to boost interest in science and technology among children and young people. For young people and children to get a deeper understanding of the various educational paths and career opportunities identified in the space industry, showcasing various role models and cases beyond physicists and engineers, the overview should grant teachers and students more knowledge of the Danish landscape within space-related industry.

2. Development of School-Business Collaboration Programs: House of Natural Sciences encompasses the development of concrete school-industry programs and cases for primary and high schools. Connecting theory with practice, allowing students to engage with practical and close to everyday from the space industry issues through hands-on activities are addressed by schools (see Fig. 6). We do this by utilizing existing concepts from HNS. The development of specific cases for vocational education are addressed for the first time where they integrate space-related activities into their curriculum to communicate the skilled profession in space.

Fig. 6. School kids learning how to code in an Astro-Pi course. Credit: Anders Bruun, Experimentarium

3. Promotion and Storytelling of the Danish Space Industry: Using video productions, articles, and podcasts to communicate compelling stories about the space industry. Videnskab.dk provides a behind-the-scenes look at research-intensive Danish companies working with related space content, showcasing processes and other areas of the everyday life of a profession within the Danish space industry.

The produced material highlights the space industry in a multidisciplinary context, increasing interest among young people through thematic content related to green transition, health, and technology. The produced materials are coordinated in themes with other project initiatives in Rumrejsen/The Space Journey to ensure coherence and strong connectivity. All content is distributed on Videnskab.dk and its popular YouTube channel.

4. Danish Master in Skills Competition 2024: The annual Danish Master in Skills competition which is the national championship for young people studying a vocational education. HNS uses the event, with up to 50,000 visitors, to showcase vocational opportunities in the space industry through an interactive exhibition stand.

Another key point is informing students in schools about the importance of a vocational education for the space industry and career opportunities within space in Denmark. In collaboration with the national judges of the Industrial Technician discipline, HNS facilitated the development of the competitions in CNC-Milling and CNC-Turning integrating space.

4.1.2 Impact and Outputs

- *Materials Developed:*
  - Mapping an overview of space related industry and educational opportunities in Denmark.
  - Five thematic information-rich packages with videos and articles on research and development activities in Danish space companies and academia.
  - Three programs for collaboration between companies and primary schools.
  - Two programs for collaboration between companies and high schools.
  - Two cases for vocational schools with space-related activities.

- *Expected Reach:*

  - At least one million readers through Videnskab.dk's website.
  - 50,000 visitors at Danish Masters in Skills in 2024.
  - Up to 4,000 students participating in School-industry-collaboration programs with Danish companies.
  - Dissemination of resources on esero.dk.

4.2 The Importance of School-Industry-Collaborations in Space Industry

The activities in Signature Project 2: Space in Business emphasize the crucial role STEM (Science, Technology, Engineering, and Mathematics) education plays in engaging and inspiring future candidates for the space industry.

By involving students in various educational levels and integrating practical hands-on and inquiry based programs through collaborations with the industry, the project aims to foster a deep interest and understanding in STEM topics. This effort contributes to the growth and innovation within the Danish space sector by inspiring the next generation of space enthusiasts, researchers and skilled workers [see Fig 7].

Fig. 7. The Youth Space Conference, where ESERO presented new teaching materials based on five of the ten research experiments carried out by ESA Astronaut Andreas Mogensen on the ISS during his mission.
Credit: Frederik Lunding, SDU

4.3 Results

The comprehensive overview of space-related educational and career opportunities in Denmark has successfully identified and documented numerous entities involved in space research, technology, and innovation development. The developed resources, including guides, articles, and educational activities, have already begun to impact educators, students, and the general public. The project, which is anchored in ESERO Denmark will keep on the good practice acquired from the Space in Business-project.

School-industry-collaboration programs and events have provided hands-on experiences and practical insights into the space industry, effectively bridging the gap between theoretical knowledge and real-world applications.

The project's outreach through Videnskab.dk and participation in national events like Danish Masters in Skills has further amplified its reach and influence, promoting STEM education and careers in the space industry to a broad audience.

5. Signature Project 3: The next Generation Space Station – developing Education Materials

Signature project 3 is made in collaboration between Science Museerne, Naturvidenskabernes Hus og Astra.

The purpose of signature project 3 "The next Generation Space Sstation" is to engage students with all sorts of interests and backgrounds in a space project. The next generation space station will operate in deep space (around the Moon or Mars) and would therefore have to be sustainable to a very high degree. A high priority is also to make it more liveable for those that will stay onboard for years.

Building the space station will therefore require expertise in everything from the traditional STEM skills to design, sports and food production etc. Likewise, students with all sorts of different interests and skills were able to contribute to the teaching project.
The project aimed at producing high quality teaching materials that would engage students. We wanted to show the students how STEM skills and collaborative work can be utilized in building a space station which is a highly complex construction but also something that everybody can relate to - a place where people can live and thrive.

An important part of the project was that Danish companies and researchers contributed to the project by sharing their expertise and enthusiasm for space science.

5.1 Material and methods

The teaching materials were developed for elementary school through high school and vocational education. All teaching materials were made freely available at the Danish Esero website (Esero.dk).

5.1.1 Goals and Target Groups

The primary goal was for at least 25.000 students to participate in the project. Another goal was to make the teachers more comfortable using space science as part of their STEM teaching. Lastly it was important the project increased the students' knowledge about ESA Astronaut Andreas Mogensen and his Huginn mission, about space in general and about Danish companies and researchers involved in space science.

5.1.2 The Main Product.

The main product of the project is a suite of 24 didactic packages. Each package is aimed at a specific grade and focuses on one of the modules that the next space station will include. The package includes two introductory videos explaining the challenge: one by ESA Astronaut Andreas Mogensen and one made by a Danish company or researcher working in the field. The packages focuses on making the lives of the crew onboard not only safe but also as pleasant as possible. It requires the students to think about how they themselves would thrive on the station they design.
We developed didactic packages for 6 different types of space station modules:

- Greenhouse module – production of food and oxygen
- Sleep module – improved sleep quality and privacy
- Training module – fitness needs to be fun
- Toilet and bath – necessary but difficult
- Social module – a place to relax and socialize
- Technical module – focusing on power, water and air quality.

The last element of this project was an Inflight Call with ESA astronaut Andreas Mogensen.

5.1.2.1 The Teaching Materials

All of the materials started out with introductory video by ESA Astronaut Andreas Mogensen where he introduces the students (and the teachers) to life at the International Space Station (ISS) and the hopes he has for a next generation space station.
24 sets of didactic teaching packages were developed and made freely available [11]. Packages for multiple grades were developed for most of the modules listed above.
A key element in all packages is an engineering model which is widely used in Danish schools. The students use the engineering model to guide them through the necessary steps to solve a complex problem. The final product is a prototype which could be either a physical model, a virtual model, a drawing or a poster. Key to all problems is that the space station should be sustainable and a place that they would want to stay at themselves. Each package includes:

- Two introductory videos explaining the overall purpose of the module. One by ESA Astronaut Andreas Mogensen and one made by a Danish company working in the field.
- A teachers guide to the engineering process.
- A guide for the students.
- A collection of resources and links that will help the students in their work on the project.

Fig 8. The Engineering didactics model with the 7 sub-processes: *Understand the challenge*. *Acquire relevant knowledge. Generate ideas. Construct prototype subelements. Choose subelements and materials. Improve – test subelements and obtain feedback. Present a possible solution or product.* Credit: Astra

5.1.2.2 Inflight Call with ESA Astronaut Andreas Mogensen

We kicked off the teaching project with an Inflight Call on September 26th, 2023. The event was streamed to all schools that had signed up for the project. ESA Astronaut Andreas Mogensen told the students about his life as commander of ISS and several students were given the opportunity to ask questions directly to him.

5.2 Theory

The engineering didactic is widely known and used in Danish schools as an engaging and motivating way to promote interdisciplinary learning; encourage problem-solving and critical thinking, experience hands-on learning and practical applications of STEM skills; foster creativity and innovation; and provide exposure to STEM careers.

By applying engineering didactics to the concept of a next generation space station which is not only advanced, complex and cool, but at the same time involves challenges all students can relate to, we wanted to get many different types of students engaged – including those that struggle with STEM. We also wanted to get more students interested in space science.

5.2.1 Engineering Didactics

Engineering didactics [12] (see Fig. 8) is a method inspired by the way engineers work. The students work on a specific and relevant challenge. They follow a design process consisting of seven sub-processes:

- Understand the challenge
- Acquire relevant knowledge
- Generate ideas
- Construct prototype subelements

- Choose subelements and materials
- Improve – test subelements and obtain feedback
- Present a possible solution or product

The students work iteratively (see Fig. 9) and typically go through each step several times and not necessarily in the order listed.

The method and the didactics help the students understand the relevance of the STEM skills and the opportunities open to those that master them.

To help the teachers using engineering didactics the package includes small videos describing each step in the engineering process. The package also includes recommendations for method cards to be used by the students in the process.

5.3 Results

The teaching materials are freely available at esero.dk. They are presented in a way that also makes them relevant now that ESA Astronaut Andreas Mogensen is back on Earth and the project is officially over. Since the teachers downloaded the materials freely, we do not know why they downloaded them or how they used them.

Our evaluation of the website traffic shows a large interest for the project and the materials. We also estimate that our goal, that at least 25.000 students should use the materials, has already been met.

We did carry out interviews with 10 teachers, who have used the materials. The interviews show that they found the packages relevant to their teaching and that they assessed that their students have acquired STEM competences and increased their knowledge of space science. Many students have been more active in the process of constructing the modules and have shown increased interest in science and technology.

Using ESA Astronaut Andreas Mogensen as a role model has significantly increased the relevance of the project for the students. The teachers have used the materials in many different ways. They have been inspired to do similar activities, they have remixed some of the challenges or used them as intended.

The most used materials were the student activities and the videos with ESA Astronaut Andreas Mogensen. The videos have been particularly important for the project. They provided the hook that made the project relevant and interesting for the students.

Fig. 9. Students show ESA Astronaut Andreas Mogensen a prototype from their work on the next generation space station. Credit: Astra

The teachers have acquired knowledge about space science which will be very useful in their future STEM teaching. They also found that the engineering didactics was key to the success and that the students learned from the engineering process, where they acquired subject-specific knowledge, problem-solving, modelling, technology, endurance and collaboration.

The engineering didactics thus support the student's ability to solve a wide range of challenges – including those that require STEM skills. It also shows them that STEM skills open doors to a wide range of interesting career opportunities.

6. Signature Project 4: On Mission with Andreas Mogensen - developing an Exhibition

In august 2023 the Danish ESA Astronaut Andreas Mogensen was launched from Kennedy Space Center on his six-month mission to the International Space Station. Earlier the same month, a different launch had taken place on three different locations in Denmark, when the exhibition "Rumstationen – på mission med Andreas Mogensen" ("The Space Station – on a mission with Andreas Mogensen") opened.

This part of the overall "Rumrejsen" project was a collaboration between a number of Danish museums and science centres: Experimentarium, Science Museums at University of Aarhus, Brorfelde Observatory, Kroppedal Museum, Danish Museum of Science and Technology and Tina Ibsen.

The idea was to create an exhibition that would bring the Huginn mission out to venues around the country. Therefore, we decided to develop an exhibition that was produced in three copies, allowing three

institutions to host the exhibition in the fall of 2023, when the Huginn mission was launched, and three other institutions to host the exhibition in the Winter-Spring of 2024, when ESA Astronaut Andreas Mogensen returned to Earth.

6.1 The Exhibition Concept

In the exhibition group we wished to create an exhibition for the family audience, with a focus on kids aged 10-14. The visitors should get a feeling for the life and work on board the International Space Station, and an understanding on how the research done in space affects us here on the surface of Earth. The exhibition had to be flexible, and the design should be able to work in five very different locations, and we would have to produce three clones, so that it could be at several locations at once.

This resulted in a design where we had an inner core and an outer section (see Fig. 10 and Fig. 11), focusing on two different aspects of space flight. The entire exhibition was held together by talking head videos with ESA Astronaut Andreas Mogensen, telling stories and giving introductions to the topics. These videos were recorded in Danish with English subtitles.

The center of the exhibition focused on life on the space station. How do astronauts sleep, what do they eat, and how do they keep their health. Here we exhibited space food from the Danish chef Torsten Schmidt and showed a version of the health monitoring system made by the Danish space-tech company Danish Aerospace Company, as well as a sleep monitoring system from Aarhus University.

In the outer part of the exhibition, we focused on the more technology driven aspects of the space station, talking about the station itself, and highlighting some of the atmosphere experiments done on the space station. One example is the Thor-Davis experiment, where ESA Astronaut Andreas Mogensen was to photograph upward travelling lightning. We also focused on how ESA Astronaut Andreas Mogensen used his education as an aerospace engineer in his work as an astronaut.

When we started developing the exhibition, the full package of the experiments that ESA Astronaut Andreas Mogensen would be doing in space, was not available. However, 10 Danish experiments (see section 2.1) had been chosen to be conducted during his mission, and we chose to use these experiments to represent the research in space, in the exhibition.

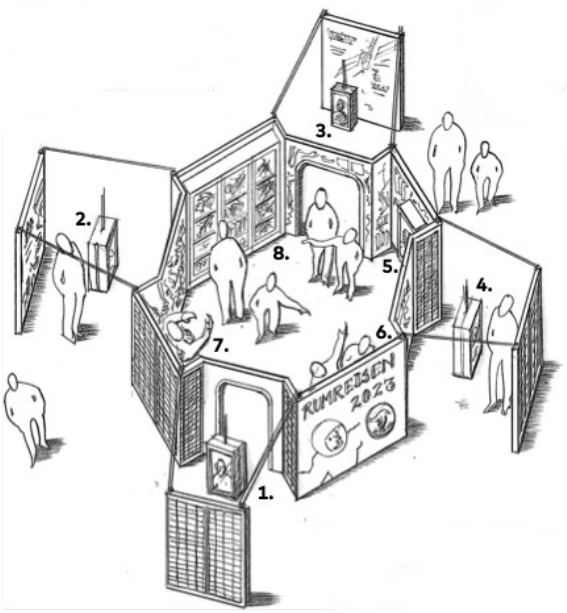

Fig 10. Sketch of the exhibition.
Outside: Space research and technology: *1. Space exploration helps life on Earth. 2. Lifescience and monitoring of the body. 3. Water and water purification in space. 4. Giant lightning in the atmosphere and the moon.*
Inside: Private life and research. *5. Planning and structure in everyday life. 6. Exercise and well-being in space. 7. Light, well-being and sleep measurements in space. 8. Diet and hygiene.*
Credit: Experimentarium

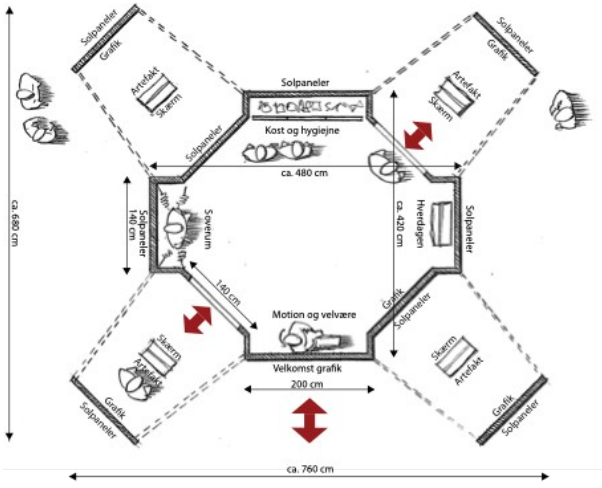

Fig.11. Sketch of the exhibition seen from above.
Credit: Experimentarium

It was important to anchor all this work, going on in space to our life here on Earth. So, every part of the exhibition had explanations on how the research on the space station could be used to benefit life back on Earth. All the texts in the exhibition started with an example or concept that the audience know from their everyday life, such as a bike ride to school, breakfast, planning your day etc. This was done to make space relevant for the audience, as the distance and technology driven narrative about space research can alienate some people from the subject.

6.2 The Exhibition in Use

Apart from being an attraction at each of the six venues, "The Space Station" (see Fig. 12) was at the centre of several activities and events. Science Museums in Aarhus, Jutland, added more installations combining the experiments carried out on the Huginn mission with objects from their own collections; Brorfelde Observatory added a VR experience allowing visitors to virtually visit the ISS, Experimentarium hosted both launch events and homecoming events, Kroppedal Museum organized holiday activities around the exhibition, and Danish Museum of Science and Technology developed a teaching material combining "The Space Station" exhibition with the museum's permanent display of the Soyuz Capsule that brought ESA Astronaut Andreas Mogensen to ISS in 2015.

6.3 Results

All in all, "The Space Station" was a very successful project. First of all, the exhibition communicated basic information on the Huginn mission to a large group of visitors. While most Danes would know about ESA astronaut Andreas Mogensen and his position as the first Danish astronaut, not that many people knew about the aims of the Huginn mission and the role of ISS in general.

Secondly, the project generated a very positive collaboration between several institutions that would otherwise have competed for the same, limited amount of money. Having experienced how a collaboration like this could work points to similar collaborations in the future strengthening the communication on space research and technology to Danish children and youths. Many of the collaborators in the exhibition project participated in each other's events, Brorfelde Observatory visited other museums/science centres with their portable planetarium, and Experimentarium toured their rocket science show to several of the other partners.

Fig. 12. The exhibition in use.
Credit: Experimentarium and the Danish Museum of Science

7. Results and Discussion

In this section we give an overview of the results and provide the learning points from the STEM outreach and educational activities related to the Space Journey project in connection with the Danish ESA Astronaut Andreas Mogensen's mission to the ISS in 2023-2024.

7.1 Examples of Activities and Outreach

The examples below illustrate the breadth of the project, which includes many more activities.

7.1.1 School and High School Programs:

Educational Materials: Developed in collaboration with ESA, adapted to Danish contexts and implemented in many classrooms nationwide.

7.1.2 Events:

The **House of Natural Sciences** and **ESERO Denmark** held events for schoolchildren, high school students, and vocational students, including interactive workshops and presentations.

7.1.3 University Activities:

Danish Technical University held a Launch Event: Approximately 250 students, researchers, and families attended the internal launch event, which was streamed to over 10,000 viewers.

7.1.4 Inflight Call Event at Danish Technical University:

Around 1,000 participants watched live, and the event was streamed via NASA and ESA, with excerpts broadcasted on Danish national TV, reaching thousands of citizens.

7.1.5 Vocational Education and Skills Events:

During the Rumrejsen/Space Journey project, outreach activities were integrated with Skills 2024, a Danish championship for vocational education in the metal sector (there is also a European Euro Skills). This initiative was leveraged to promote interest in STEM at a practical and vocational level. Competition tasks, including creating a star tracker camera casing for space navigation and a hardware enclosure for space software, clearly demonstrated the connection between STEM education and practical work in the industry.

Skills 2024 thus became a platform to highlight how technical skills and STEM competencies are central to future space research, technology development, and industrial production. In a broader societal context, the project contributes to efforts to ensure a sufficient supply of trained personnel in STEM and related industrial fields in the future, a challenge seen across Europe.

7.1.6 Public Events and Workshops:

A variety of public events and workshops were held to engage the general population.

The **Danish Astronautical Society** hosted 9 events with all in all 450 participants. The magazine "Dansk Rumfart" (Danish Spaceflight) - a journal made by the Danish Astronautical Society [13]) had articles about all 10 Danish experiments (see Table 1). The magazine (No. 80 and 81) was printed in 12,000 copies and was available for the public at events. It is expected that each journal will be seen by between 3 and 4 people.

Another example is of activities outreach in the project is **Coding Pirates Denmark**. They have developed Rumrejsen/Space journey-themed workshops and been part of 25 events nationwide, engaging over 1,300 children and young people aged 7-17. In addition local chapters have held 30-50 club nights with the same theme.

7.1.7 Space Exhibitions:

Interactive and physical exhibitions engaged the broader public.

An example of special events organised in connection with the mission is project **partner Danmarks Tekniske Museum** (Technical Museum of Denmark) at their site:

Space Exhibition Opening. Children and families (mainly 10-12 years old): Approx. 500 participants.

Science Week + Science Day + 'Into Space'. Primary school: + 1,100 participants.

7.1.8 Welcome Home Event:

Upon ESA Astronaut Andreas Mogensen's return to Denmark in April 2024, a large event was held in Experimentarium for the general public and specially invited guests, including the ESA Director General and Denmark's Minister of Higher Education and Science, bringing together Danes both physically at the event and online via live coverage (see Fig. 4 and Fig. 5).

7.1.9 Digital Outreach:

The project's website, Rumrejsen2023.dk [4], had over 657,300 visits/hits between May 1st, 2023, and June 20th, 2024. Though subject to further analysis, this figure indicates a strong interest in the Space Journey project and its associated activities. The site was a central information source and featured a calendar function, and articles and posts from Rumrejsen/Space Journey 'ambassadors' on topics and events related to the mission, which could be pitched to the media and other stakeholders. Additionally, other partners' activities were promoted across their various online platforms.

Another example of the project's digital outreach is provided by the main partner **Experimentarium:**

LinkedIn.

6 posts on LinkedIn in connection with the launch of the Rumrejsen/Space Journey project at DI (the Confederation of Danish Industry), Lift-off day at Experimentarium, and the exhibition 'The Space Station – On a Mission with Andreas Mogensen'. These posts reached + 11.000 people.

Facebook

Throughout the entire Space Journey project a total of 22 posts were reaching + 205,000 people.

InFlightCall :

In Flight Call Live event in Experimentarium, 3 posts reached a total of 10,500 users who streamed the event live.

Instagram/Facebook Stories

30 stories posted. These stories reached a total of +21,000 people.

At main partner, **Dansk ESERO** key figures document a lot of activity both online and by participation in courses and physical activities (here meassured from January to June 2024):

About 18,000 unique visits and +1,300 downloads at www.esero.dk where information and learning material on space science can be downloaded.

Additionally +90,000 students/pupils have participated in physical events or courses related to the Rumrejsen/Space Journey project.

7.1.10 Media Coverage

The mission of Danish ESA Astronaut Andreas Mogensen to the International Space Station (ISS) captured the attention of the entire country. The mission received extensive coverage in Denmark from major national TV and radio channels, DR and TV2, and most other Danish print and online media.

From January 1st, 2023, to June 24th, 2024, ESA Astronaut Andreas Mogensen was mentioned in at least 5,484 media segments in Denmark (source: Infomedia search) often relating to Rumrejsen/Space Journey project activities. This comprehensive media coverage exposed many of Denmark's 5.9 million inhabitants to the mission and the related outreach and educational activities.

7.2 Evaluation of Results and Impact

Our evaluation of the Rumrejsen/Space Journey project indicates that the activities reached a large portion of the Danish population. Thousands of primary, secondary, and university students participated in specific learning activities. This widespread exposure increased interest in STEM among young people in Denmark and strengthened support for Danish space research and industry.

The effort to disseminate STEM activities and related endeavours took place before, during, and after the mission, spanning most of 2023 and the first half of 2024. Extensive planning preceded these efforts. Overall, we assess the project as a success, given the high level of interest and the fact that the mission's communication reached most of Denmark's population.

7.3 Learning Points and Future Perspectives

The Rumrejsen/Space Journey project has provided valuable insights that can serve as a model for future STEM outreach initiatives.

7.3.1 Coordinated Collaboration

One of the biggest criteria for success was the coordinated collaboration between different institutions. This collaboration ensured broad dissemination and great creativity in planning and executing activities. The network structure, which included regular meetings and coordination via the secretariat at DTU (The Danish Technical University), was crucial for maintaining momentum and ensuring a consistent approach across all involved parties.

7.3.2 Early Planning and Involvement

Early involvement of relevant stakeholders ensured broadly based idea development that strengthened the project's implementation. This allowed extensive preparation and fine-tuning of activities to maximise their impact and avoid overlap, ensuring both large and small actors were accommodated.

Early planning ensured that all relevant parties could contribute their expertise and resources, leading to more successful and effective activities.

7.3.2 Use of Rumrejsen/Space Journey Ambassadors

The project's 'Space Journey Ambassadors' played a significant role in spreading the message and securing support from key decision-makers and stakeholders. These research, education, and industry profiles shared knowledge related to the mission within their networks, enhancing the project's visibility and legitimacy.

To fully leverage this potential, such profiles should be supported with resources and time so they can engage more deeply and share their insights more broadly.

7.3.3 Integration of Technology and Social Media

The extensive use of digital platforms and social media enabled a broader and more effective reach. Online events and livestreams engaged both national

and, at times, international audiences, amplifying the message and increasing interest in STEM.

Future projects should continue to utilise these technologies to reach even larger audiences and create more interactive and engaging experiences.

It is worth adding a point that the project participants could have benefited more from SoMe by making more cross-references to each other's projects and activities. There are big events and postings that get a lot of views and then there are many postings that are also of high quality, but don't get a lot of exposure. This is an experience known from other projects, but which is easily forgotten in the final stages and is therefore left to chance.

7.3.4 Flexibility and Adaptation:

Flexibility in planning and execution allowed for quick adjustments to new opportunities and challenges. This was crucial for maintaining relevance and engagement throughout the mission's duration. One takeaway is that projects should remain agile and open to adjustments based on feedback and changing circumstances.

7.3.5 The Danish Experiments

Having a pool of national experiments turned out to be a very good base for informing about what the Danish ESA Astronaut Andreas Mogensen would be doing during the mission. The ten Danish experiments (see section 2.1) got a lot of publicity in the media; they served as inspiration to the exhibition, and they provided the public with an insight into the purpose of the mission during the Space Journey project in form of articles and lectures.

7.3.6 The Importance of having a STEM Role Model

In addition, one of the things we have learned is that having a great role model within STEM is really something that reaches a lot of people. Also, the fact that the Danish ESA Astronaut Andreas Mogensen was so 'committed' to following up, re-posting SoMe posts and communicating himself on an ongoing basis has made it possible for Denmark to gather. It is rare that we have seen such a varied audience at our events - which actually reaches out to all ages.

8. Conclusions

ESA Astronaut Andreas Mogensen's mission to the ISS has effectively promoted awareness and interest in STEM fields and space research in Denmark. Through a well-coordinated partnership and a wide range of involved institutions and activities, the Rumrejsen/Space Journey project successfully engaged a large portion of the population. It helped inspire the next generation of scientists and engineers.

The experiences from this project can serve as a model for future initiatives in STEM outreach and dissemination, focusing on fostering strong collaborations among a broad range of partners, early planning, and strategic use of digital media.

Acknowledgements

Thank you to the foundations that supported the project: Otto Mønsted Fond, Ellehammer Fonden, novo nordisk fonden, Thomas B. Thriges Fond, Villum Fonden.

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