Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Social and Educational Sciences
Department of Social Anthropology

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Encountering Space in the Sub-Arctic:

Launching student rockets and the human urge to explore the extra-terrestrial.

Master's thesis in Social Anthropology
Supervisor: Jens Olgard Dalseth Røyrvik
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Sammendrag

I denne masteroppgaven knytter jeg meg til, *Anthropology of Outer Space,* og har undersøkt romfartsaktiviteter i en norsk sammenheng. Masteroppgaven undersøker lokale romfartsaktiviteter i samspill med det globale, og hvordan disse aktivitetene er med på å endre hvordan mennesker relaterer seg til jorden og til universet. Oppgaven utforsker hvordan lokale aktiviteter som studentrakettoppskytninger muliggjør utforsking av utenomjordiske fenomener, slik som nordlys og jordens magnetiske felt. Gjennom grundige beskrivelser presenterer jeg to slike studentaktiviteter, ved et norsk romsenter. Ved å se på disse operasjonene, og å betrakte de gjennom antropologiske perspektiver på teknologi, viser det seg at samhandling mellom menneske og maskin, standardisering og kroppsliggjøring, er viktig for gjennomføringen av rakettoperasjoner. Kroppsliggjøring og kunnskapsoverføring, fra en generasjon til en annen, er viktige grunner for å la elever og studenter *selv* ta rollene som utforskere og ikke minst romforskere.

Videre undersøker jeg hvordan oppdagelser og forståelser av fenomener i atmosfæren og universet, gjennom enkeltaktiviteter, er med på å forandre hvordan mennesker forstår og tilnærmer seg utenomjordiske objekter og fenomener. Jeg argumenterer for at utforskning av utenomjordiske fenomener gjennom bruk av instrumenter slik som raketter, laser, radarparker, teleskoper, satellitter og kikkerter er med på å gjøre universet mer familiært for mennesker på jorden. Videre i oppgaven ser bort faktiske aktiviteter som rakettoppskytninger, og legger fokuset på det empiriske materialet hvor informantene selv diskuterer og forteller om sin fasinasjon for universet. Historier om hvordan vi mennesker er bygget opp av stjernestøv og at vi selv *er* universet, er gjennomgående i disse fortellingene. Videre diskuterer jeg hvordan den indre menneskelige trangen til å utforske det ukjente ikke er noe nytt for romforskning, men at dette er noe mennesker alltid har vært opptatt av.

Helt til slutt ser jeg på de faktiske konsekvensene den lokale og globale romfartsaktiviteten har på folk. Blant annet hvordan det oppstår lokale konflikter mellom romsenteret og fiskere, og hvordan en bevisstgjøring rundt miljø sees i sammenheng med forsøpling av havet og orbitale baner. Jeg ser videre på hvordan konsepter som *´green space´* og *´green rockets´* brukes som legitimerende tiltak for å fortsette med romfartsaktiviteter. Jeg argumenterer for at konseptet om Antropocen må utvides, slik at det strekker seg forbi jordens fysiske grenser, til å dekke det utenomjordiske.

Abstract

As a part of the Anthropology of Outer Space, this thesis investigates space activities in a Norwegian context. It explores local space activities in relation to a global context and examines how such activities change how humans relate to the earth and to the universe. I investigate how local activities – such as student rocket launches – enable the exploration of atmospheric phenomena like the northern lights and the Earth's magnetic field. Through thick descriptions, I present two student activities at a Norwegian space centre. By looking at these operations through an anthropological perspective on technology, I find that human-machine interaction, standardisation and embodiment are important for the implementation of rocket operations. Embodiment and knowledge transferred from one generation to another emerges as an important reason for letting pupils and students themselves play out the roles of 'space scientists' and explorers.

Furthermore, I investigate how the exploration of phenomena in the atmosphere and the universe, one activity at a time, contribute to changing how humans understand and relate extra-terrestrial objects and phenomena. I discuss dialectically with the anthropological literature that the exploration of extra-terrestrial occurrences through the use of instruments such as sounding rockets, telescopes, satellites, binoculars Lidar-ray and radar-parks plays a part in making the universe more familiar to humans on Earth. I set aside actual activities such as rocket launches and focus on the empirical material where informants themselves discuss and talk about their fascination with the universe. Stories about how humans are built of stellar dust, and that we *are* the universe, are pervasive in these stories. Furthermore, I discuss how urges to explore the unknown are not a novel consequence of the contemporary space age, but rather a time-old fascination of human beings.

Moreover, I examine the actual consequences of local and global space activities; how local conflicts arise between the space centre and fishermen, and how an ´environmental awareness´ arises when conversing with informant about littering of our oceans and orbit. I look at how narratives of ´green space´ and ´green rockets´ are used to legitimise continued space activities. I argue that the concept of the Anthropocene must be moved beyond earthly physical boundaries.

Through an anthropological and comparative lens, this thesis argues that the space 'industry' and space-related activities continuously fill the universe with new cultural values. How humans respond, relate, and think about Earth, as well as the extra-terrestrial, is changing the world we live in, and thus situates humans in a larger cosmological context.

Acknowledgement

I want to express my deepest gratitude to the participants of this study, without you none of this would have been possible. I am forever grateful.

First, I want to thank the employees at NTNU Samfunnsforskning and CIRiS for inspiring me throughout my degree. I want to make a special mention to my supervisor Jens Olgard Dalseth Røyrvik, for his excellent guidance and uplifting comments. Furthermore, I also want to thank Trond Berge for only being an e-mail away, and for his many thought-provoking literature suggestions. A thank you goes out to David Jeevendrampillai for being a great academic sparring partner, and to Alexander Berntsen for his great tips and analytical points.

To my dear friend Bao-Mai Huynh, thank you for keeping me motivated and ensuring that I remembered to rest throughout the writing process. Tonje Amundsen, thank you for always being just a phone call away.

I want to especially thank Nina Helen Amundsen for our daily correspondence during lockdown in the beginning of our fieldwork period. Without you and our serendipitous chats, this process would never have gone as well as it did. And thank you Maren Ryan, for keeping the atmosphere in our office humorous and light. And to my other classmates, Amalie Brekkan-Davidsen and Yvonne Strømsnes – thank you for all our discussions, Foodora breaks, and walks around campus this last year. Thank you Fride Jøsok for helping me solve obstacles that I have met on my way, and to Helen Amundsen for all your help. To you all, thank you.

To my mother and father for having taken care of my beloved dog almost every day since I started my endeavour almost two years ago – I am extremely grateful.

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Chapter I

An anthropological approach towards the space ‘industry’

1.1 Introduction

> The fundamental event of the modern age is the conquest of the world as a picture. The word “picture” [*Bild*] now means the structured image [*Gebild*] that is the creature of man’s producing which represents and sets before. In such producing, man contends for the position in which he can be that particular being who gives measure and draws up the guidelines for everything that is.
>
> *Heidegger 1977: 134*

Since the launch of the satellite, *Sputnik,* in 1957, the universe has been carefully examined by human beings. Engaging human activity on an extra-terrestrial scale has provoked a change in how humans relate to Earth and the universe. Extra-terrestrial phenomena and objects have been carefully investigated using mediated instruments (Ihde 1979; 2011), such as scientific rockets, telescopes, satellites and Lidar and radar-rays. In the late 1960s the first human being sat his foot on the moon, and with the famous “That’s one small step for man, one giant leap for mankind” (Neil Armstrong, NASA 2019) the world was forever changed. Three years later the famous picture of Earth viewed from the outside, *Blue Marble,* was taken from space and presented to the people of Earth. All these events have had dramatic consequences for how people relate to Earth and the universe. In this thesis I investigate how the contemporary Space Age continues to change how people relate to Earth and the universe. The empirical basis is local and Norwegian: A Norwegian space centre located in the Sub-arctic. I argue that space activities must be seen in relation between both local and global actors. By going in depth on some of the local activities, and through in-depth conversations with informants, I point to how every activity changes the world, little by little. Moreover, I conclude that, by considering these activities together, it raises a “planetary consciousness” (Boes 2014: 154) and local environmental awareness. These, I refer to as events that gradually change the way human beings interpret themselves as Earthbound and the world beyond planetary boundaries. This is eventually a way of ‘worldmaking’.

On one of my first days on the Island I waited outside in the reception area of *Spaceship Aurora* with the other excited guests, about 15 minutes before the opening of this new spaceship. When the doors opened, they revealed a big oval room consisting of two floors. The ground floor was exhibiting a radar antenna. Pictures of the northern lights were hanging on the walls. One side of the room exhibited a workshop for making paper rockets in order to launch them through a plastic tube that went all the way to the ceiling. A rocket, a drone, a satellite and a weather balloon were hanging from the ceiling. The second floor was designed like the bridge of a boat, with an overview of both floors. Excited guests started gathering around and facing one side on the second-floor balcony as the lights in the room were dimmed. Around ten little girls between, maybe, eight and fourteen years old, dressed in matching grey indoor spacesuits with silver makeup, came out and took the empty place on the balcony. The visitors were quiet and watched the girls. They performed two songs from the artist David Bowie, *Life on Mars?* and *Space Oddity* – this really affirmed the feeling of being in an environment of Space exploration. The women and men working around in the spaceship visitor centre were dressed in matching blue indoor spacesuits, with labels from the European Space Agency (ESA) and National Aeronautics and Space Administration (NASA) attached to the upper bodies of the suits.

From Andøya Space Centre (ASC[1]) the atmosphere and the universe have both been explored since the early 1960s, using sounding rockets, Lidar and radar-rays. The year 1962 marked Norway's entrance into the space age, whereas the first northern lights[2] rocket was launched on the 18th of August from Oksebåsen, Andøya (Brekke and Egeland 1994: 126). Making the unfamiliar familiar has always been paramount to space activities. From Andøya, investigation of the pervasive northern lights and Earth's magnetic field has been of great scientific interest[3]. In order to explore how space activities are changing how humans relate to the terrestrial and the extra-terrestrial, and how such activities consist of many social and cultural layers, as procedures, standardisation, imaginations, innate urges to explore, junk and environmentalism I shall carefully describe local events in-depth, and relate stories from my informants.

After a successful student rocket launch, we were all gathered in an auditorium at ASC, and an elderly male teacher took to the podium and addressed the students, similar to when

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[1] During my fieldwork the local space centre had the name Andøya Space Centre (ASC), only after fieldwork ended, they changed to Andøya Space (AS). Therefore, in this thesis, I stick to ASC.

[2] I use northern lights, aurora borealis, and aurora when I refer to the Northern Lights. The northern lights have fascinated humans for centuries and have various different names. For example, Aristoteles called them; '*chasms' and 'chasmata'*. The Sámi people call them (among other names); *'guovssahas'*. They are also called *'aurora polaris'*. The southern lights are called *'aurora australis'*.

[3] Amongst several other activities. However, I will stick to a few.

Armstrong stepped down onto the Moon. He proclaimed that "… yesterday the government had a meeting about Norway as a future Space Nation. This marks a milestone for Andøya Space Centre, and for our nation."

1.2 Main Argument

> We enable our customers to safely test, launch, fly, research and to gain new knowledge and to create new technology that benefits our society. We build and launch advanced sounding rockets, and we operate two launch sites in the Arctic. . . We educate and inspire the next generation of engineers and scientists. . . *We empower explorers.*
>
> *Andøya Space 2021, emphasis added*

My main argument is that *Space activities (such as student rockets, Lidar and radar measurements) contribute to changing how humans relate to Earth, and to the universe. Every activity recreates the world, piece by piece.*

To explore this empirically, I divide my argument into seven sub-assertions. 1) Local activities enable exploration of the world and the universe. 2) These activities take place in a human-machine-interaction. 3) Even though these activities are locally situated, their influence is global, in producing meaning of the explored phenomena. 4) Despite that these activities are based on science and technological instruments, the main role is played by the imaginative human being with their inherent urge to explore. 5) The way in which humans interpret reality is changing from the interaction of local and global activities. 6) The consequences of these activities provoke an environmental consciousness that takes terrestrial and extra-terrestrial littering into consideration. 7) An environmental consciousness makes it necessary to legitimate activities that produce waste.

Examples of local activities include student and research rockets, and atmospheric measurements using Lidar and radar instruments. Throughout this thesis I use the term 'activity' when referring to local student and research rockets, and Lidar and radar measurements, and when I point to local and global space related activities in general (everything from launching a sounding rocket and to a manned spacecraft). Andøya's geographical position, right below the northern lights oval[4], was essential for establishing a

[4] "The auroral oval is the footprint in the atmosphere of the boundary between the highly stretched field lines of the polar cap and the more normal field lines at lower latitudes. When the solar wind blows hard, this boundary moves equatorward - sometimes as far as Huntsville, Tel Aviv, or Kyoto - as more high latitude field lines are blown out into the tail." (Dooling and Giles, 2006 [1996])

rocket range here in the early 1960s. As a result of this establishment, the northern lights have been carefully explored and mapped through numerous rocket and measuring activities from Andøya Space Centre. Norway, with its rocket range on Andøya, became a pioneer not only in exploring the northern lights, but also in facilitating rocket operations for researchers worldwide. When the world was presented as a *Blue Marble,* this changed how people intuitively thought of Earth (Lazier 2011). This was a dramatic event that recreated the world as a picture. In comparison, local space activities on Andøya, like rocket operations and Lidar- and radar measurement, are on the other hand small and less dramatic events. They are events that change how human beings relate to, for example, the northern lights, one activity at the time. With an established infrastructure (consisting of humans and machines) on Andøya, such activities enable the exploration of the atmosphere and the universe. In the 1960s, technological instruments found new uses, and thus enabled several of the activities that are carried out on the base today (see chapter V). Moreover, local activities contribute to the exploration of atmospheric phenomena, such as the northern lights and Earth's magnetic field. Which again, little by little, changes how human beings relate to Earth and the universe.

In order to execute a rocket operation, there must be a specified interaction between humans and machine. The machine is here understood as all parts of the system (students, operators, switches, controllers and procedures) that need to be included in an operation (cf. chapter II). During an operation at ASC all three control rooms that are located on the premises work with each other in every step of the countdown. These control rooms collaborate with each other throughout an operation, and all parts are segments of the whole machine, however their functions differ. Operators, technicians and scientists use their knowledge of procedures, science, atmospheric objects, terrestrial and extra-terrestrial weather to implement bodily movements (see chapter III) to accomplish a successful launch. The different operators are tool users who depend on continuous feedback from the parts and the whole (instruments and machine) to enable the necessary adjustments and modifications for carrying out those actions and movements required to launch a student or scientific rocket. The instrumentation with its switches and buttons becomes an extension of the operator's experiencing, and thus allows the operator to enter into a mediated relation with, for example, the northern lights. Mediated experience is understood through Ihde's (1979) perspective, where the instrument (for example the telescope) is seen as a tool that enables the interpretation of a phenomenon or object that is not accessible with the human body as the main experiential tool. This, in turn, places the phenomenon in a mediated position for human experience (cf. chapter II). As Ihde (1979; 2011) argues, the Moon is standing in a position ready to be unveiled with its mountains and crates through a mediated instrument as the telescope – the Moon becomes dramatically changed by the telescope, and the observer's relation to the Moon is therefore also changed. Through unpacking and mapping of phenomena and objects in the atmosphere and universe (like the northern lights or another planet), human beings simultaneously enter into mediated relations with them, and thus fill space with social and cultural meaning (Gorman 2005). At the same time, unpacking, mapping and detecting are all acts of producing meaning for the tool user, which in turn facilitate a relation between what is 'out there' – in the atmosphere and universe – and what is 'down here' – the terrestrial and familiar (see chapter IV).

Through the use of instruments that measure and detect objects outside terrestrial (physical) boundaries, the objects become open to human interpretation. These measures visualise objects and phenomena in numeric (sometimes photographic) values. Values that are interpreted and put into graphs and diagrams by the tool-user, and in that way becomes visible to others. These values may be partially known or unknown to the tool-user (cf. CaNoRock operation). Knowledge about the phenomena is produced through interpretative processes – for example, an interpretation of the values detected in the northern lights help the tool-user understand the composition of electronically charged particles inside it. This knowledge is then shared in international journals, between research communities and with the general public. Through this new knowledge the data measured in the northern lights have enabled humans to see the heavenly dancer aurora from new perspectives, and thus, the experience of her is altered into new aspects. The northern lights are no longer only seen as a bridge to the *'hinsidige'*[5], or as consisting of a dark and mysterious force that can crawl down from the heavens to abduct people who wave their white scarves at it (as the folk stories go). However, the northern lights are still given human characteristics, as a cosmic woman dancing on the blackened winter sky in the Arctic regions (see chapter IV). Put differently, the northern lights have been explored, unpacked and conquered by humans and through our extensively instrumental engagement with it. As the telescope revealed the mountains and craters of the Moon and thus changed the observer's relation to it, the observer's relation to the northern lights has changed (or at least, extended) through careful examination from Andøya. Andøya and the local space centre are not alone creating such events; they must be seen as related to other commercial and

[5] A Norwegian term connoting the life after death, the otherworldly and hereafter. Literal meaning is "the other/opposite side".

governmental institutions around the world. Local and global actors like SpaceX and NASA are also creating interest and fascination for the universe and outer space. These events in turn provoke a *change* in how human beings relate to the terrestrial and extra-terrestrial.

The curious and exploratory human who asks wonder-questions (see chapter IV) about phenomena and objects in space is important to consider in launching activities, both locally and globally. Those are the imaginative humans that ask questions like, what is a star? Where do we come from? Is there water on Mars? These questions serve as the bedrock for space activities. Moreover, these questions often provoke new questions. Human inherent urges to explore is not a new phenomenon raised by the space industry, rather, it has always been a part of folk stories and population movements (Smith 2019). Imagining and wondering what is out there – in the universe – and where human beings originate from, are questions that are constantly connected to explorational activities. Nevertheless, what science *actually* does, does not create as much public interest as do, for example, Elon Musk when launching a red sportscar into space (Gorman 2019) or SpaceX with their *Humans on Mars* narrative. Travelling to Mars or the moon also serves scientific endeavours, such as, exploring the composition of minerals, and to investigate questions like those presented above.

The way in which humans interpret reality is changing from the interaction of local and global space activities. Commercial actors, such as SpaceX and Boeing, and governmental actors, such as NASA and ESA, are substantial meaning makers in the space industry[6]. SpaceX, for example, demonstrate symbolic powers when they use narratives of human settlings on another planet, such as Mars. By comparison, NASA demonstrate scientific superiority with their Mars Rovers, which are rolling around on Martian surface to help human beings on Earth search for traces of water and life. These are dramatic events, that are similar to the *Blue Marble* picture and to humans walking on the Moon.

The substantial amount of northern lights on Andøya has spurred ideas of the possibility of harnessing electricity, to use it as a resource on Earth. A big eruption of northern lights has the electrical potential to knock out local power-grids that in turn can kayo communication technologies. In a worst-case scenario, it may cause lasting changes to regional power-grids[7]. The furious forces of the heavenly dancer aurora would not have been known without activities such as, rocket operations and interpretation of atmospheric measurements during an aurora

[6] When I refer to the space industry without considering it from an organisational perspective, I use the Norwegian term *'Romfarten'* or 'industry', because this term does not directly point to it as an industry.
[7] The exceptional forces in the northern lights, illustrates why questions of harnessing electricity from her have been posed.

eruption. The aurora has been opened up to a new kind of human experience, through extensive investigation of it. Moreover, these locally situated activities from Andøya contribute significantly to how meaning and knowledge about heavenly phenomena is produced. Through their instruments, local and global activities enable a new perspective. They allow humans – *homo faber, the-tool-maker* (Ihde and Malafouris 2019) - to see celestial phenomena from the inside and outside, through the use of mediated instruments like, rockets, telescopes, satellites etc. This kind of visualisation takes part in the recreation of how human beings relate to Earth and those phenomena explored in the atmosphere and in the universe. The distant becomes familiar through the use of mediated instruments (Hoeppe 2012; Ihde 1979, 2011).

In addition to produce knowledge about heavenly phenomena and extend human experiences through instruments, space activities create a substantial amount of waste. Space junk is a growing issue, and it is comprised of both environmental and material issues (which create economic issues). The kinetic potential increases the further out into space a vessel goes, and if the vessel is to collide with space debris – space junk – the vessel itself is demolished into space junk. Waste and space junk is becoming a major issue and is getting more and more international attention. Simulated images of garbage lanes[8] in orbit, create an anxiety for the climate and environment that exceeds terrestrial boundaries. This, in turn, contributes to *changing* how humans relate to the terrestrial and extra-terrestrial; our boundaries are constantly stretching further and further out into the universe. When a multi-stage rocket is launched, it discards engine stages, which splash down into the oceans, where they'll usually remain. A dead satellite can, for example, make a re-entry, or be pushed out into *junk-orbit;* however, usually the dead satellites float around in their launch orbits – forever floating with the other satellites. On Andøya, several locals communicated their concerns regarding waste, but at the same time they were waiting for the world-community to step in. Our present epoch is called the Anthropocene, because humans are making lasting and enormous changes to the landscapes that surround them. The Anthropocene usually concerns human activity on Earth (see chapter V). As I argue in chapter V we must move the Anthropocene out of terrestrial boundaries as well – we need to *follow* the junk; as anthropologists Olson and Messeri (2015) argues, we need to *un-earth* the Anthropocene.

Increased public focus on environmental issues makes it necessary to legitimate activities that produce waste. Space junk is a growing problem that necessitates that any

[8] When conversing with informants regarding space junk, they often referred to '*Søppelbaner'* (Garbage lanes), where dead satellites could be pushed out to. These are orbital lanes devoted to garbage.

activities that litter must be legitimised if they are to continue. The advantage of continuing with producing waste must appear positive. Such as, launching satellites to enable Earth observation (see chapter V). Launching a satellite is the same as launching a rocket, however, it is the size of the rocket that determines the amount of waste that is produced; bigger rockets equal more junk. When launching a satellite, usually, it is with the use of a gigantic rocket. Those rockets are able to piggyback additional satellites up into orbit. Bigger rockets have more engine stages than those researching the northern lights, this means that more waste splashes down into the oceans, and more junk remains in orbit when their lifetime is over.

Narratives like *Green space* and *Green rockets* legitimise activities. At the same time, these narratives, contribute to creating interest in, and fascination about, outer space and the universe. On Andøya, you as a visitor can ride in a space shuttle simulator (at the visitor centre), and carry out a mission, on the behalf of humans, on their way to Mars. This creates excitement, and hopefully it creates enough fascination to recruit children and youngsters to the natural sciences and space technology (which is taught on the local upper secondary school), to hopefully educate a new generation of space explorers for the future. Moreover, it is not possible to make *green* rockets, and nor is it possible to have a *green* space industry. *Green space* means, by definition, zero activity. In this thesis, green space is viewed as a legitimating narrative, which in no way cleans up orbit waste.

Following these sub-assertions presented above, I will throughout this thesis examine in depth how some local space activities at Andøya Space Centre contribute to changing how human beings relate to the terrestrial and extra-terrestrial. It is through the tool-users continuing unpacking and mapping of phenomena and objects beyond terrestrial boundaries that these relations change. What was previously distant or unknown to humans is constantly filled with social and cultural meaning (Gorman 2005). A hermeneutic approach will demonstrate how meaning is produced through the interpretation of objects, phenomenon's and context, and how this understanding constantly changes (Geertz 1993; Zimmermann 2015) with new discoveries. What was previously only seen as a dark and furious force dancing in green, white, purple, yellow and sometimes red, on the blackened starry skies, has been explored to the extent that the understanding and relation human beings have to the northern lights has indeed changed. The northern lights have been investigated, and we now have knowledge about how electrically charged particles are colliding with Earth's atmosphere, creating chemical interactions that manifest themselves visually in different shapes and colours. Despite this knowledge the northern lights are still displayed as a dancing cosmic woman performing on the dark winter sky (see chapter IV). Through the interaction of local and global actors, terrestrial boundaries are moved further and further out into the dark cosmos by each new activity. We shall see that local space activities are not isolated events in the global act of exploration, rather we shall see that the human need to imagine, and wonder are important parts in *Romfarten*. Moreover, homo faber (Ihde and Malafouris 2019) and the artisan's (Ingold 2000) ability to interpret, develop and use tools becomes important as I approach how humans continually change how they relate to Earth and the universe in the contemporary Space Age (cf. chapter II). The universe is constantly filled with material culture (Morphy 2010), descending from human activity on Earth. Those materials are consequently filled with cultural meaning (Gorman 2005), and this, in turn, provokes awareness of the human impact on terrestrial and extra-terrestrial environments. Space junk is thereby 'creeping out from the shadows' of the universe. Observing how human beings not only dump waste and litter on Earth, but also send waste into orbit, pushes the Anthropocene beyond its terrestrial boundaries.

All these assertions described above are empirically examined to show how space activities change how human beings relate to Earth and the universe, and how terrestrial boundaries, constantly and little by little, stretch further into the universe. By going through these assertions throughout this thesis, I explore my main argument, *Space activities contribute to changing how humans relate to Earth, and to the universe. Every activity recreates the world, piece by piece*

1.3 Location – 'A window to the universe'

> Gazing up at the night sky from the edge of the Norwegian sea, you know you're in an unusual place. The frigid winds stream across an open sky, painted by the dance of the northern lights. Outer space almost seems closer here. It turns out, that's not so far from the truth.
>
> *Rob Garner NASA 2018*

In his statement Rob Garner metaphorically paints a divine picture of the island at 'the end of the world', as many locals half-jokingly describe it. Breaking down the mystique often attributed to the universe, the exploration and exploitation of outer space becomes a structural and tactical place. In the early 1960s, analysis found Andøya to be the best place for establishing a rocket range in Norway (Brekke and Egeland 1994). The reason, as mentioned, was because of the island's geographical location just below the northern lights oval. Andøya is on the same latitude as the oval and the polar cusp[9] both, making the sub-arctic island, surrounded by the Norwegian Ocean, a suitable place for launching scientific rockets "into a cold and calculating heaven" (Redfield 2000: xiv). The aim was to learn more about the insides of aurora borealis and Earth's magnetic field, enabling the investigation of the unknown, thereby 'opening' the insides of the aurora borealis to human interpretation.

The Norwegian Civil Aviation Authority functions as the legislative authority permitting launches from and over Norwegian soil. "And this is clear, when they are going to launch rockets, then, it is us that gives the final go/no-go, because this is controlled airspace, and shared airspace" (Air-traffic-Controller 2020). The local space operators and local air-traffic officers cooperates in real-time during rocket campaigns and other kinds of launching operations (for example technological testing[10] of military weapon systems). The high-energy reactions at work during launching operations, and the proximity to international airspace, makes it advantageous to have a rocket range on Andøya. In international airspace, "you can do what the hell you want to … And that's why we have a rocket range here, because our closest neighbour is international airspace" (Air-traffic-controller 2020). The proximity to international airspace, the aurora oval and polar cusp makes this place a *window to the universe*, creating a "near distance" (Ihde 1979: 10) to outer space. Moreover, taking a brief look at a global live flight tracker, it is clear that airspace traffic is lighter this far north, almost non-existing in comparison to, for example, Europe's main artery with Paris, Amsterdam, Frankfurt and London.

In the near future the local space centre is increasing their activities and the establishment of a small-satellite launcher is under construction, at time of writing. The geographical position of the island is just as important for establishing this new launch site as it was for establishing the rocket range in the 1960s. Additionally, the local space centre has an already well-established material and human infrastructure. An infrastructure consisting of human competence, available radar-parks, a laser mountain to enable Lidar measurements, and a military airport big enough to house one of the world's biggest aircrafts, all at the disposal to customers intending to conduct research projects. Andøya Space Centre has been granted a danger-area on 25,000 square kilometres from the Norwegian Civil Aviation Authority

[9] "The polar cusps are essentially two holes in our magnetosphere. Here, Earth's magnetic field lines funnel the solar wind downwards, concentrating its energy before injecting it into Earth's atmosphere, where it mixes and collides with particles of Earthly origin" (Hatfield 2018).

[10] Technological testing refers to "full-scale test of heat shields for spacecraft, technology of hypersonic vehicles, advance missile systems, large unmanned aircraft and hybrid propulsion for rocket motors…" (Andøya Space 2021).

(Andøya Space 2021). Andøya is the only place in Norway that is afforded such a vast area for testing and launching. According to one operator at the space centre, Andøya is probably one of the few places in the world with a launching area of this size. The new launch site is going to be bigger than today's rocket range, and the launch activity will heavily increase as well. Today's launch pad has the capacity to launch sounding rockets that weigh up to 7,000 kilograms. The new launcher is built to facilitate launching rockets between 50,000 and 100,000 kilograms. The sub-arctic window to the universe is enlarging, stretching further and further beyond terrestrial boundaries and into the dark and cold universe.

1.4 Scholarly attention

The sub-field of anthropology called *anthropology of outer space,* has flourished in the past two decades, yielding thick ethnographies. Valerie Olson, Lisa Messeri, Debbora Battaglia, David Valentine, Peter Redfield and Stefan Helmreich are significant contributors to this field. Olson (2010; 2012; 2019 among other publications) brings attention to how habituality in extreme environments on Earth is seen as analogous to the extra-terrestrial, focussing on how such places create social conceptions in the sense that extreme environments on Earth correspond to extreme environments in outer space. Moreover, she flips the coin on anthropology and attends to systems as ethnographic objects, rather than mere interpersonal relations. Olson investigates how multi-disciplinary fields such as, medicine, environmentalism, technology and science play important parts in the American space programme. Messeri (2014; 2016; 2017, among other publications) brings geology into focus, and how the space industry drove *geology to the moon*. She discusses how this has impacted the American astronaut training programme. Bringing geology to the moon was paramount to implementing a three-month fieldwork into astronaut training, where astronauts are made to collect surface samples from the Utah desert, and live for several weeks on the seabed of the Florida coast. Messeri draws attention to human perceptions of being attached to something greater and bigger than themselves, entering some kind of *companionship* with outer space. She focusses in great depth on the astronaut training situation, and compares the anthropologist and astronaut in several cases, as both desire to accomplish a resonance between something unfamiliar, and in turn to make it familiar in analogues settings. Battaglia (2005; 2012 among other publications) describes how the field focuses on the imagination of human beings living on another planet or out in the universe, and thus argues that human encounters with outer space is in fact cultural. Cultural in the way that scientific disciplines, religions, magic, superstition, imaginaries, social organisations, and such are all topics one encounters when approaching outer space from an anthropological perspective. She draws on autoethnographies of Russian cosmonauts, and argues that *being* in space changes the relational human being. The perception of Earth changes, bodily structures change, thoughts change, and relations[11] to the universe change. Valentine (2012; 2017 among other publications) outlines how space actors plays a part in producing cultural imaginations, focussing on space exploration through social life, ideological beliefs and cosmological realities. Further he discusses how space activities provokes an idea of capitalistic winnings for policy makers and other actors in the industry. Put differently, human engagement with outer space opens the possibility for economic growth. Valentine also brings attention to astronaut training, and compares space activities with the hegemonic discourse of what it means to be human in zero-gravity. Redfield (2000; 2002), with his excellent ethnography on the French space centre in Kourou, draws attention to the penal colony in French Guiana and the French technological prowess of the Ariane programme, launching rockets from the *gates to the heavens* in Kourou. He describes in depth how the rocket came to be launched from the tropics, and how that has affected every part of social life in French Guiana. Redfield brings together the colonial history of Kourou and the ritual practices of the Ariane rocket program. He describes the historical context, and the hopes for the future in the contemporary Space Age. Helmreich (2009; 2012) compares the microbiological seas with outer space, and refers to the oceans as an *Alien Ocean.* He points to how the ocean and human culture *mix* when humans explore the sea. They listen to the *messages from the mud* and interpret this into cultural meaning. He compares *Spaceship Earth* with the mysterious oceans. He explains how microbiologists and students encounter the oceans so close that they enter an embodied relation with it. Further, Helmreich, discusses a *Blue-green* narrative, arguing that the ocean withholds mysterious and renewable resources for human detection and exploitation. He also draws on how astrobiologists connect extreme analogous to outer space, elaborating on how scientific research and technological tools enables relativism and synergies between the terrestrial and extra-terrestrial.

The anthropology of outer space is gaining more and more attention at university departments all over the world. Ethnographies differ in topic, anthropological locus and

[11] In the field, anthropology of outer space several of the authors discuss human engagement with outer space, or space activities as relational. With relational, relation and "relationism" (Helmreich 2012: 1127) they point to how various form of scientific, political, economic, local and global interaction with outer space, make the universe more familiar.

methodological approach; however, they share the same notion: that anthropology of outer space has a lot in common with traditional anthropology. The field concentrates on *boundaries* and *limits (*Pirni 2016)*, relativism* (Helmreich 2012; Valentine 2017)*, myth, imagination and science fiction* (Smith 2019)*, analogous fields* and *geology* (Olson 2010; Messeri 2016; Messeri 2017; Olson 2019)*, systems of interaction* (Olson 2019)*, Earth and environment* (Boes 2014; Olson and Messeri 2015; Lazier 2011), *visual and bodily practices* (Hoeppe 2012; Vertesi 2012; Messeri 2016) *policy making* (Olson 2012; Valentine 2012; Olson 2019) and *narratives* (Helmreich 2009; Messeri and Vertesi 2015).

This all comes down to, *what does it mean to be human in a terrestrial and extra-terrestrial context?* The anthropological pioneers in this field have approached the topic examining, not just their fieldsites with anthropological literature, but also how disciplines in STEM (science, technology, engineering and math), history, science fiction, geology, and NASA (and other space agencies) have conceptually approached outer space.

Because I have had the opportunity to use all these earlier works by established anthropologists studying the field, my focus has mostly been on the anthropological literature. However, limiting myself solely to anthropological literature has not been appropriate. I have also benefitted by using literature from outside anthropology, especially when it comes the phenomena described by the natural sciences, such as the composition of the northern lights, or the explanation of the polar cusp, and how the local space centre present itself towards the public. The field is still 'under construction', and there is still much to learn by paying attention to other disciplines which work in the same field. However, these kinds of ethnographies are mostly (to my understanding) carried out by established anthropologists, and is usually not a first-fieldwork-experience. I have encountered *one* graduate student at the University College of London (UCL) that has carried out a similar fieldwork at *Spaceport America.* This thesis will, hopefully, provide a contribution to the sub-field, anthropology of outer space.

1.5 Outline of thesis

This thesis is divided into six chapters. The first two chapters is an introduction to field topic and methods. The three following chapters – III, IV, V - present empirical material, each building on the main argumentation and sub-assertions. The final chapter summaries main topics discussed throughout this thesis.

Chapter I describe the field, and positions the thesis in the anthropological sub-field outer space. Empirical material is put into a Norwegian context, and I thereby argue that local and global activities must be examined in the same context. Andøya is portrayed as a window to the universe, and I argue that the local activities contribute to how human beings relate to Earth and the universe. A brief disciplinary outline is presented.

Chapter II presents which ethnographic methods and techniques were used during the fieldwork. The chapter begins with a presentation of the novice anthropologist arriving in the field. At the earliest stage of the fieldwork, the SARS-CoV-2 pandemic paralysed society and discouraged face-to-face interaction. Therefore, I have included a section which describes any resulting fieldwork obstacles and methodological changes, as these had implications for my access to data. I discuss how I interpret technology, nature, and hermeneutics through an anthropological and philosophical perspective. Thereafter, I show how a 'backstage' (Goffman 1959) position in a local household made me acceptable to the gatekeepers of the local space centre. I draw attention to the 'domestic fieldwork' situation, and discuss this as a favourable opportunity to carry out contemporary fieldwork. Finally, a brief summary of ethical concerns, and 'Norsk Senter for Forskningsdata' NSD approvals are addressed.

Chapter III describes two student rocket operations that were launched from ASC in depth. These show how a rocket operation is a multi-faceted activity. On the one hand, rocket operations prove to be a seemingly non-human activity, yet, the individual human beings are equally important to ensure a successful launch. These two rocket operations are presented *in-situ* and *hands-on* from the science centre at ASC. The science centre is a control room for measuring scientific conditions during launching operations. The students perform the operational roles, and I discuss how this is an embodied practice, where the students are to feel like rocket scientists. Moreover, a rigid system of standardisation procedures pervades throughout operations. I focus on *thick descriptions* (Geertz 1993; Geertz 2005) in these two operations, showing how standardised procedures through the intercom system and countdown sheet is of utmost importance. I argue that the human-machine-interaction is paramount to launch a rocket.

Chapter IV leave standardised procedures and actual activities from previous chapter behind and investigate the dreaming and exploratory human. Homo faber (Ihde and Malafouris 2019) and the artisan (Ingold 2000) breaks free from the modern division of art and technology, and rather goes back to its traditional understanding that combine them (*ibid.*). It is described how every aspect of the human is important in space activities. Outer space ventures are filled with social and cultural meaning, and in this chapter, we will go behind the structural procedures (schematic procedures, and countdown sheets). The will to explore, the dreaming human and the experience of being emotional connected to the universe through common building bricks is a driving force to continue with engaging the universe with material culture (Morphy 2010). The coexistence of technological instruments and the individual imagination plays an undeniable part in the tales of locals when they talk about their fascination for space activities and the universe. A discussion around poetry and prose, and the act of making the unfamiliar familiar is inarguably present in all these stories. Mediating instruments, such as sounding rockets, radar-parks, laser-rays, satellites and binoculars are important tools to extend the human experience beyond planetary boundaries. The act of seeing the world from the outside-in, and the continuous break-down of planetary boundaries, pervades throughout this chapter.

Chapter V is the final empirical chapter of this thesis, and it brings to the fore some actual consequences of the human engagement with the universe. A distinction between actors – explorational and exploitational – is made, which points to a significant difference between commercial and scientific actors in the space industry. The social contract is discussed, and how local activities contribute to tensions between local fishermen and the space centre. Space activities produce waste and garbage, and thereby raises consciousness of space junk and environmental issues. To answer these questions seriously in an anthropological fashion, I suggest moving the Anthropocene beyond planetary boundaries. A continuous pull between the local and the global is presented in this chapter when discussing the problems of Space junk, and the efforts to legitimise continued littering. The mysterious universe, our *Terra nullius,* the place of dreams and creation stories (Gorman 2005) is converted into a strategic place, consisting of race of contracts and economic growth. The term *Green Space* is introduced, and I discuss why we *can't* make *green rockets*.

Chapter VI analytically summaries these empirical chapters, going back to the main argumentation of thesis. And I address my contribution to the field *Anthropology of outer space.*

Chapter II
The illusion of the 'perfect' fieldwork

2.1 Arriving in the field

As I was standing there, in the winter freeze, outside of the local airport, I could feel the wind push its way through my thick winter clothes, and instantly I felt the harsh sub-arctic climate on my body. The sky was dark blue-ish, even though it was only the afternoon. It is a known postulation that doing fieldwork at home is not foreign nor exotic, however the combination of nature's forces so far north, and me standing there as a curious novice anthropologist, made this place feel both exotic and foreign. And as anthropologist Van Maanen emphasises, the exotic is, indeed, a subjective feeling belonging to the fieldworker, and this subjective feeling "is the central rite of passage serving to initiate and anoint a newcomer to the discipline" (1988: 14). On the northern hemisphere, 69 degrees north and 15 degrees east, we find the island of Andøy, where I was about to settle down for the coming six months. An island surrounded by steep mountains, miles and miles of marshlands, outstanding nature, explosive eruptions of the northern lights, and home for a vibrant collection of animal life including whales, puffins and eagles. I settled in the capital village, to be near the local space centre and hopefully the people working there. I knew that the months of polar nights were over, and that daylight was slowly coming back to the north, and eventually would be replaced by its opposite, the midnight sun. The island is full of contrast, polar nights and the midnight sun, untouched nature and material culture (radar-parks all over the island, rockets launching into the heavens, Lidar-rays strong enough to blind someone, etc.), remote but still central.

Arriving from a larger Norwegian city I soon discovered that the pace of life and mindset of locals was quite different than my regular routines back home as a university student. In this, nobody seemed to stress about the transition from one thing to another, but rather took their time to engage in impulsive conversations, coffee visits and enjoying their time outdoors with friends and family whenever they wanted to. Engaging in ways of life in the arctic, like trying to bicycle through heavy snowstorms, with gusts up to 25 m/s during the winter, not being able to sleep one good night during the months of midnight sun and going to bed several hours too early because winter-storms caused power failures, became a common way of life during my six months on the island, from Mars to September of 2020.

This anthropological journey came into being through my interest of dense technological environments. Moreover, the way that such environments are so pervasive as to usually be taken for granted, grabbed my interest. I was certain that environments like this affected both culture and social life in a way that is not yet extensively explored. I was determined to find a place where advanced technological systems were somehow part of daily life, and with that in mind I figured that the more advanced or pervasive, the more it must affect social life surrounded by it. With this initial thought in mind, the space 'industry' excited my academic curiosity. A remote island with traditions in agriculture, fishery, international military services, and a local space centre, seemed like the perfect place to start a novice fieldwork. Before arriving in the field, I had been denied access to the local space centre. However, determined as I was, I was sure the access would be granted if I just arrived, and on that account, I packed my bags, booked a plane ticket, and went to the Norwegian sub-arctic.

2.2 Triangulating a suitable methodology

Social anthropology, as with other social sciences has a history of not always agreeing about the ways things should be done, or how it is we should interpret *the others* (Ingold 2014; Pelto and Pelto 1979 Geertz, 1993; Hazan and Hertzog 2012, amongst others). Nevertheless, the undeniable bedrock of our discipline, participant-observation (Ben-Ari 2012; DeWalt 2002; Ellen 1984; Spradley 1980; Madden 2017, amongst others) were to be my preferred and most used method during fieldwork. The data material provided by this method is argued to be best suitable to analyse social life (DeWalt 2002). Participant observation for me unfolded in several ways. It involved being present during rocket operations (cf. chapter III), however participating in the form of pressing buttons and being an active part of the countdown procedure was not not accessible to me. This was because of my lack of operational practice, knowledge about space operations, and my lack of security clearance from the National Government. Moreover, investigating how a local space centre contributes in a worldmaking narrative, is not as easily embodied, as for example helping someone to paint a garden fence.

As I a part of the participant observation method, I spent a lot of time hanging out with my informants and locals in general. I went on hikes with them, participated in birthday and dinner parties, spent holidays with them, and went on occasional cabin trips. Additionally, I spent a lot of time engaging in the local community by being a volunteer in a local organisation. Embodiment through participant-observation is not a singular event, it takes place in particular situational contexts throughout the entire fieldwork, while learning to become a member of a new community. Despite that, in the science room during rocket operation, the procedures, the words shared and not shared on the telecommunication system, are felt intersubjectively between those sharing the room during an operation (see chapter III). Moreover, building relations with informants over time also created a mutual environment, making me as the anthropologist feel their frustration, amazement, anxiety and suchlike, when conversing and hanging out together. Fieldwork is about participating and being able to manage to get as close as possible to our social environment and informants, so close that we become a part of it (Fyhn 2005), at the same time a conceptual distance is desirable (Rivoal and Salazar 2013) to facilitate hermeneutic movement (Cerwonka and Malkki 2007) throughout the fieldwork. Participant-observation is a manifold practice (Bernard 2006), often moving between participation and observation, dependent on the situational context.

This fieldwork was determined and categorised in advance as "a topic oriented micro ethnography" (Spradley 1980: 30), which means that my locus was already determined by a specific social phenomenon. From this perspective, I preferred to use semi-structured interviews (Bernard 2006) with loosely defined questions. Giving me, as an anthropologist, the opportunity to be 'educated' in the body of work going on with local space related activities. These questions were easily altered during interviews if necessary. Interviews were recorded and transcribed, and usually lasted around one hour.

Informal chit chats (*ibid.*) were a third technique used throughout the fieldwork. I found this technique really interesting, and at times difficult to balance. Difficult in the way that one needs to balance between 'regular' conversations, being a friend and fellow peer, and simultaneously being on the analytical alert. Informal chats were more complicated to handle during dinner parties, than during for example café meet ups or hikes. As Scheper-Hughes (1992) emphasised, anthropologists are always on duty when being in their field.

2.3 Looking at people

> Being ethnographic is really a rather strange way of being in the world that attempts to approximate naturalness.
>
> *Madden 2017: 97*

Planning for fieldwork as grad-students, we are required to learn how to find and define our ethnographic gaze, before setting out our first fieldwork into practice. Madden (2017) argues that looking at people, being in the world, and trying to understand what we are observing, is shaped by the exchanges between anthropologist and participant (*ibid.:* 97), and thus by our ethnographic toolbox. Anthropologists out in the field are themselves considered as the main research instrument, and "… what we see is shaped by our experiences, and our 'gaze' has a direct bearing on what we think" (Stoller 1989: 39). Our toolbox then consists of our theoretical orientation, personal interest for the subject of empirical investigation, as well as contemporary society and the disciplinary paradigm we are educated into. Our anthropological toolbox is therefore our starting point for developing a methodology for a particular fieldwork. Every piece of fieldwork is different, and every fieldworker is different; therefore, every methodology must be different. I understand methodology as the combination of theory, method, and project topic, in addition to my own interest for the ethnographic subject of examination. To develop my ethnographic gaze on *Romfarten*, I saw the emergence of clarifying my 'technological' understanding. And with that, I would like to cite Røyrvik (2012):

> When the concept of technology is used without any clarification, often it points to objects that are recognised by their specific qualities or function… When technology is being explained it points to explicit knowledge connected to technique (*ibid.:* 177, own translation).

And this I shall clarify in detail, by combining the perspectives of Ingold (2000), Røyrvik (2012), Ihde (1979) and Ihde and Malafouris (2019). This should enable us to understand the meaning of technology, which is, understanding the social realm it is included in. Preparing such an understanding of technology, we must break with the Cartesian dualism (Hornborg 2006) of subjects and objects. Acknowledging that both subjects and objects impact each other.

2.4 Theoretical clarifications

2.4.1 'Technology'

> The revealing that rules throughout modern technology has the character of setting-upon, in the sense of a challenging-forth. That challenge happens in that the energy concealed in nature is unlocked, what is unlocked is transformed, what is transformed is stored up, what is stored up is, in turn, distributed, and what is distributed is switched about ever anew.
>
> *Heidegger 1977: 16*

Throughout this thesis my analysis and understanding of space related activities is guided by a perspective on 'technology'. I interpret the emic term 'technology' through a practical perspective, and explore this through how my informants use it in in their everyday language. My theoretical understanding comes from my interpretation of Røyrvik's (2012) discussion of 'technology'[12]. Røyrvik (2012) writes that "… technology is not a thing nor an object that can be separated from the human being, socially or within a society" (*ibid.:* 211 own translation), implying the importance of recognising this, because when the term is used in general, it often refers to an "object or specific machine" (*ibid.:* 211, own translation), identified from particular qualities or functions. It is these kinds of objects or things, with these kinds of qualities inscribed, that I point to when referring to 'technology' in the emic point of view, and when I use the term without further qualification. The pragmatic perspective, Røyrvik argues, is often linked to an instrumental understanding of technology, whereas "technology in itself is not regarded as having any impact" (*ibid.:* 182, own translation), rather, 'technology' is seen as an "invisible joint between cause and effect" (*ibid.:* 182, own translation). Furthermore, he brings attention to a deterministic approach towards 'technology', the position often taken by scholarly papers (*ibid.:* 211). This is a perspective where 'technology' is taken to be an explanation for how "A is a premise for its consequence B" (*ibid.:* 184, own translation). Moreover, Røyrvik[13] addressed that the latter is the one approach most philosophical thinkers on 'technology' separate themselves from, because the development of 'technologies' is not solely determined by one particular (linear) turn of events. The way I use technology, might therefore be labelled as an instrumental approach to 'technology', however I do recognise that

[12] Røyrvik bases his understanding on technology on Heidegger (1977), Ingold (2000), Marx (2005), Larsen (2009) and Johansen (2008).

[13] Røyrvik explores technology more deeply than I intend to, ontologically considering a worldview and understanding of reality with perspectives on *technological metaphysics* and *metaphysics,* explaining how "*metaphysic distance* defines everything that exists in the being" (*ibid.:* 208).

this is not straightforward. I also argue that 'technology' is more than an 'invisible joint' (*ibid.*), and I take a perspective that considers 'technology' that itself *do* have an impact on the social. Moreover, it is through mediated interaction that 'technology' enters the social sphere in space related activities on Andøya. When I point to mediating instruments, I follow Ihde (1979) and his theory of action. Ihde emphasises that a theory of action includes embodiment relations between human tool-users and mediated instruments (*ibid.*). As I understand Ihde, he proposes to take one step further than Heidegger (1977), by investigating the human-instrument-tool relation as an extended human experience, using instruments. He stresses the importance of acknowledging human-mediated experience through instruments and tools, and how the human experience is mediated using machines. Ihde remarks an important implication in the human-machine-relation, that I follow throughout this thesis:

> … there is an experience of the microscopic and macroscopic universe through instruments. Scientific investigation is embodied by technology. However, it is equally important to note that such embodiment is different from the world of the naked perceptions of earthbound man [*sic.*]. (*ibid.:* 10).

This perspective becomes especially important considering that much of my empirical descriptions are on the human activity of launching student rockets from Andøya Space Centre. In chapter III, I describe how these activities are instances of human embodiment using mediating instrumentation, as is the case with, for example, a sounding rocket. Even though I lean towards an instrumental approach concerning 'technology', this does not limit my analysis. I also emphasise the importance of examining how such activities (as I have described in chapter I) impact the social sphere and our understanding of Earth and the universe, and what it means to be human in the contemporary space age. I do agree that an instrumental approach is not suitable on its own, and, as my empirical findings suggest, embodiment using mediated instruments (Ihde 1979) is so pervasive in space operations, that it changes what it means to be human in the contemporary space age.

Homo faber and the Artisan

Student-rockets, radar-parks, and control-rooms are tools and instruments which the tool-user, 'man-the-maker' (Ihde and Malafouris 2019), and the artisan (Ingold 2000) engage with in the world and in space activities. The operator, student, or scientist, is given the opportunity to inscribe meaning and practical movement using their tools and instruments. I understand the term artisan in its traditional perspective, before a division of art and 'technology' emerged in modern society (Ingold 2000). The Latin and Greek etymology of art (*artem* or *ars*) and technology (*tekhnē*) literally means the same, "namely *skill* of the kind associated with craftmanship" (*ibid.:* 349). Therefore, combining rather than distinguishing art and technology, is paramount for examining how space scientists, operators, and other personnel at the local space centre unfold their tasks during operations, and when talking about the universe and space related activities. Further, Ingold (2000) argues that this modern distinction between art and technology "has brought a profound change in the way we think about the relation between human beings and their activity" (*ibid.:* 295). And this, I argue, is the best suitable approach for my examination of space activities; the traditional approach should be brought back as a lens. The artisan is very much present, and "of course, knows what he is making" (*ibid.:* 295) and is thereby aware of a manifold of different capabilities for producing meaning, knowledge, and the various opportunities for bodily movements to accomplish their tasks. Skill, Ingold (2000) argues, is the combination of 'techniques', 'technics', intelligence, sensibilities, and the bodily movement of the "practitioner in his or her environment" (*ibid.:* 349).

Moreover, the artisan is closely connected to homo faber, which is, in Ihde and Malafouris (2019) understanding, human beings themselves carving out a representation of their environment using practical skills, materials and 'technologies'. Furthermore, they argue that humans themselves are "constituted through making and using technologies that shape our minds and extend our bodies" (*ibid.:* 195). These 'things' that we produce, for example a sounding rocket, are not only made by us, but they consequently also *make* us (*ibid.*). Meaning, that they contribute to a change in how we perceive the environment around us (terrestrial and extra-terrestrial). Homo faber in comparison with the artisan is also driven by creative abilities to create and develop material tools and instruments. The Latin word *homo* means human, and the Latin word *faber* means an artful craftsman (material worker) that masterly percept's, builds and develops materials (Johanssen 1998) into an object (chair, sculpture, rocket, weather balloon etc.). The "creative abilities of human consciousness" (Ihde and Malafouris 2019: 203) cannot be separated from culture, because all "… opportunities for material engagement … are embedded in specific social and historical environments" (*ibid.:* 204). Similarly, the local scientist, operator, or other personnel are all embedded in the cultural act of worldmaking in the local and global space 'industry' (*romfarten)*. Homo faber (man-the-maker) "change[s] the world" (*ibid.:* 197), and thereby also changes the way "… we experience and make sense of it" (*ibid.:* 197).

Put differently, I understand the term technology as human interaction with instruments and tools, that together, in interaction, 'reveals' a particular purpose of the 'thing'[14] itself. Secondly, combining my understanding of Røyrvik's (2012) on technology, with Ihde's (1979) theory of action and Ingold's (2000) theory of the *skilled system* (*ibid.:* 306), our relationship to technology becomes more framed.

Theory of action, as mentioned above is understood here as the embodiment of 'technological' instruments through human activity, for example when a student rocket is launched from Andøya it is dependent upon systems that enable the rocket to lift and launch, and human engagement through the expertise of controlling instruments and reading telemetric data. This interplay between human and machine displays the instrument as a human extension of knowledge and embodied experience (Ihde 1979: 8). The interplay between machines, techniques and human activity is important to deliberate when empirically examining space activities, where it is not the operator, scientist or technician's muscular power that determines action. On the contrary it is human will, dreams and perception of various outcomes of movement, that sets out into practice knowledge about different techniques that endorse the "skilled system" (*ibid.:* 306). The skilled system as described by Ingold, unfolds when a machine consists of two systems: On the one hand, he explains the deterministic system where "… all possible motions are fixed in advance by the structure of the machine…" (*ibid.:* 306); on the other hand, in the skilled system, "… intended result is achieved through a continuous process of modification and adjustment, requiring constant… attention." (*ibid.:* 306), because it is the operator that adjusts, modifies, and analyses all possible movements and feedback during an operation to reach a desired result (*ibid.*).

2.4.2 'Technology' as a cultural logic

Cultural representations and expressions differ between social groups all over the world, however, some expressions can sometimes be 'universal'. Clifford Geertz (1973) in *The Interpretation of Cultures* stress that, in presenting culture without conceptualising how it is understood, or worse, developing an understanding of culture that is based on the "sensitivities of the person who presents it "…is regarded as a travesty – as, the anthropologist's severest

[14] I follow Ihde and Malafouris (2019) in my understanding of 'things'. They explain that they refer to the term "… in the broad sense of material forms and techniques – it refers to the materiality of mundane objects, tools and artefacts as much as it refers to modern technologies and new forms of digital culture" (*ibid.:* 196).

term of moral abuse, ethnocentric" (*ibid.:* 24). Therefore, culture is here interpreted as "those skills, perceptions, and behaviours" (Eriksen 2010: 15, own translation) people learn as members of a society or social group[15]. The skills and knowledge to develop and use tools and instruments, are regarded as part of the cultural symbiosis. I understand tools and instruments as mediators for exchanging meaning between human and non-human actors. Instruments and tools help the tool-user (operator or scientists) to represent parts of 'nature' through interpretation of data material that is 'downloaded' from the instrument, and thereby inscribed with meaning. By comparison, Sharp (1964) describes the way in which the Yir Yoront cultivated land and structured their society around a stone axe, and "the production of a stone axe required a number of simple technological skills" (*ibid.:* 65), I understand activities in *romfarten* in a similar way. Moreover, how societies represent, arrange, respond, develop, and use instruments and tools makes up what I choose to call the cultural logic of technology. All these practices are based on human action, driven by norms and practical knowledge, the dreams and curious minds of men and women; action which is, indeed, culturally conditioned.

Finally, technology as cultural logic in the contemporary space age stands in relation to human conquest of the forces of 'nature'. Thus, the world as it is perceived (through continuous unpacking of heavenly bodies) is organised using tools and instruments (like sounding rockets, radar-waves and Lidar-rays). In the 'technological age' we now live in, our understanding of reality is continually reshaped by the activities that are included in the skilled system (*ibid.*). Representations are thus formed by the contemporary age's hegemonic compulsion of objectification and standardisation (Almklov, Ulset and Røyrvik 2017), as we shall especially see in chapter III. Technology as cultural logic, then, blends together the human and non-human (Koksvik 2017) in the same experienced social universe.

[15] This understanding is similar to Geertz definition of culture; "… a system of inherited conceptions expressed in symbolic forms by means of which men communicate, perpetuate, and develop their knowledge about attitudes toward life" (*ibid.:* 1993: 89).

2.4.3 'Nature'

The term 'nature' simply consists of two differing positions that defines the relation between 'technology' and 'culture'. These positions are the dualistic and non-dualistic perspective. One of the perspectives argues that nature is primary and detached from the social corpus (Berge 1998). From the other perspective the dualism between nature and culture is empirically problematic, especially in social anthropology. And even more so when we try to understand human activity and the continuous engagement with 'nature'[16], using tools and instruments. And as anthropologist Trond Berge (1998) argues, "nature and society are dependent on each other to appear as separate entities" (*ibid.:* 229 own translation). A dualistic approach towards 'nature' neglects the fact that societies adapt and adjust to their environmental surroundings (Holt-Jensen 2009), "like a snail to its shell" (*ibid.:* 68). Society and 'nature' are therefore different sides of the same matter (Berge 1998: 229).

'Nature' is never isolated and alone, detached from culture, as something primary or 'pure'; it is an interwoven part of homo faber (Ihde and Malafouris 2019) and the artisan cultural logic of the world we live and act in.[17]

2.5 Forming a methodological approach

The hermeneutics of ethnography, however, involves a reading of social practices through theoretical concepts without simply reducing the practices to mere "illustration" of theory.

Cerwonka and Malkki 2007: 16

Interpretative anthropology has, since the 1980s, (Cerwonka and Malkki 2007) flourished in the social sciences and anthropology as a popular approach for understanding cultural peculiarities and those everyday 'things' often taken for granted (*ibid.*) in societies that we as anthropologists study. I too choose interpretative anthropology, and a hermeneutic way of understanding my informants and how they relate to the world, space activities and the universe.

Geertz (1993) and Zimmermann (2015) emphasise that everything we as humans relate to is already interpreted and valued with some sort of meaning. Such forms of interpretation

[16] Hornborg (2006) argues that 'nature' as society is in fact "… brimming with agency" (*ibid.:* 23), and that perceiving nature as something detached or 'un-affected' by culture, potentially robs nature of its own subjectivity. Moreover, he argues, the dichotomy between nature and culture, is a modern one.
[17] For further discussion on this topic, se Richardson (2016), Descola (2012) and De Castro (2004).

occur in our pre-supposition (Geertz 1993; Zimmermann 2015), fore-meanings and fore-conceptions (Gadamer 1975) of the 'things' and environment around us. And in many ways, as anthropologist Simon Roberts (2020) emphasises, embodied knowledge is important for understanding meaning. He explains that through observation we learn that the body is a "perceptual and sensory" (*ibid.:* 193) resource that master the practice of skills. Practice, he continues, is the act of bodily movement that sometimes is performed "without too much conscious direction" (*ibid.:* 193), and further, that this is "our ability to improvise in unfamiliar situations …" (*ibid.:* 193-94). And this is what I understand as a hermeneutic approach in anthropology; we already have presumptions of the world and universe around us, as have we regarding exploration of the atmosphere and the universe. However, it is through observation of practice, skills, following of procedures that I examine the material gathered in the Norwegian sub-arctic.

Similarly, as Cerwonka and Malkki discuss in their book, *Improvising Theory* (2007), we as anthropologists are also biased with presumptions of those topics we chose to investigate through fieldwork. Therefore, being reflexive and sensitive towards my own fore-conceptions (Gadamer 1975) is of utmost importance (as far as I can do it). Nevertheless, the anthropologist and his or her informants share an intersubjective space that is filled with similar and different presumptions of the same topic. Hermeneutics is understood, in Zimmermann's[18] (2015) terms, as a circular movement of interpreting "… words, signs, and events into a meaningful whole" (*ibid.:* 7). Put differently, how my informants, talk, relate, act, respond and practice space activities are all parts of the whole when I interpret how space activities change the way in which humans relate to Earth and the universe. Moreover, when asking questions about my informants' thoughts and perceptions of human engagement with outer space, their responses make them reflect over their own presumptions of the matters we discussed. Additionally, when questioning them about their actions in launching activities, other questions arise, and other questions are answered. As we shall see, especially in chapter V, more often than not when talking about space activities (what they do, how they do it, what they think about it, relate to it, etc.), it became apparent that many informants were occupied by thinking about space junk and environmental issues. A topic that I did not consider (and did not even occur to me) when planning for and conducting fieldwork. It was through analysing and "… sorting out the structures of signification …" (Geertz 1993: 9) in my data-material that I first discovered the

[18] Zimmerman (2015) build his understanding of hermeneutics on Heidegger's (1962) book Being and time.

importance of examining people's responses to actual consequences as substantial parts of the whole.

The chapters of this thesis could perhaps seem unconnected to each other. However, it is the different parts of local space activities, bodily knowledge, dreams, urges, procedures, and consequences that all make up the parts of the whole. And as Geertz (1993) argues, it is not the different parts that make up the whole, nor is it the whole that make the parts. Rather the whole and the parts are different sides of the same matter. People's presumptions are already part of a cultural logic of norms, values and symbols. And as Wadel (1991) explains, the anthropological qualitative methodology as a ceilidh[19] between theory, method and data, is similar to the hermeneutic way of interpretating data material gathered in the field. For every new discovery, new questions were posed, methods were changed, topics altered, and in turn, new material differed from the previous. It is a circular movement, whereas the starting point is the presumption of a particular activity or perception, but at the same time, when new discoveries are made, it functions in a retroactive way back on the whole. This is how Fyhn (2005) describes a book; the title of the book tells the reader something about the contents of the pages to come. And for every new page that the reader read in the book, his or her own presumption of the content changes, and therefore the meaning of the book changes as well. The readers' presumptions of the book are taken to the foreground through the reading process, and through this process, the new pages functions in a retroactive way back on the whole that the reader is already included in. Put simply, the hermeneutic method I use throughout this thesis, is the interpretation of words, activities and symbols, that were shared with me by my informants when considering the local space centre, and the global space 'industry' in general.

2.6 Doing fieldwork at 'home'

In the anthropological literature there are various opinions when it comes to doing fieldwork in one's home country, or "domestic anthropology" (Frøystad 2003: 39) as some call it, because this, as it is argued, can lead to *home blindness* (*ibid.*). Frøystad challenges the idea of the 'proper' or 'real' fieldwork, and postulates that there should be no reason for not being able to

[19] I use Ceilidh to point to the interactional and circular movement that anthropologists practice in their fieldworks. Ceilidh in its original meaning, point to an old Irish and Scottish folk party were dancing in circle, storytelling and interacting with friends and neighbours is in focus. Moreover, its similar to the anthropologic approach in the way that one is acquired to move between these party activities throughout the night, as the night unfolds, using their learned skills of dancing and storytelling.

do a 'proper' domestic fieldwork. I argue in a similar manner, and emphasises that the idea of cultural misinterpretations, or loss and reduction of cultural peculiarities when doing fieldwork at 'home', implies a conviction that whole countries are inhabited by a more or less homogenous group, which is far from the truth. Howell (2011) proclaims in a rather distressful manner, "the end of anthropology" (*ibid.:* 142), and depicts a deprivation of the adventurous anthropologic spirit in grad-students doing fieldwork at 'home'. After my opinion, Howell undermines grad-students' intellectual curiousness to discover particularities in cultures and disbelieves our ability to soak in the magic of classic anthropological ethnographies. Howell clearly shares an anxiety for the loss of discovering a holistic understanding when more and more grad-students choose to do fieldwork at 'home'. This implies a naïveté towards contemporary society, not taking seriously that cultural life in various forms is to be found everywhere. And I argue that a holistic approach is perhaps not available in any kind of fieldwork, because access to data in any kind of society will depend on the anthropologist's gender, character, rapport with informants etc. Further, she argues that a holistic understanding is only possible abroad and in 'small-scale' societies. This implicates a rather nationalistic assumption. Gupta and Ferguson (1992) problematise such "isomorphism of space, place, and culture" (*ibid.:* 7) as hegemonic thoughts and criticise anthropological literature for not being self-conscious (*ibid.*) enough.

Regardless, doing fieldwork at 'home' in a remote island in Northern Norway gave me as a novice anthropologist several benefits. Firstly, domestic[20] anthropologists can bring new knowledge and ask new questions connected to phenomena that are taken for granted (Rugkåsa and Trædal Thorsen 2003) in familiar societies. Secondly, as Borchgrevink (2003) addresses, there are problems facing anthropologists using interpreters because of lacking language skills in foreign countries. The point that I speak the same languages – Norwegian and English – as my informants made it easier for both novice anthropologist and informant to understand and ask questions back and forth without being interrupted and confused by language bias or an interpreter's subjective understanding. Bourdieu (1977) calls this *Linguistic capital*, where language is also penetrated by cultural values, norms, ideas, and social interaction. That could certainty be a problematic implication when doing fieldwork at 'home', but, as mentioned, a country is not populated by a homogenous social group, rather it is populated by various

[20] However, I do not agree with the use of categorising anthropologists as domestic, traditional, romantic or other terms. I argue that an anthropologist is an anthropologist regardless of where the fieldsite is located.

heterogenous groups. Being self-reflecting of potential cultural translation errors and reduction of meaning is helpful.

Whether we do fieldwork at 'home' or abroad, we take on as our projects to search for meaning in our observations and conversations with informants. Nevertheless, in my fieldwork the crux was never to do a cultural nor a holistic analysis of the local community, rather it was the local space 'industry' as a social phenomenon that served as ethnographic attraction and interest. Building rapport with informants and my role as an anthropologist in the field was partly established because of my acquired position in the local community (Wadel 1991), and my linguistic capital (Bourdieu 1977). My ability to understand jokes and tell them was certainly helpful (Ben-Ari 2012; Swinkels and De Koning 2016) as well.

2.7 From epidemic to pandemic status

> Streets were empty … local grocery stores were running out of basic food supplies like wheat, yeast, egg, milk, frozen pizza and even frozen berries. I watched an old man collect the last bags of frozen berries from the freezer, about 15 packages. …

No more than eight days into the fieldwork, everyday life for most Norwegian citizens was paralyzed and put on hold, what at this time was categorised as an epidemic was now re-categorised to a pandemic. On every news channel, every radio channel, Norwegian politicians were talking about this Corona Virus (SARS-CoV-2). Messages and emails started to come in from possible informants that I was supposed to meet up with. They all had to cancel and delay our appointments. People had been sent home from their workplaces and had to decrease their social contacts down to a minimum (whatever that meant at the time). The Norwegian Institute of Public Health (FHI) informed on the National Broadcast Channel (NRK) that all schools, all kindergartens, universities, and other educational institutes would immediately close. FHI and the Norwegian government strongly recommended people not to use public transport, not to travel, and health workers were prohibited from leaving the country. The combination of being a novice fieldworker, alone in a new place, living with a family I had just met for the very first time, and society closing for the first time in my lifetime made everything feel bewildering and unreal. Fellow students one after another had to leave their field place abroad and return to Norway. Some were ordered to assist the National Home Guard on the Norwegian borders, and others, like me, had to rethink the entire fieldwork situation.

Fieldwork became more and more difficult in the days after lockdown, I had to decide whether to pack my bags and go home, leaving the dream of becoming an anthropologist behind, or change the whole horizon of my project. Anthropological literature teaches us as fieldworkers to always move around in the social environment as it moves, trying to prepare us to always be ready to handle unforeseen situations (see for example, Vaan Maanen 1988; Wadel 1991; Nielsen 1996). Corresponding frequently by email with a fellow student, Nina, we discussed how serendipity could help us forward in this new and uncertain situation. Serendipity is understood here as stumbled-upon (Rivoal and Salazar 2013) "adventures and escapades" (Hazan and Hertzog 2012: 2) that change important parts of fieldwork in a positive direction. Moreover, it is the nomadic characteristic of the anthropologists that allows for the serendipitous movement to take place (*ibid.*). This nomadism is explained as his or her ability "to be physically mobile, mentally alert, emotionally resilient and socially agile; she must be prepared to modify and revise her theoretical standpoint time and again …" (*ibid.:* 1). This was what Nina and I discussed, trying to figure out how to proceed in our fields. Our discussion centred on how to be proactive, how to change our approach to the project topic, how to ask new questions, and finally, how to extend and rethink methods. Having a methodological tool-kit available made this new obstacle, the Corona virus, an opportunity to take these tools out into practice. Instead of packing my things and going back home, I incorporated digital platforms into my study, and instead of keeping my locus on only space related activities, I invited every part of the local community into my study. This I concluded, could give me a chance to bulletproof my study, in case the new situation was going to last. I changed the plan to conduct interviews from the last part of fieldwork, and moved these plans to the first part, inviting people to participate in interviews over various digital platforms.

In 'normal'-times without social restrictions, anthropologists are encouraged to hang around where people are. However, in this situation, the possibility to just show up and hang around was not an option. I always had to check in with my informants beforehand, always make an appointment, and make sure they were comfortable with their choice of meeting up either digitally or physically. This I argue had major implications on what kind of data material became available to me. Always giving informants a heads up created a situation where the body of interaction was situated beforehand. Nielsen (1996) argues that the anthropologist is always working, and on the other side, often, the informant is just living his or her life. On the contrary, in this situation one could say that the informant in some ways was also working; they could plan what information to share, how they wished it to be communicated before we conversed. The impulsive conversation where decisions are made in real-time slipped because of planning all meetings beforehand. Luckily, restrictions eased during fieldwork, and the infected were nowhere to be seen locally, and people seemed to have a relaxed relationship to the whole situation as spring approached. However, the opportunity to just hop into someone's garden or sit myself down at a café table to engage in any impulsive chit chat (Bernard 2006) was not an option during the entire fieldwork.

2.8 Being 'backstage' – part of a household?

> … the process by which a resident foreigner is incorporated into the conceptual world of his hosts and in turn learns the role or roles assigned to him. The relationship between an anthropologist and his hosts are in some respects like all other human relationships. They are not static but dynamic, and their development can be viewed as a process of progressive conceptualization.
>
> *Briggs 1986: 39*

The anthropologist arriving into a community, moving in with a local family, will always be a little displaced and anomalous. The novice fieldwork as mentioned is the 'perfect' "rite of passage" (Van Maanen 1988: 14) and in this liminal phase we ought to strive to socialise into the local community that we have settled down. As a blessing in disguise, regarding the Corona-situation, my host family did not see me as a temporary tenant, but they 'adopted' me into their family. When they introduced me to friends and neighbours, they always joked, whilst at the same time being serious, that I was their adopted adult daughter. In contrast with Briggs (1986) and her struggles to sometimes understand what was expected of her assigned role as *Kapluna Daughter* in an Eskimo family in the Canadian arctic, my assigned role as an adopted 'daughter' in a Norwegian household context was not as difficult to understand. I did not have to learn any new skills to become a valid member of the household. We cooked together, ate together, went on hikes together, watched tv-shows together, and I was always invited to dinner parties with friends and other family members from outside of the household. The postulation that Fyhn (2005) emphasises about coming so close to become a valid a member of the society we study, is certainly a right description of this novice anthropologist living in a local household on an island in Northern Norway. Fieldwork, I learned, was to be filled with reciprocal relations with the people I encountered, thus being a part of a household, being 'adopted' into a family increased the reciprocal pull. In western societies the act of giving is often seen as 'free will', but on the analytical and conceptual level, when we accept what is given to us, we have an unspoken duty to reciprocate (Mauss 1995 [1950]). The warmth and dedication Karianne and Rune (my field 'family') offered me whilst living with them, made it difficult for me not to care for them as well. They always assured me to keep the lights on as long as I needed to work, included me when having meals, had freshly brewed coffee ready for me in the morning before they left for work, and let me use the media room as much as I wanted. All such small everyday gestures are often taken for granted when we are comfortable at home, however, in a field situation those taken for granted things showed that they had taken me into their family and were comfortable to include me into their social sphere. Another point to mention in this particular situation, is *where* the roles were played out. Being a part of a household as I was, could be said to be behind the scenes, or as Goffman (1959) addresses, in the back region, this place "… tends to set the tone for interaction, leading those who find themselves there to act as if they were on familiar terms with one another in all matters" (*ibid.:* 127). It was through my 'backstage' position, behind the scenes interaction, that I met some of my key gatekeepers.

2.9 Ethical considerations and formal approvals

Ethical concerns are important in anthropological research, especially because of the general conduct of getting close to people and their daily lives. I have adopted the term *Ethical Relativism* from Scheyvens, Nowak and Scheyvens (2006 [2003]), and have tried through the entire process, from pre-fieldwork to writing out my ethnography, to be reflecting on this. This has had several implications throughout the process. When planning for my first adventurous fieldwork I made myself familiar with the guidelines provided from the American Anthropology Association (AAA 2019) and reflected around potential situations that would require me as a fieldworker to make ethical considerations to protect an informant's identity and safety, and to meet university standards for ethical research.

After a couple of months in the field I was on a hike with one informant. While walking we met another man that was a friend of my informant, this man (working in the municipality) was also a man that I had wanted to meet. I introduced myself to him and told him about my project, and he signalled that he was interested in participating in my study. However, what happened was that he asked me who I had been in contact with at the local space centre, and as I told him, rather apologetically, I could not reveal names of my informants to anyone and explained that anonymity and research ethics was important to me (hoping this would make him more relaxed about participating). His tone changed immediately after this, "Oh I have so much to tell you, but unfortunately I can't", he responded. For a second or two I had to rethink pros and cons of sharing a bit of information to get this potential informant to participate, but the consequence of breaking codes of ethical conduct (Scheyvens *et. Al.* 2006 [2003]), and the potential of harming informants or their relationships to others in the community made me certain in my choice; not to share information with anyone.

Ethical considerations I learned of during fieldwork, are like the 'ethnographic circle'. I shall call it the ethical circle. Every situation, every happening, especially way out into the field period, often required me to take a step back and evaluate and consider how my doings or sayings could in some way or another affect my informants negatively. This continuous awareness is what Scheyvens *et. Al.* (2006 [2003]) points to when they talk about ethical relativism. This relativism, or circle, is far from closed. Whilst writing out this thesis I have taken many steps back to resonate and reflect over, *how* I disseminate *their* story. The final ethical implication I encountered during fieldwork was how the information shared with me changed over time, the more rapport I built with some of my informants, the more sensitive information was shared with me. I believe that penetrating my reflections with ethical considerations as well as analytical considerations has given me the faith to believe that my moral compass is guiding me in the right direction. Both for my integrity as an anthropologist and for the safety and anonymity of informants. However, some informants have given me permission to not anonymise them.

2.9.1 Norwegian Centre for Research Data - NSD

This project has been reported and approved by 'Norwegian centre for research data' (NSD) prior to the beginning of fieldwork Mars 2020. Cf. to NSD approvals: no personal information about ethnicity, race or sexual orientation is registered. I have collected consent when I have registered personal data. All names are presented in pseudo, and recordings are permanently deleted. Documents are protected with password and not available for others. Given the particularity of this project, location is not possible nor beneficial to anonymise. Throughout the entire process I have acted in accordance with uniform research ethics, not doing any harm. I cannot detect any conflict of interest in any parts of this project.

Chapter III

Give Me a Rocket and I will Unpack the Skies

To continue moving forward in technology and scientific understanding, many bright young minds will be needed in the future… An increased attention towards recruitment is clearly needed. Especially in times when it seems that ever fewer young people are drawn towards a career in science and technology. We need to increase awareness of science and technology as something positive and exciting…

Nylund and Rønningen, 2007: 1
(writing about student rocket operations at the local space centre)

From the subarctic, student rockets launch and lift out into the open sky several times a year. Every year, upper secondary school and university students get different opportunities to come to the island to participate in building and launching a rocket, the goal being to embody and internalise a feeling of being a 'space-scientist' and a 'space-explorer'. In this chapter, two such student rocket operations are examined through activity that is embedded and included in a human-machine-interaction. Unpacking these two operations one at the time, the proximity between human and non-human actors becomes tangible. This I will do by describing the procedures step by step from the science room at Andøya Space Centre (ASC). The intent is to illustrate how a human-machine relation prevails throughout these operations – from 'Pre-flight meeting(s)' to 'Post-launch meeting(s) between people, instruments and knowledge. Different forms of interaction, control, standardisation and accountability are key terms when examining these two rocket operations. It will become apparent that operations are multi-faceted. On the one hand, systematic and predetermined motions (using schematic procedures) define human activity. On the other hand, interpersonal relations, such as mutual trust and knowledge about each other, needs to be present before the implementation of a launch. Mutual trust is especially important when considering troubleshooting, as we shall see in the second operation. Every step, from preparing the weather balloon to igniting and launching the rocket are founded upon human activity. By describing these two operations in depth, I will examine *how* local space activities, like student rocket campaigns, enable exploration. And thereby, we shall see how local activities contribute to a change in how humans relate to Earth and the universe.

Using longer excerpts from rocket operations invites us to unpack the complexity of interactions in the course of a rocket operation. In the following chapter I describe the two rocket operations through the technical language that is used in the countdown procedure. The language in itself is interesting to follow, because it points explicit to how operations manifested through determined forms of standardised interaction. Moreover, the technical language show how the space centre facilitate embodiment for the youngsters in an operation. Put differently, the technical language is interesting to follow because it allows us to see how bodily movement with different parts of the machine (systems) is determined by the standardised countdown sheet.

3.1 Corona Star

On warm summer days the fog lies low and heavy on the northern side of the island. The space centre is located a couple of hundred metres past what is called the 'fog wall'[21]. The last couple of days had been warm, and the fog had been lying low, but for the moment it had lifted, revealing a clear sky. Weather conditions are important when working with high kinetic reactions such as a rocket launch, and because of that, a rocket cannot be launched in a low fog. One day in June 2020, I was invited to come to ASC to watch an upper secondary school rocket launch from the science room. The science room is a control room where scientists monitor and measure scientific conditions, to ensure that they are encountering the atmospheric phenomenon they want to explore and investigate. The goal of launching a rocket is normally[22] to investigate a celestial body that is not yet detected or fully understood. The instrumentation attached inside the rocket enables 'downloading' information about the celestial object that is under investigation. This causes the "micro-structures of things to come into view" (Ihde 1979: 30), opening up the object for the operator to produce its meaning, like the northern lights have been unpacked and opened up, enabling the operator to produce new meaning concerning its insides conceived as electrically charged particles. What was previously "hidden, unsuspected, unpredicted now may be seen" (*ibid.:* 30), and on that account, the rocket becomes an extension of the operator's (or the student's) experience (*ibid.*).

Seventeen to eighteen year old senior students from the local upper secondary school, were going to launch a rocket *they* had been working on and built during the school year. These youngsters – by the locals called 'Romlinger' (spacelings) – were taking a subject called 'Romtek'[23] (Space Tech). This subject is only taught on Andøya – because of the proximity to

[21] The mountain dividing the space centre and the capital village, Andenes.
[22] Rockets are also launched for the purpose of testing instrumentation technology, for example heat shields in the front of the rocket nose. (see chapter I, location)
[23] Local jargon used when referring to the Space Technology course taught on the Island.

the space centre - and consequently, students from all over the country move and live as spacelings for a year on the island in order to attend this course.

I had been told to announce my arrival in the reception area of *Spaceship Aurora,* and wait to be picked up by Marius, the local astrophysicist. Standing there in the reception, I could see lot of teens hanging around in the reception area outside of the spaceship. In the crowd of boys, I only detected one girl. I saw Marius walk down the stairs towards me, he greeted me and accompanied me to the *Saturn* – an auditorium - for the 'pre-flight and safety' meeting. The meeting was scheduled to start at eleven am, but due to logistical issues the meeting was postponed by an hour until all the spacelings were present and seated in Saturn. The 'pre-flight and safety' meeting was held by Director of Launch Operation, Martin, and the safety manager, Paal. Before Martin began, he handed out a 'Countdown Procedure Sheet' for today's operation to everyone present in the auditorium (students, teachers, employees and anthropologist). He began by explaining the steps of the lecture, before he continued on to the countdown procedure, one step at the time. Though student launch operations are smaller than scientific ones, the formal steps of the countdown are the same. However, in the bigger scientific operations, the 'weather window'[24], 'scientific window'[25] and 'danger zone'[26] are more crucial and must form a perfect mosaic with each other. The most delicate parameter is the wind, even small gusts of wind would delay the rocket to launch. However, Martin explained that since this rocket was not for scientific research, "… the scientific window would say yes, regardless" of science conditions.

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[24] The scientific window is where physics meets operation in practice. Every single rocket configuration has its own determined boundaries for wind-safety. Several things impact this window: area versus weight, centre of gravity versus centre of pressure (pressure need to be behind gravity on the rocket's longitudinal direction; more distance between these two, means more stability), acceleration (a rocket that accelerates slowly will be more impacted by wind in a dense atmosphere, and vice versa). And finally (marginally), wind direction: some rockets cannot be launched with low elevation, because they are not structurally strong enough to 'hang' from the launchpad in such conditions. For example, if aiming and launching with a low elevation, problems start occurring; if nominal elevation is set at 84,5°, then maximum elevation would be reached quite quickly if wind is approaching ahead. As I was told, this description is a simplified and brief explanation of the weather window.

[25] "Each rocket has a scientific goal, and we need to be sure that the conditions are optimal for making the desired measurements. For example, we may be interested in measuring some parameters related high aurora activity. Then we need to be sure that we do have that activity. This is done by monitoring with additional ground-based instrumentation like Alomar lidars, satellites etc. The scientist will only launch the rocket when the scientific window is perfect" (Scientist 2021).

[26] "These areas are defined for safety. It is crucial to do a proper risk analysis considering everything that can go wrong during the launch. There will be some things that are more dangerous than others. Extreme dangerous episodes are, for example, an explosion of the rocket on the pad, or just after ignition. The procedures take into consideration how debris, fire and shockwaves can affect the surrounding areas, and define a restricted area because of these scenarios. That is why the launchers at Andøya Space is a little far from the administration buildings. This distance increases depending on the size of the rockets" (Scientist 2021).

After going through the lecture, Martin went through every step in the 'Countdown Procedure'. Today's rocket had 48 steps; from 1) "Prepare and launch 1st weather balloon. Track to maximum altitude" to 47) "Announce time and place for Post Flight Meeting", and the last, 48) "End of Operation." Weather balloons measure wind and other weather phenomena up to a maximum altitude of 30 kilometres. In a scientific or military operation, the countdown procedure could be everything from forty pages and up, whilst today's launch consisted of a mere three and a half pages. Although the size and complexity of operations differ, the structure is very much the same. Before the students could go and prepare for operation at their designated positions, Paal had to go through safety considerations. Safety as an emic term is used when talking about the physical danger that personnel is exposed to, and risks to life and health. Moreover, safety is divided into 'ground safety' and 'flight safety'. Ground safety are all the activities happening on the ground during operation (and to a certain degree, storing of explosives and other dangerous and contaminating materials). Flight safety has to do with risks prior, during, and post lift-off. Paal, unlike from Martin, approached the spacelings more dialogically, asking them why safety was important, other than just keeping people away from the danger zone. Immediately the youngsters started putting their hands up in the air to answer. "Boat!" one spaceling said, "yes, correct, we don't want to hit a boat, even though this one won't sink it, but it would have been very unpopular" Paal responded. "Animals!" another spaceling yelled, "I would like to say yes, but we do not have any insurance against hitting, for example a whale," Paal responded again. He continued, "other things we need to think about?" Looking around in the auditorium, Saturn was silenced for some seconds before one enthusiastic spaceling said, "aviation!", "yes, correct, we don't want to hit a Widerøe plane, nor a plane that is crossing to Svalbard, because they *can* go over the launch area" Paal responded. The spacelings seemed very energised and confident in their answers during this conversation with Paal. Before the spacelings could leave Saturn, Martin had one more thing he wanted to elaborate: T- 12 minutes before launch the Road Guards (RG) had to check the road between the fog wall and the next village one last time, and this morning they "actually had to make some campers leave the area" Paal interjected. It is important to have overview over every person in the area during the launch, due to the possibility of rocket debris and potential malfunctions (for example an explosion).

The 'Safety and Pre-flight' meeting was now terminated, and operation *Corona Star* could begin. The name of the rocket was chosen by the spacelings during the Pre-flight meeting[27]. The Corona Star launched successfully, while two male spacelings, Marius and I were stationed in the science room. Marius explained that the science room is the most important room during scientific operations. If the science is wrong, the scientist will not launch, and if the weather is not right, Range Control (RC) would not launch. These two windows need to overlap perfectly to ignite and fire anything. "As a consequence, in some cases, a campaign can extend for a couple of weeks with several days where the other window is not satisfied" (Astrophysicist 2021), and scientists can sometimes be more inclined to bend the weather window, than security and safety officers in RC. RC always have the final GO/No-Go in any operation.

Marius logged on to the computers and displayed the parameters, showing altitude, azimuth, temperature and telemetric data from the Middle Atmospheric Alomar Radar System[28] (MAARSY) on eight big flatscreens hanging on the west-facing wall of the science room (See *Fig. 2-3*). The two spacelings sat down in the middle of a u-formed desk, equipped with another ten computer screens – also mounted on the western wall. Located in the centre of the u-formed desk was a control panel for coordination with the other departments during operation. The desk was equipped with a stationary operation microphone, different controllers and a rectangular device with green and red GO/No-Go lights. All those different screens displaying different parameters are understood as tools that mediate information (Ihde 1979) between human and non-human actors, thus enabling the human operator to interpret and produce meaning in atmospheric objects. Facilitating scientists and, in this case, students, to participate in a rocket launch is providing them an opportunity to see previously unseen objects. This facilitates an extended experience of heavenly phenomena through the visualisation that is 'downloaded' from the rocket instrumentation (*ibid.*). Students, operators, scientists, instruments and procedures are all included in a human-machine interaction. Together, all these components form what is called the system, every human and non-human actor is a part of the

[27] I do not know why they chose to name the rocket Corona Star, but probably it was meant as a pun concerning the Covid-19 situation wreaking havoc around the country and world.

[28] "The Middle Atmosphere Alomar Radar System (MAARSY) on the North-Norwegian Island Andøya is a 53. 5 MHz monostatic radar with an active phased array antenna consisting of 433 Yagi antennas… This arrangement provides a very high flexibility of beam forming and beam steering with a symmetric radar beam of minimum beam width of 3.6° allowing classical beam swinging operation as well as experiments with simultaneous multiple beams and the use of interferometric applications for improved studies of the Arctic atmosphere from the troposphere up to the lower thermosphere with high spatio-temporal resolution" (Latteck, R., Singer, W., Rapp, M., Vandepeer, B., Renkwitz, T., Zecha, M., Stober, G 2012).

whole. At the same time, bodily movements, as pressing switches, reading telemetry data, talking and listening are also included in this human-machine-interaction (see chapter II).

The students, without instruction from Marius, began to read their voice checks in the 'voice loop system' (Almklov, Halvorsen and Johansen 2020). This system makes available coordination during a launch operation, which is constituted by "… a number of channels, or loops, available for different functions and positions" (*ibid.*: 192), and thereby allowing operators in the different control rooms at the space centre to speak and "listen in on interaction between other operators" (*ibid.*: 193). This system allows for standardised communication across departments during operations. Throughout this operation their job (the spacelings) was to embody the role as Principal Investigator (PI) (that is usually the chief scientist in the science room), and thus, all the steps of operation were now in the hands of the two spacelings: all the way from Radio Silence (operation begins) to Radio Silence Lifted (payload is armed and rocket lifted). Countdown starts at T- 01-00-00 and from there it should take one hour before the rocket is ignited and launched at T- 00-00-00, however, some seconds of delay is common.

Before describing the operation steps, a list of functions and abbreviations (that were listed in the countdown document) is needed. Abbreviations are used throughout the chapter, and full terms are not always presented.

ALL	ALL Stations
ALL TM	ALL TM Stations
AATC	Andøya Air Traffic Control
BT	Balloon Team
RC	Range Control
Main TM	ASC Main Telemetry Station
Mobile TM	Mobile TM Station at Toften
NAROM TM	NAROM Telemetry Stations
TM Readout	Payload TM (TM Readout in experimenters room)
PAS	Pad Supervisor
PI	Principal Investigator
RG	Road Guards
RSO	Range Safety Officer

TPS	Launch Control Support and Trajectory Calculations
AWICS	Andøya Wind Calculation System
PM	Pad Manager

Figure 1. List of launching operation abbreviations.

All personnel and spacelings were now seated at their designated positions, and as we could hear the spacelings say, "loud and clear" in the microphone, the cooperation and operation had begun. In 'Pre-flight meeting' Martin had emphasised to the spacelings, "do not answer loud and clear if it is not!." The 1-hour count had started, and by now entered a couple of minutes into the green section of the countdown procedure (Radio Silence). The countdown screen was blue, and in the top centre of the screen 'Corona Star' was displayed with big letters. Another rectangular box at the top right was green and displayed "Radio Silence." The spacelings went about on their own in the voice loop; Marius did not interfere and seemed very pleased when they played out their PI roles.

Operating in international airspace requires that ASC "must operate in synch with many world clocks" (Redfield 2000: 277), and in such they synch in with the "rhythm of space" (*ibid.:* 227)" Countdowns are therefore scheduled in UTC + 2, and Corona Star was scheduled to start counting at 10 am UTC + 2 (12 pm local time). Count starts at T – 01-00-00 hours (1 hour, 0 minutes and 0,0 seconds), and at T – 00-00-00 rocket arms and launches towards the heavens. The count procedure is divided into three parts: green, yellow and red. Green consist of six steps, from 1) T- 01-00-00, RSO to BT "Prepare and launch 1st weather balloon. Track to maximum altitude," to 6) T- 00-50-00, RC to ALL "Conduct Check of GO/No GO Lights."

While Marius and I had been sitting in the rear of the room talking, the countdown had reached the end of the yellow phase – The Hazardous Zone. During the yellow phase, hazardous work is being finalised on the rocket. This meant that the ones down at the launchpad were getting the rocket out on its launcher and initiating nominal settings before arming. The count continues: 7) RC to PAS "Bring one rocket and payload to launch pad and install it and confirm," PAS to RC "Confirmed," 8) RC to PAS "Connect umbilical and firing lines and confirm," PAS to RC "Confirmed," 9) RC to PAS "Elevate Launcher to the following Settings: Azimuth 320° Elevation: 65° and confirm," PAS to RC "Confirmed," 10) PAS to RC "Clear Launch PAD and report." The spacelings were not allowed outside on the pad, they had to sit still inside a block house (secure container), where all personnel at the pad is located during fire. Any treatment of the rocket down at the pad is performed only by authorised personnel, and therefore the spacelings down at the pad were not allowed 'hands-on'-treatment of the rocket. This is a safety matter. A fetish for safety and security[29] is equally present at ASC, and, as Redfield (2000) elaborates about the Space Centre in Kourou, it is a "… inherent conservatism and focus on control" that "marks space transport as a strangely static technology, wedded to regulation and structure…" (*ibid.:* 227).

In a blink of the moment the count was way down in the red zone – RF Silence Lifted. T- 00-15-00 before launch, 25) PI to RC "PI announce "Continue Count" or "HOLD," 26) RC to ALL "Possible HOLD for launching conditions," 27) RSO to RC "Verify Nominal settings is correct in AWICS," 28) RSO to RC "Confirm hazard area closed," 29) RSO to RC "Clearance from AATC to launch," 30) RSO to RG "Close road Andenes-Bleik." When RP confirm that the road is closed, the final voice confirmations before fire were completed. Counting on, T- 00-08-00, 31) RC to PAS "Final launcher settings" from nominal azimuth to actual, and from nominal elevation to actual. The PM confirms that the payload is connected to external power, and the rocket is thereby getting ready to be ignited and leave the Arctic ground. The personnel are confirmed safe, and the final voice checks are executed." On T- 00-03-00 a loud alarm bell goes off in the whole building and danger zone, alerting everyone nearby that a rocket is about to be launched.

When the count is on T- 00-01-30, 36) RC to PM "Switch Payload to internal power and confirm," 37) RC to Main TM "Verify and Report when oscillator is stable." This is the moment that everybody had been waiting for in the last hour (and the spacelings probably much longer), when the PM confirms and the main TM verifies, then it is time for the final Go/No-Go's from the different positions before the PM arms payload. Marius told the students to confirm with a green light signal to the other stations at T- 00-01-20 before launch (usually it would be at 60 seconds, sharp). This way he made sure that we all had time to go to the cafeteria to watch the rocket. At 1 minute and 20 seconds before fire, the spacelings pressed green 'Go' light, and we hurried to the cafeteria. T- 00-01-00, 42) RC to ALL "Time Count at one second interval T-0, On T+ time, count ten-second intervals until impact (90sec)." Marius pointed at where to look, and in a blink of a moment ("4, 3, 2, 1, fire!"), the rocket launched 8934 meters

[29] Security, as opposed to safety, deals with the protection of sensitive information: business secrets, military secrets, and risks of attacks on information technologies (IT), and espionage, etc.

up and into the skies. After just a couple of seconds the rocket was out of sight and had disappeared into the sky.

The visualisation of the rocket's whereabouts was now handed over to the instrumentation (rocket instrumentation and NAROM-radar). The feeling in the cafeteria (even though nobody made a sound) is best described as sweaty and overloaded. It felt like everybody had been holding their breath, starting to breathe again only when the rocket fired successfully. The "… technical prowess (Redfield 2000: 227)" of the sub-arctic space centre now manifested as the visualisation of a rocket firing and flying up towards the heavens. When a rocket is launched, control transfers from the human operators on the ground to the rocket itself. Put differently, all those close-monitored parameters and standardised procedures before a launch, contribute to (in most cases) a predictable flight, even when the control is transferred from the operators to the rocket. In the very moment a rocket is launched, the human operator is not able to do anything but hope that everything turns out as planned.

48) RC to ALL "End of operation" was announced over the voice loop, and the countdown was a success. We went back to the science room to collect our things, and together we walked back to Saturn, where the "Post Flight Meeting" was held. On the walk I expressed my fascination to Marius about using several months of planning and building a rocket to simply blow it up in a couple of seconds. When everyone, students, teachers and personnel had gathered back at Saturn, Martin congratulated the students with a successful launch and emphasised that he was impressed by their performance as operators during the day. The Teachers from 'National Centre for Space Related Education' (NAROM[30]) came down to the podium and displayed on a big screen telemetric data that had been 'downloaded' from the rocket instrumentation, using the new NAROM radar-antenna for the first time. Two spacelings came down to the podium as well. They explained to the other spacelings present in Saturn what they could read out of the data: pressure, temperature, altitude and so on. The two spacelings struggled a bit to read the diagrams clearly, and as one of the teachers explained, the data was polluted with disturbance by an unknown factor. And consequently, the NAROM teachers had to do some 'cleaning' before the students could use the data-material in their final exam.

[30] NAROM changed their name to Andøya Space Education after I left the field.

3.1.1 Summary Corona Star

When local activities enable exploration of the Earth and the universe through the extensive use of rocket launches, and Lidar and radar-measurements, a student rocket campaign does not contribute to *change* how humans relate to the terrestrial and extra-terrestrial. However, student rocket campaigns do *change* how youngsters relate to space activities, interaction with systems and machine, and the feeling of being a 'rocket scientist' or 'space explorer'. All these practices are important for the future of space activities, without educating a new generation of explorers, space activities would die out with new generations.

During Corona Star, the "interwoven relationship" (Almklov *et. al.* 2020: 194) between human and non-human appears as "seamlessly meshed and blended" (*ibid.:* 194) together in a rocket operation. The spacelings act out bodily movement through the operation, they are talking in the voice loop, pressing buttons and switches, they are listening, waiting and acting in an appropriate manner for the delicate pace of space operations. In this sense, the spacelings are included a human-machine-interaction; they embody their roles as explorers. The Corona Star operation shows how voice loops and spacelings are necessary for communication with the different positions during operation. The countdown procedure shows that the standardisation of interaction "is largely characterized by standardized forms and phraseology leaving limited room for small talk or relational talk" (*ibid.:* 197). The PM is calling on the PI, and the RC is calling on the RG and so forth, this leaves no room for other positions to interrupt and participate unless they are called upon in the loop. Moreover, and contrary to the voice loop in the example of Almklov *et. al.* (2020), where positions in the loop are geographically distributed, the voice loop at ASC is not outgoing and only includes positions internally and physically located on the premises.

Facilitating a student hands-on-experience is a question of how knowledge is shared and translated to the younger generation (Nylund and Rønningen 2007). Allowing the youngsters themselves to play and practice the roles of the operators and scientists is an embodying practice. In the way that the blind man is "extended into the world through his cane" (Ihde 1979: 86), the youngsters are extended into, and embody their roles using tools and instrumentation. The mastery of tools and instrumentation in a rocket operation is, as presented, not founded upon the individual. Rather, it is founded upon collective cooperation between the different positions that take place during a rocket operation. At the same time, an fixation with control (Redfield 2000) pervades throughout the countdown to ensure accountability, as well as to accomplish a successful launch. To increase the feeling of control under a rocket operation, standardised procedures are used, like task sheets and a voice loop system, and as Almklov *et. al*. (2020) argues, this determines acts of communication. The human-machine-interaction is here interpreted as 'the skilled system' (Ingold 2000), where the operator is depended on continuous feedback from the different parts of the machine; systems, instrumentation and his or her understanding of how the machine could be used (see chapter II). If the feedback from parts of the machine ceases to exist, the operators (students, scientists, and other personnel) could not proceed with the countdown. In the next section a systemic failure in the feedback occurs in the CaNoRock operation, and when this happens, we will see how this interferes with the operators' ability to proceed with operation. When the PM is confirming, the RC is asking, the TM is verifying, it points to a mode of standardisation. A standardisation of the individual behind the different controllers, performing their roles as 'rocket scientists' and 'space explorers'.

3.2 CaNoRock - Troubleshooting E-Launch

> E-launch has been a different, but interesting experience.
>
> *Professor, 2020*

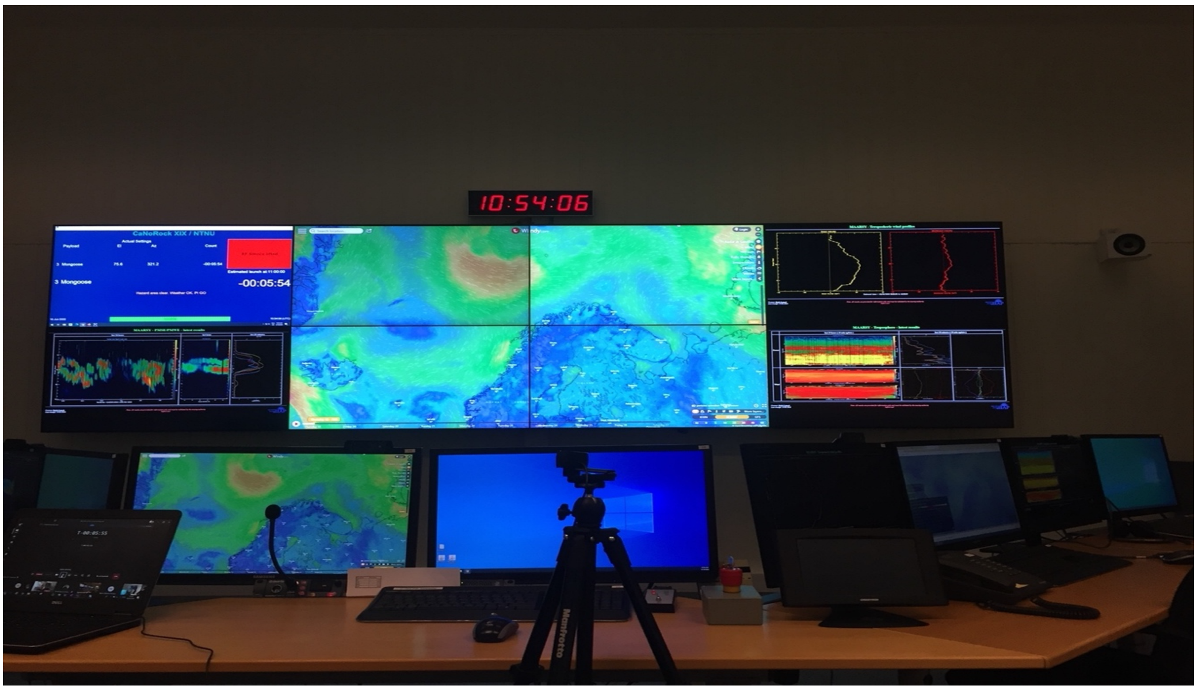

Photo 1. Screens in the science room during operation

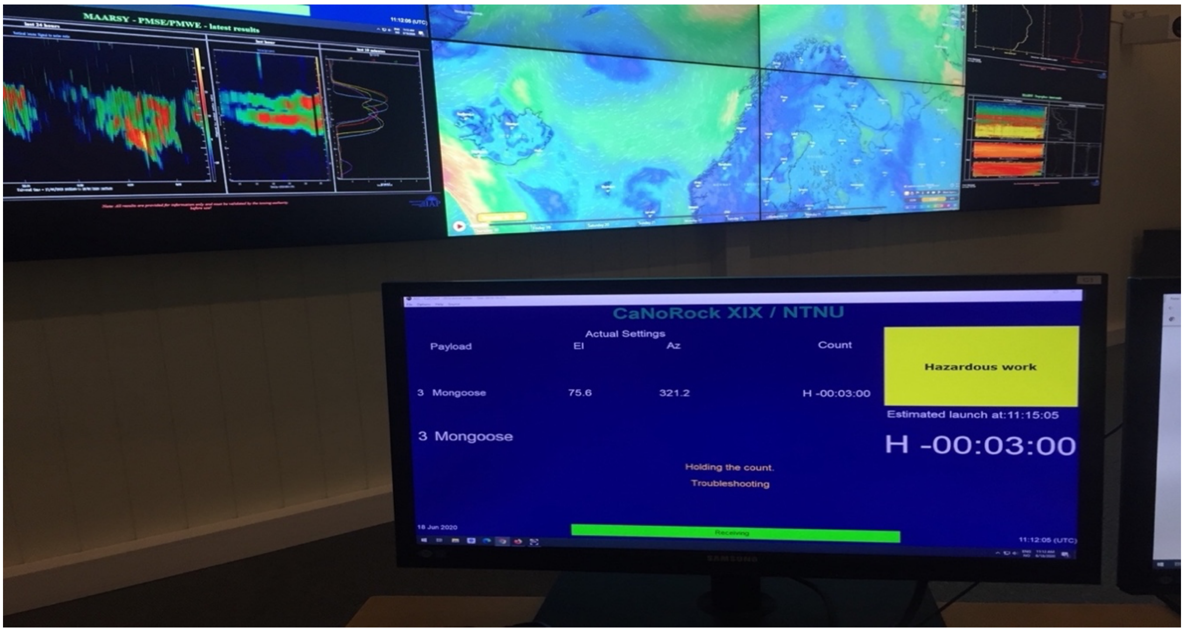

Photo 2. Countdown screen in the science room during operation.

One week after the successful launch of Corona Star, another student rocket was to be launched up into the sub-arctic sky. Because of the pandemic, this launch was going to unfold in a new and different way, through a livestream: an E-launch. Contrary to last week's local spacelings, this week, university students from Norway, as well as from abroad, were launching their rocket, CaNoRock. I was invited by the NAROM team to participate in the operation. The CaNoRock operation lasted three days, as opposed to the previous single day operation. The first day of operation the "Pre-flight and Safety meeting" was held on the digital platform Microsoft Teams. It seemed especially important to interact more during this launch than Corona Star launch, in order to motivate the students for the launch, since they could not physically participate in it because of the pandemic. After the meeting, the NAROM team sent out an email with a link for the day after stream:

> Dear all,
> I can now confirm that the live video stream of the rocket launch will be on Thursday June 18th starting from 1150 with a short introduction and the one hour countdown starts at 12:00, local time. If there is no hold in the countdown, the rocket will be launched at 13:00. However dependent on the weather condition, the latest launch attempt on Thursday is at 16:00. (…)
> Please keep the link to the livestream internally, not on social media etc. This is because of we do not want to risk that we reach the maximum limit of connections to the live stream.
> Kind regards
> The NAROM team

A rocket operation is standardised through its rigid countdown procedures and continuous need for control to assure accountability. As Almklov *et. al*. (2020) argues, accountability is seen as a preventative risk-reducing measure. And Following Douglas and Wildavsky (1982), accounting for risk is based on specified knowledge, and our "perception of risk and its acceptable levels are collective constructs" (*ibid.:* 186). Furthermore, "space operations are designed to control risk" (Almklov *et. al*. 2020: 199) and considering that CaNoRock was, for the first time, going to be a streamed launch (E-launch), the matter of control over unforeseen risks were challenged. What is usually concentrated *on-site* was now made accessible for people outside ASC's premises. Douglas and Wildavsky (1982) emphasise that risk assessment is more difficult when new blind spots occur, and in this example when a link is made possible outside of the physical premises, it could, per definition, be used by anybody and subsequently create new blinds spots in the operation. However, the email shows an attempt to regain some of the control lost, by appealing to the university student's' morality. We may understand this practice through what Foucault (1988) called the *Technologies of the Self,* provoking the morality of the receiver of the link, thereby encouraging a certain attitude (*ibid.:* 18) to unfold during a livestream rocket operation.

Similarly, to the Corona Star launch the previous week I was told to meet up in the reception area of Spaceship Aurora and wait for the astrophysicist to pick me up. The spaceship had already opened for visitors, and as I was standing there, a woman dressed in a blue indoor spacesuit, covered with emblems from ESA and NASA was talking to a man, ready to greet curious visitors wanting to learn about space. The man wrote my personal data into a visitor book in the reception, and then we walked through a restricted corridor to get to the science room.

The science room looked a little different this day compared to the Corona star launch. The big screens on the walls displayed more pictures (graphs and diagrams) than last time, and on the middle of the floor, a camera on a tripod faced the southern wall of the room. Marius (the Astrophysics) explained that since the CaNoRock launch was going to be on a livestream, they had put some more effects on display to make it more visual for the students on the other side of the binary. Taking extra care to visualise the launch for the students is an act of *impression management*[31] (Goffman 1959), and the positions that are normally off-stage and

[31] During a performance, as this E-launch in many ways could be categorised as, it was "…necessary for all the participants in the interaction, as well as those who do not participate, to possess certain attributes… in practices employed for" (Goffman 1959: 207) to successfully perform the E-operation. The different performer from the

in-situ were modified and converted partly to frontstage[32] (*ibid.*). In other words, during the Corona Star launch everybody that participated in the launch were seated in the different control rooms for the entire operation, watching everything going on. Whilst with the CaNoRock livestream, the students were located around the world, and participated only as viewers through a digital link. However, the control rooms are interpreted as off-stage because they are usually not available for people that do not participate directly in the launch, and when going on a livestream, backstage is partly converted into frontstage. In other words, the stream was only showing pre-determined parts of the control rooms.

In Ihde's (1979) perspective, techniques and instruments that bring the previously unseen into view, offer the observer an opportunity to experience. Even though Ihde concentrates on the telescope, microscope, blindman's stick and the chalk (Ihde 1979; 2011), the act of making something visible or sensible through a tripod-mounted camera is comparable. Because the students on the other side of the stream are given the opportunity to acquire knowledge through visualisation, as opposed to reading a countdown procedure sheet at home by their desk, or at their university office, the impact they gain is different. It is not like watching an old recording of a rocket launch, on for example a YouTube channel, because the students are already involved in the process of building and planning for the launch, and at the same time they have been given the opportunity to follow the launch on an internally link in *real-time.* They were still able to look 'inside' the skies when the rocket instrumentation brought recorded data-material back down to the ground.

The camera on the tripod was facing a famous picture of Dr. Birkeland and his *Terrella experiment*[33], printed on a big piece of glass, and this was perfectly displayed behind Marius as he conducted his operations, visible on the stream. During today's launch he was going to take the role as the PI, and therefore he had to do more than during the Corona Star where it

different control rooms had their own designated role and performed in a theatrical way on the stream. The stream was simply not impulsively running without a 'show-procedure'.

[32] I understand the E-launch performance in a Goffmanian way. Because, when the operation was made available through a link, pre-determined places in every control room had to converted into a 'scene' "… the place where the performance is given'' (Goffman 1959: 110), and thereby a part of the control room were made into 'front-stage'. The 'back-stage' region on the other hand, as Goffman emphasise, is the "… place, related to given performance…" (*ibid.:* 114), the place where the operators "… can run through its performance, checking… expressions when no audience is presented..." (*ibid.:* 115). And in the E-launch operation, I could observe that the different regions was clearly separated, and that the 'performance' given was not similar to what played out when the operators was outside of the camera focus, in the 'back-region'.

[33] Dr. Birkeland is known for his ground-breaking science of the northern lights, some even call him the king of the aurora borealis. Birkeland was the first scientists to successfully make an experiment that confirmed old theories of the northern lights. His famous experiment is called the *Terrella experiment,* and showed how Earth consists of two magnetic poles – one on the southern hemisphere and one on the northern (Brekke and Egeland, 1994).

was the two spacelings that shared this role. The human-machine-interaction in the CaNoRock operation was to some extent different to the Corona Star launch, considering the livestream that also took part in the interaction.

The count was to begin 10 am UTC + 2 (12 pm local time). Following the "rhythm of space" (Redfield 2000: 227) was even more important this time around, considering that students were participating from around the world, and crossing time zones. Marius started of the stream with welcoming everyone to today's E-launch.

The one-hour countdown begun, and the operation now entered the green phase – RF Silence. Voice checks through the voice loop system (Almklov *et.al*. 2020) were conducted in a slightly more theatrical way than they were in last week's launch. From the screens in the science room, we could see all other workstations participating in the operation, and another screen showed what the students could see. The streamed screen revealed this 'backstage-frontstage' (Goffman 1959) dualism. All cameras were carefully angled and did not move around in the different control rooms. Moreover, when different workstations on the stream did not perform and talk, their microphones were turned off, making the operators exert total control of what was shared on the stream.

Count clock was running, and the count were now counting on: 7) RC to PAS, "Bring one rocket and payload to launch pad and install it," the count had now entered the yellow phase – hazardous work were performed on the rocket down at the launchpad. Marius was getting himself ready to go on camera just as Martin came into the science room and invited me to come on a tour to Range Control (RC). RC is much like the science room, it is a control room, but for controlling everything that happens during an operation. All safety measures are controlled from here; the danger area, launchpad, science conditions, weather conditions, etc. Four men, including Martin, were present and working on different machines[34] with differently shaped buttons and switches in the control room, one especially was working with a camera and clearly communicating with the other camera stations involved in the operation (this seemed to be the heart of the stream operation). Paal from the pre-flight meeting on the Corona Star launch was handling a lot of computer screens and monitors with several different switches and controllers. The screens in the room were displaying different outlooks (confiscated ocean area – during operation -, danger zone and alerted area, etc.). Martin pointed on a blue radar screen, and to a fishing vessel that was just outside of the danger zone, but within the alerted area. He explained that using radar equipment like this, they could communicate with ship

[34] Here machine is understood, as different stationary computers.

traffic, although they (ship traffic) are not obligated to answer. In comparison with the science room, weather conditions and the MAARSY-antenna is closely monitored from the RC as well.

One of the screens displayed a live video connection from the launchpad where the rocket was placed on its launcher. This exact camera was not seen from the science room, nor on the stream. From here I could see the launcher from new and different angles. To the inexperienced eye, the sight of the rocket was blurry. Martin and Paal zoomed in with the camera down at the pad, whilst emphasising that the personnel down at the pad would probably not be overwhelmingly delighted that the angle was changed from the RC. The operators down at the pad and inside of the block house usually want to have full control of this camera themselves, since it is they who engage in hazardous work on the rocket. The camera showed a long black missile looking rocket with big white NAROM letters on it. As soon as they were assured that I had seen the rocket up close, they slowly put the camera back to its original position.

The RC have the predominantly responsibility and control over personnel, tools and instruments during a rocket operation. The Director of Launch Operations, who is located in the RC, has the final say in any operation. Additionally, as Martin expressed, if someone in the RC for whatever reason does not want to arm the payload and ignite the rocket, a mutual understanding goes without saying, and it was emphasised that "I do not make Paal fire if he doesn't want to." Martin went back to his seat and ticked off with a pen the count steps that had been performed whilst talking to me. Martin pointed to a pile of papers and made sure that that I had gotten the procedure for the CaNoRock operation, and explained that I could not stay much longer up in the RC tower; "it's not ideal to have to many people up here" he concluded. Range Control is the tallest structure on the premises and have windows all the way around the room. It could be compared to an air-traffic-control tower, except rectangular. A rectangular room covered with windows on all walls, resulting in a panoptic vision of the physical surroundings of the space centre. In many ways, the RC functions as a digital and physical panopticon[35] (Foucault 1999; 2014[1975]) during a rocket operation.

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[35] Foucault explain the panoptic system as a "closed room – detached, guarded on all angels, where the individuals has its fixed place, where all that happens is recorded, whereas an uninterrupted writing process connect the centre and the periphery, a place where the power is not shared, but exercised hierarchal, where every individual is always observed, investigate and assigned place – all this creates a firm network of disciplinary tools" (Foucault 1977: 172]. This is similarly to what happens in the RC tower; however, the observation is not only constituted through the physical visualisation of the outdoor premises, but the panoptic vision itself, is embedded in the digital system that all operators use during a rocket operation. Therefore, the disciplinary effect that constitute the panoptic system is not only set by face-to-face observation, but also through digital surveillance.

Down in the Science Centre, the door had been locked. I knocked and waited a few seconds before Marius came and opened. On the screens I could see that Paal now had shifted the countdown screen to the red phase – RF lifted, and the count was now on T- 00-30-00 before fire. The count moved slowly to the end; we could hear that the cars had stopped driving through the road outside, concluding that the road must have been closed by now.

At T- 00-08-00, 31) "Final Launcher Settings" were confirmed, and nominal azimuth and nominal elevation are adjusted to actual. 32) RC to PM "Confirm Payload on External power and confirm." A new set of voice confirmations are hereafter performed, and the rocket is getting ready for its final checks before launch. Counting on T- 00-01-30, 36) RC to PM "Switch Payload to internal power and confirm." Marius, as the PI for operation, had to sit tight in the science room during lift off. I, on the other hand, was just about to leave the science room to witness the rocket launch and stretch up towards the heavens at T- 00-01-01. In that exact moment the countdown clock stopped, and it was reported through the voice loop system, PM to ALL "signal was lost when shifting from external to internal power." It grew quiet in the science room. It was remarkably quiet on the voice loop, and it felt like everybody was holding their breath for a couple minutes (the non-human agents as well).

I asked Marius what was going on, he knew just as little as me, only that the signal was lost, and that the count had been put on hold. The RC and the PM were talking in the voice loop, it was not easy to hear everything they said as the standardised language used in the voice loop (Almklov *et. al.* 2020) had given way to mundane everyday language. After several minutes, they decided to try again. The count was set back a couple of minutes, and confirmational voice checks were again performed. At T- 00-03-00, the alarm siren bells for the second time during the operation. This time the feeling in the room was different than before. Now it was more a feeling of, 'is this rocket going to launch?' Counting on T- 00-01-45, the count was put back on hold. The PM to ALL reports that the same problem had occurred, the signal was lost for the second time when switching from external to internal power. The voice loop was quiet again, and nothing was shared on the livestream to the students; everything was happening offline and on-site.

After a while, the PM reports to ALL that they think there is something wrong with the batteries inside the rocket, so they must bring it into the laboratory to open it. In a Latourian perspective, the laboratory is the function that combines the 'outside' and 'inside' (Latour 1983) of the rocket operation. Only authorised personnel are allowed to manage hazardous work on the rocket and rocket instrumentation. Allowing only authorised personnel down at the pad, and to manage the rocket, is a risk-reducing matter, and this again increases the feeling of control and safety (Redfield 2000). CaNoRock was now taken down from the launcher and brought inside the laboratory to be autopsied. Nothing happened on the stream or voice loop; we all just had to sit still and wait for further updates from the personnel working on the rocket inside the laboratory.

The count had been sat back to the yellow phase – hazardous work is being done on the rocket – and the countdown screen displayed, “Holding the count: Troubleshooting,” “Estimated launch at 11:15:05,” “T- 00-03-00.” The clock is still working on the ‘rhythm of space’ (*ibid.*). Twenty-five minutes passes in silence before the PM broadcasts to ALL that they “think there is trouble with the battery.” The RC puts the count back to T- 00-30-00, still on hold. The stream and voice loop is still silent. The telephone rang in the science room, and I could hear that the conversation concerned the stream, and that somebody needed update the students on the other side of the binary.

Marius turns on his camera to address the students and explained that the signal with the rocket was lost when switching from external to internal power, and that the rocket currently was inside the laboratory being investigated to figure out if it was caused by the batteries or not. He continued by saying that he hoped that they would figure it out quickly, as today’s weather conditions and scientific window were perfect.

The new update was set at 12:30 UTC + 2. The road had opened up again. At 12:38 UTC, RC to ALL, “prepare for voice check” sounded over the voice loop. The count starts at 12:46 UTC, and a new set of voice check confirmations are performed. The count is now running at 12:58 UTC and the count starts at T- 00-30-00 in the yellow phase.

At T- 00-08-00, 31) RC to PAS “Set Final Launcher Settings” from “Nominal Azimuth” to “Actual Azimuth” and “Nominal Elevation” to “Actual Elevation.” The T- 00-03-00 alarm siren goes off for the third time this day in the space centre. Voice checks are finally confirmed. At T- 00-01-30, 36) RC to PM “Switch Payload to internal power,” 37) RC to Main TM “Verify and Report when oscillator is stable.” I looked at the count, it was still going! T- 00-01-00, 38) RC to ALL “Time count at 10 seconds interval.” On the way to the cafeteria to watch the launch, a speaker system counts aloud in the corridor, 50, 40, 30. . . T-00-00-10, the count was still aloud, 10, 9, 8, 7… 3, 2, 1, and in the glimpse of a moment the rocket fires and disappears into the grey-ish skies. Back in the science room the count screen read T+ 00-03-00, and end of operation was announced, and finally CaNoRock launched successfully into the sub-arctic heavens.

During bigger campaigns, delays happen now and then, and troubleshooting is not uncommon. Unlike CaNoRock's troubleshooting, in bigger campaigns the personnel and scientists are not normally as calm as were they today. I was told that usually the 'heat grows higher', especially in the science room. As "every failure represents not only the loss of merchandise but also a costly delay, because the reasons for the malfunction must be determined before operations can recommence" (Redfield 2000: 227), and in space activities accountability (Almklov *et.al.* 2020) and control is very important, especially to a mission accomplished. Accountability is closely connected with risk, and risk is socially and culturally conditioned (Douglas and Wildavsky 1982), however, as Douglas and Wildavsky ask, can we really know all the risks that we face? Probably not, although monitoring every step of the countdown procedure, using specialised personnel that interact in 'the skilled system' (Ingold 2000) (see chapter II) ensures the level of accountability that is needed for operation, and thus decreases the changes of unforeseen risks.

End of operation was announced, and Marius walked me back to the spaceship reception, through the restricted corridor. I was signed out as a visitor and left the space centre.

3.2.2 Post-flight Meeting on Microsoft Teams

A as consequence of CaNoRock's troubleshooting, the "Post-flight Meeting" had to be postponed to the following day. The NAROM team sent out a new link to the meeting. An employee from NAROM started off the meeting with proclaiming, "yesterday we had some snags," an issue with the battery during countdown, but "as soon as it was fixed it launched fine," the female employee explained. The students were absent in their answers and even presence (their cameras were off, and they barely talked). Marius breaks in and asks if she can explain in more detail what happened with the troubleshooting. The female employee elaborated; when the rocket switched from external to internal power the signal with the rocket was lost. After trying it a second time, the same malfunction occurred again, they suspected that there could be something wrong with the batteries, so they needed to take the rocket inside to the laboratory to investigate it. When the rocket was opened, they discovered that there was something wrong with the 9-volt batteries inside the engine, and therefore these had to be changed. This could have been caused by the time the batteries had been laying around without being used. Perhaps, the woman explained, they could have lost some of their capacity.

This turned out to be a new kind of malfunction, and thus provoked an opportunity for an extension of existing knowledge in rocket operations. In this example it is explicitly shown how a hermeneutic movement between presumption, rocket malfunction, enables the PM to investigate the rocket, and thereby acquire new knowledge (see chapter II) about rocket batteries. Thanks to this malfunction, in future operations the personnel are now aware of the potential problems with batteries that have been laying around for a while. The malfunction taken into the experience of the operator, advances his or her knowledge of what was previously unknown (Ihde 1979) and is therefore given an opportunity to avoid such malfunction in future operations. However, this malfunction, or 'snag' as the female employee called it, took approximately one hour to fix, whereas in bigger scientific campaigns such 'snags' could potentially take several days just to investigate and detect. Furthermore, as mentioned above, space activities are costly activities, producing an intrinsic fixation to control (Redfield 2000) their every step. A malfunction which causes troubleshooting must be detected, and the problem must be solved before the operation may proceed.

The CaNoRock students, like the Corona Star spacelings, were to use the data material provided from rocket instrumentation in their final exams. The material was 'downloaded' from the rocket using the new NAROM antenna, and the reading was a bit more complex this time around. With measures of pressure, magnetic field, rocket sensors, acceleration, temperature, gravity, and battery. As with the case with Corona Star, the material was again polluted and disturbed by some unknown factor. The university students, contrary to the upper secondary school students, had to clean the data material themselves, using programming languages like MATLAB or Python[36].

3.2.3 Google docs. Post-data-presentation

The CaNoRock launch was not the only part of this operation that necessitated troubleshooting. The presentation, accessed through a new link, was delayed because of trouble connecting to Wi-Fi. The students were divided in different groups, depending on what phenomenon they were looking at in the experiment. They had made a shared Google document, where they had merged all their slides into the same document. Group one with the PI role started out. The

[36] MATLAB and Phyton are programming languages and compilers used in informatics. Technological data material is presented using formal languages such as these. Telemetric data is encoded in machine code which is in turn read by computer programs written in these languages, which compiles the data into a more human-readable form.

cameras were off, but sound and slides were available through a shared screen. A male student started out presenting their case: ‘compare model data with actual sensor data’. He explained that their preliminary model had expected the rocket to reach 9800 meters above surface, when the actual data showed 9400 meters above surface. He continued to explain that his group believed that they did not consider the rocket-spin beforehand, and therefore the data was faulty.

By discovering a miscalculation in their data-material, considering rocket spin, the student’s preliminary knowledge of rocket behaviour and forces of nature were challenged, and consequently new knowledge were hermeneutically produced (see chapter II). Between the short presentations there was no digital dialogue. The students rarely replied if the presenters asked if anyone had questions. The next presentation was conducted by a female. This group were interested in measuring the maximum altitude after 33 seconds, approximately, and minimum pressure after about 34 seconds. The next presentation was also given by a female. Her group presented their findings of the rocket latitude on start 69. 29 °, and end 69. 35 °. Longitude, start 16. 01 °, and end 15. 92 °. After these, three more females held their group presentations, still no cameras were on.

One group had calculated 50 g (acceleration of gravity) on one of their datasets, and asked the employees about this, since they thought this was a very high value. One of the employees emphasised that this value does not usually exceed 30-40 g, so they wanted to investigate this closer in case there was something wrong with the sensors attached to the rocket instrumentation. Marius joined the conversation. He thought that this value, if it were right, “would be an opportunity for actual science.” He explained that there have been no experiments with those rockets before that measured such high levels of g. Therefore, it could be a great opportunity for actual scientific experiments, and especially for geology. This measurement did not only change the pre-understanding and knowledge themselves had regarding gravitational measures using similar rockets, it also changed how the employees and Marius (the astrophysicist) understood how to investigate the acceleration of gravity. In that we see that the hermeneutic circle (see chapter II) is included in everything we humans encounter at all times. For every new value, especially if it turns out as an anomalous, positions the operator to produce new and unexpected knowledge about a particular phenomenon.

3.2.4 Summary CaNoRock

As shown in the Corona Star operation, local activities like student rocket operations do not contribute to a *change* in how humans relate to Earth and the universe, but rather in how students relate to space activities. In the CaNoRock operation students were not able to internalise and embody the different roles and positions as rocket operators and rocket scientist to the same extent. Even so, they got the opportunity to be a part of a new kind of operation. A rocket operation where improvisation through digital platforms and visualisation of the positions functioned as a mediator for communicating and translating knowledge. This is what Ihde (1979) elaborates concerning mediated instruments and how such tools stand in position for the tool-user to discover something "previously hidden or undetected" (*bid.:* 28) (see chapter I).

The rocket-spin and the measured values of g would not have been possible without the use of mediated instrumentation as sounding rocket, lidar and radar-measures. Making the operation available through a livestream, with a live (real-time) connection produces several concerns. Firstly, the lack of complete control over who is watching. This concern is implicitly shared in the e-mail from the NAROM team that shares the link. Secondly, during troubleshooting the stream goes cold, and it is undoubtedly a higher priority to take the rocket into the laboratory for investigation, than is keeping the stream warm. When the stream had been quiet for a while, the phone rang down in the science room, and the backstage position (Goffman 1959) in the operation was addressed. On the phone, the employees discussed that not keeping the stream active could make the students less enthusiastic about their feelings of involvement.

In a system of strict procedures, to maintain safety, security and accountability for a successful launch, unpredicted 'snags' disturb the movement (Ingold 2000) that must happen between personnel and instruments, from, 'prepare weather balloon' to 'end of operation'. This is comparable to what Ingold (2000) refer to as the *Grindstone man,* whereas he is actually "… working in two systems simultaneously (*ibid.:* 301). Ingold describes how a pot-maker, for example, use his body the move his feet on a wheel, and that this action "… requires no skill" (*ibid.:* 302). However, the "… co-ordination of manual, visual and tactile functions" (*ibid.:* 302), requires a sensible and intelligent craftsman, that can percept to outcome of his making throughout the process of handling the tool. As the operators are pushing buttons, typing letters, communicating in the voice loop, analysing feedback and measurements provided by the

MAARSY-antenna “the body of the worker becomes kinematically chained with the machine” (Reuleaux 1876:501, cited in Ingold 2000: 305).

If we consider the system as all parts of the human-machine-interaction, then the heart of the operation lies, in the heights, in the range control room (RC). Range control have complete domination and jurisdiction over anything that happens and ought to happen during a launch operation. And contrary to Redfield (2000) that argues the control room as “floating in some placeless, modern space” (*ibid.:* 180), RC is endorsed in interpersonal relations between operators that are built on trust. This is especially the case when Martin explained that they do not fire if someone in RC does not want to, and when RC, PI and the other positions stand still whilst the PM is taking the rocket down from its launcher to bring it inside the laboratory. Additionally, the cultural logic that is brought about in strict procedures and schematic ways of performing is very well present (see chapter II). Rather being a ‘placeless, modern space’ on ASC, the control room is a place where cultural logic interacts with science to achieve an acceptable level of accountability.

Finally, carrying out a rocket launch on a livestream opens the opportunity to internalise knowledge through a digitally shared workspace. And as the astrophysicist remarked after the E-launch, this could provide future opportunities to rethink how to facilitate student-rocket launches. It could be possible to involve more students in the same operation using physical and digital workspaces, eventually, increasing the outreach of space activities. Put differently, facilitating for the students to participate in a E-launch, revealed new opportunities for including more students in future operation. At the same time new concerns were raised by making a rocket launch available on a digital stream, and as described, matters of control and security is of uppermost important in space activities, and this was challenged by facilitating a E-launch.

3.2 Summary chapter III

In this chapter, I have attempted to show how local space activities enable exploration. Thus, the empirical examples focus on the new generation of space explorers; university students and spacelings. I have described how human operators and all parts of a system (machine) need to interact in a ‘human-machine-movement’ to perform a rocket launch operation. In both Corona Star and CaNoRock, interactional relations between humans, tools and instruments are pervasive. However, it is those interpersonal relationships between students, scientists, operators and technical personnel, that enable rocket activity. Every role that participates in a rocket launch needs to have a certain level of trust with each other, and each other's expertise and capacity to keep focussed when troubleshooting 'on the fly' (Almklov *et. al.* 2020) occur.

During 'Pre-flight' meetings, all personnel involved with operation gathers in a face-to-face interaction, and stepwise go through the countdown procedure, safety considerations and other potential topics that need to be dealt with before countdown can begin. Facilitating for students to get "hands-on experience and a comprehensive introduction to an ordinary scientific launch" (Nylund and Rønningen 2012: 1) is understood as a proactive facilitation of embodiment – thereby allowing the students to feel like space explorers. Moreover, enabling students to take part in the safety dialogue before the countdown starts, invites individual and collective reflection on what to expect and thus, what to not expect during countdown. Douglas and Wildavsky (1982) argues that risk perception is culturally and sometimes even individually conditioned (depending on the risk itself), therefore "there is no single correct conception of risk …" (*ibid.:* 4). On that account, engaging students in 'Pre-flight and Safety' meeting(s) (which is a means of assessing risk), enrols them in the cultural logic of technics, standardisation and procedures that are included in a rocket operation. These procedures include standardised countdown sheets, a formal language to use when communicating in the voice loop (Almklov *et. al.* 2020). Using shared terms like 'weather window', 'scientific window', pressing buttons and turning switches. Providing a 'hands-on experience' as Nylund and Rønningen argues, is not only a means of embodying the feeling of being the 'rocket scientist' or the 'space explorer', but also a means of embodying what Johnson (2020) call a shared cultural logic for space operations.

Encouraging students to participate in space activities like a rocket operation is not only an act of embodiment, but also a way to translate knowledge about space activities from one generation to another. In these two operations the forms of embodiment took, naturally, different shapes. CaNoRock, an operation between the geographical and digital, employed new ways to conduct in operation, especially in the way that they had to managed coordination through a live stream. This meant that they had to include more digital components into the operation, than for example the *Spacelings* did in the Corona Star Operation. The CaNoRock students' inability to be physically present, because of the pandemic, was not postponed to post-covid, but rather carried out through digital technologies, where a live stream brought Andøya Space Centre, the launchpad, science room and range control, and university students around the globe, into proximity. Just like the telescope, what was previously unavailable 'out there', was now close "… by 'bringing close' what is there to be seen" (Ihde 1979: 24). Like the insides of the northern lights have been brought close since the early '60s, the CaNoRock operation brought high levels of gravity close, and other measurements that rocket instrumentation were able to detect.

The practice of launching a rocket up into the sky is a human conquest of 'technological' instruments, and is thus a will to mastery. The will to mastery is understood as a dimeson of control beyond the flesh of the human, a control over material culture as well as the forces of 'nature'. The way to mastery is through the system that unfolds in the operation, every position is designated, every role has its performance (PI, PM, RG, and such), and every position in the operation is controlled from Range Control (RC). Controlling every step of the operation from 'Pre-flight meeting' to 'end of operation' reduces the risk (Almklov *et. al.* 2020) of disasters and other malfunctions during operation (especially explosions or threats to human life). However, as pointed out, every risk cannot be predicted, and risk assessment as Douglas and Wildavsky argue (1982) is built on existing knowledge.

Rocket operations are delicate, and the slightest inconsistency or malfunction puts the count on hold. Confirmational voice checks are performed several times during countdown, and weather conditions are closely monitored, and any marginal change in the weather, making it outside the weather window, is consider as a non-acceptable risk. As the space centre in Kourou cannot escape the "… heat, humidity, and dust…" and "… heavy rainfall…" in the tropics (Redfield 2000: 227-28), neither can the Norwegian space centre escape the fast changing stormy and icy sub-arctic during wintertime, nor the heavy fog during warm summer days. The act of controlling instruments, human interaction, calculating for the smallest discrepancy in weather conditions, etc., is the same as managing "control over two worlds, the natural and the technological" (Mindell 2002: 2, cited in Helmreich 2009: 216). 'Nature' and culture are thus woven together, in a rocket operation. Predicting and calculating weather conditions to unpack and discover heavenly bodies (for example the northern lights), positions the operator and the cosmic ballet dancer in relation with each other. Seen in Descola's (2012) perspective, the relation between 'nature' and culture becomes 'natural' when humans interact with the forces of 'nature'.

Losing control under the CaNoRock operation quieted the science room and voice loop. In this example, the paramount feedback from the technical instruments to the human operator ceased for a moment. Consequently, the count was put on hold until the operators had regained full control over all parts of the system. A fixation with controlling (Redfield 2000) every step of the operation creates accountability during rocket operation. Communication through the voice loop is seen as the "… the key coordinative channel for time-critical questions, clarification, or requests for permissions or interventions" (Almklov *et.al.* 2020: 193), and thereby plays a big role in assuring control. However, and contrary to Almklov *et.al's* analysis of the control room of the International Space Station (ISS), where the interpersonal relations between operators was reduced to relations between roles and assignments, the interpersonal relationships between the operators at ASC was an important condition for ensuring accountability during rocket operation. At ASC nominal settings are adjusted very close before fire. At the ISS control room on the other hand, nominal settings are crucial throughout experiments (Almklov *et. al.* 2020), whilst at ASC nominal settings need to be adjusted to actual in compliance with fast changing weather conditions.

During CaNoRock and its troubleshooting just before rocket was to be ignited, the trust between the RC operators and the PM operators was of outmost importance in enabling individual improvisation to take the rocket inside the laboratory to open it up for investigation. Troubleshooting's and malfunctions during student operations could provide an opportunity to experienced operators to learn how to handle similar situations if they would appear in scientific and future campaigns. A malfunction in a student campaign is less dangerous and subsequentially cheaper than if the same malfunction were to happen in a bigger campaign.

In the CaNoRock operation, the students measured a level of gravity that had not been done with those kinds of rockets beforehand, and as the astrophysics explained, this could in fact be an opportunity for real science. And in turn, it might be a first step to discovery of something that was previously undetected.

Student rockets embody, enrol and incorporate how to interact with outer space and celestial phenomena to a new generation. And as argued in this thesis, space activities (piece by piece) contribute to a *change* to how humans relate to the world and the universe. Student activities are important in this 'worldmaking' through the activity of educating new explorers.

In the chapter to come we are leaving the student rocket, our anthropological voyage continuing into stellar dust, visiting intrinsic urges of exploring the universe, and thus ourselves.

Chapter IV

So, Are We Going to Space to See Earth?

> I believe that knowledge about the universe can make us humans more earthbound and actually make us understand how small we are in the bigger picture… We don't have very much light pollution up here[37]. And because of that, from childhood we get a strong connection with the starry sky.
>
> *Anonymous 2020*

This chapter describes and discuss how dreams, imagination and emotional attachments to the universe are important conditions for explorational activities. As long as we have records of, human beings have had inherent urges to explore the known. I will describe how people talk about and contemplate their fascination for outer space and explorational activities. Stellar dust is described as a familiar stranger, with whom humans share common building bricks – the same origins, but differing material manifestations. Beyond explorational activities, the complete human being – homo faber (Ihde and Malafouris 2019) and the artisan (Ingold 2000), are important when asking new questions and producing new meaning and knowledge about the universe. A longing for the unknown, the courage to dream big, and the asking of imaginative questions about the origins of Earth and the universe, are communicated as important conditions to reach scientific goals. Leaning on the legacy from Geertz (1993, 2005) and interpretative anthropology, I examine these topics from a hermeneutic point of view (see chapter II). Andøya's proximity to outer space seems to generate a sense of attachment to outer space.

4.1 We are the universe - We have a 'home' and that is Earth

> You go to space to see Earth and then you realise, as an astronomer you realise that for the moment this is the only place where you can be, and it's a precious place, because the combination of factors makes it unique for us. That's why we are here. We know and we expect that there are several other places where life could be, but we haven't found nothing. And for conscious intelligent life it will be difficult, so we have it, we have home, that is Earth.
>
> *Astronomer 2020*

Although the universe is continually explored in the contemporary space age, its withheld mystique is very much alive when people describe their fascination with it. In fact, preserving some of its mystique is crucial to the development of new space technology, and this is what it

[37] Referring to Andøya.

means to build a bridge between the natural sciences and culture. Scientists make use of their imaginative capacities to ask questions about the universe, questions that may appear to have no apparent function, or even make any sense. However, these questions, as the local astronomer explained, are the questions that drive scientific curiosity forward.

The astronomer – enthusiastically and emotionally – elaborated his fascination for the universe, describing it as a part of us, and us as a part of it; how his approach to the universe is considered childlike. He emphasised that a childlike approach to the universe anticipate technological development. Such a childlike approach is 'free'[38] from cultural bias, and therefore makes the world appear as a *Tabula Rasa*: a place to be filled with meaning, derived from human experience. He went on to explain how this approach drives technological development, not for the sake of technology per se, but rather because the curiosity of researchers prompts questions concerning the universe – questions that may only be answered using novel technology. These are questions that occur when someone is gazing up towards the stars, and the imagination begins to wonder: What is this star? Where does it come from? Can we find other planets like our own? Some of these questions have been answered because of the development of new instruments that have enabled humans to see and explore new things; as is the case with, for example, the telescope.

The development of the telescope transformed the perspective from which heavenly objects (as for example the Moon) are conceived, and consequently, what "was previously invisible" (Ihde 2011: 79) is now taken into the experience of the observer. Similarly, with the development of the satellite, new answers are continually discovered, thereby provoking new questions. The same is true for the development of Lidar-rays and radar waves. Curious scientific questions are posed, sometimes requiring the development of new "'knowledge gathering' instruments" (Ihde 1979: 16) to produce answers. It is only through this dynamic that these new questions are answered, and new meaning is produced. This dynamic is understood hermeneutically, in the circular motion of asking questions and discovering new answers; that is, discovering our own presumptions about the world around us (Zimmerman 2015; Geertz 1993, 2005), and thereby change how we understand celestial objects.

One year after *Sputnik,* United States launched its first satellite, and eleven years later, in 1969, the first human walked on the lunar surface (Olson 2019) and filled space with

[38] Ideally it is 'free', however, humans are born into cultural landscapes and therefore we can never be completely free from cultural bias.

western[39] values, as "U.S. astronaut Neil Armstrong spoke of his first step on the moon" (*ibid.:* 8).

Without humans and their urge to explore, and curious imagination to ask questions, the extensive exploration of outer space might not have become what it has become today. The "Earthrise era" (Lazier 2011: 605) began with the launch of *Sputnik,* and, in 1972, the Apollo 17 crew presented the world with the iconic *Blue Marble* (NASA 2021) picture (cf. chapter I). This picture contributed to a fundamental change to the associations people made when thinking of Earth, because it recreated "the visceral impact of viewing Earth from space with human eyes" (NASA 2021). Similarly, when the astronomer shares his wondering and fascination of the universe with children, he explains that he actually goes back in time, by introducing outer space through the use of binoculars, rather than a digital platform (as for example, Google Earth, satellite-data, Youtube, etc.). He takes them outside on a dark and cold winter day, equips them with a pair of binoculars and asks them to use them to look up at the starry skies. This invites them to feel like explorers, letting them "make their own discoveries" (Astronomer 2020), and then he observes the impact it has on them – how it fills them with wonder and excitement. This could be compared to the experience of looking through a telescope. The previous relation to the stars, changes through the use of the binoculars, because they now see the stars through their bodies and senses. In this view, the use of instruments "includes embodiment relations …" (Ihde 1979: 10), and the children embody their relation to the stars using the binoculars.

Experiencing the stars by using a pair of binoculars is comparable to the experience of viewing the craters of the Moon using the telescope (Ihde 2011), or how the blind man experiences the world using his cane (Ihde 1979: 86). This embodied act and interplay between child, binoculars and stars, is here understood as a *cosmic companionship* (Messeri 2016: 22). Put differently, when engaging in an activity that brings a star up close, the universe and that particular star are positioned into proximity to the child, and by that, it opens the possibility for the child to enter into a cosmic relation. At other times, if he, the astronomer, were to use the telescope to awaken the inherent explorer in someone, he would adjust the telescope towards the Messier 31[40] galaxy, and in the meantime, he would just wait for the expected reaction: "You will see the telescope, you will want to watch, because this is what is happening. Like

[39] Throughout this thesis I do not address the way in which space activities are a Western domain (however some Eastern countries have well established space agencies). Nevertheless, I do recognise how these activities are indeed very Westernised.

[40] Messier 31 (M31), is also addressed as the Andromeda galaxy and it is located 2 million lightyears away from Earth (Garner 2017).

with the microscope, you want to watch" (Astronomer 2020). Facilitating for the children to use the binoculars, or facilitating for someone to look through the telescope, in order to awaken an inherent curiosity, is an embodying act that enrols the observer into what Johnson (2020) calls the cultural micro-structure of shared values, shared questions, and a common understanding of phenomena beyond the terrestrial. Johnson describes local space activities as cultural micro-structures, whereas cultural macro-structures are shared by members globally (*ibid.*), in the space 'industry'[41]. Moreover, enabling children and others to make their own discoveries about extra-terrestrial phenomena is a way to facilitate an embodying practice in a new generation of explorers (see also chapter III).

Knowledge about the Stellar Evolution, and the material components of a star, or the electrically charged particles inside of the aurora borealis, were discovered by the curiosity of researchers, and the act of asking questions about the universe. Questions like: What is a star? What is this star made of? What about the Big Bang? In order to answer these questions, and other questions alike, the scientists, with their scientific methodologies, need a variety of tools and instruments at their disposal. The scientists and operators, as described in chapter II, are skilful craftsmen (Ingold 2000; Ihde and Malafouris 2019) that percept celestial objects, develop tools to investigate them, and in turn produce new knowledge about them. Instruments that can be launched into the skies and out towards the universe, or instruments that are strong enough to make measurements or visualisations from the ground (for example a Lidar or a radar-antenna). At the local space centre on Andøya, rockets are launched, Lidar-rays measure, radar-parks measure, available satellites measure and visualise. All these instruments stand at the disposal of operators and scientists, ready to be included in a human-machine-interaction (as shown in chapter III). The wonderment and the mystique of the universe was communicated poetically by the astronomer:

> … I am the universe, you are the universe, wow! You are the universe that have taken shape to make questions about yourself. We're *in* the universe, you are carbon, nitrogen, oxygen, you are amino acids, that *is* building proteins. … And we are built of stellar dust, and then we have evolved into life, but not only into life but into consciousness, thinking, to make questions about the universe, because we are the universe, as a stone, as another star, been born inside a star, about the universe itself, about ourselves, where are we coming from, where is this worldmaking taking place. As a universe we are trying to understand ourselves, because we *are* the universe.

[41] However, we mistakenly call it the space *industry*, because it is so much more than a mere industry.

Narrating a romantic relation between amino acids and the human being is thus, framing an extra-terrestrial companionship between humans and every particle, atom and object that surround us on Earth and in the universe. Objects and phenomena in the infinite cosmos are taken into the social realm, and become a part of the *human condition* (Arendt 1998). Put differently, these objects and phenomena are brought into the social realm through human activities like unpacking, categorising, mapping, detecting, and eventually 'conquering' outer space, little by little.

Exploration of outer space, and the imaginative capacities to ask new wonder questions, in order to enable more exploration, is continually penetrating outer space with cultural values (Battaglia, Valentine and Olson 2015; Gorman 2005) for every undertaken activity. However, not only space activities and wonder questions endorse the universe with cultural meaning. Popular culture like science-fiction has played a crucial role in this for over a century. The first science-fiction movie ever to be produced was *La Voyage dans la Lune* (A Trip to the Moon) in 1902, and since then science-fiction movies have flourished. Several of my informants shared a passion for science-fiction books and movies as well. Who hasn't heard about *Star Trek, Star Wars, E.T., Planet of the Apes, Avatar* or *The Hitchhikers Guide to the Galaxy,* for example?

Anthropologist William Lempert (2015) argues that science-fiction as a part of this popular culture often shares a perspective on "hopeful futures," and discusses how, "the genre holds a special place in the collective imagination" (*ibid.*). Similarly, SpaceX and their plans for human settlements on Mars, and the Mars mission that visitors can participate in at *Spaceship Aurora* on Andøya, are comparable in this science-fiction narrative of hopefulness. Moreover, the various actors in the contemporary space age clearly benefit and take part in portraying symbolic 'hopeful futures' (*ibid.*) for humans in outer space. As popular culture contributes to a change in how we perceive the contemporary world (or at least the future), the interplay between the imaginative and curious human, scientific exploration and inherent urges to explore, are interdependent. Science fiction invites us to take an imaginative journey out into the universe, and scientific exploration makes this possible through launching activities which unpack the universe piece by piece. In that sense, human beings are continually put in relation with the extra-terrestrial, and this changes the way humans relate themselves to Earth and the universe.

Reaching out a fascination for space to the general public has been, and still is, an important nexus for the local space centre; awakening an interest for the mystique and science of the universe in children and youngsters is especially important. The main goal has been to recruit a new generation to the natural sciences, and hopefully to *Romtek* (see chapter III). Narratives such as, traveling to another planet, being a space farer onboard a space vehicle, are perhaps more fascinating than the prospect of going to Mars to study the soil and its minerals, however it is the coexistence of these that is important. The *Spaceship Aurora* visitor centre is a magnificent example of this symbolic narrative of humans engaging with outer space, that in turn, hopefully, fosters fascination and curiosity. In the local Mars mission, participants get dressed in grey indoor spacesuits, and are expected to collaborate as a space-crew flying on a mission to Mars, in an advanced spaceship simulator. This activity receives great attention from every kind of visitor (youngsters, adults, families, colleagues, tourists, etc.). Additionally, one can drive a simulated rover on Mars, using VR-glasses and a joystick – or build a paper rocket and launch it through a plastic tube towards the ceiling (see chapter I). The combination of exciting adventures and scientific exploration of outer space were explained to be an important component in "… making a nexus between the natural sciences and culture, and to building a bridge between poetry and prose" (Scientist 2020).

On my second day in the field, I attended a lecture by a plasma physicist over at the Spaceship Aurora visitor centre. The lecture was titled, *Northern Lights, Folklore and Mythology,* and the professor (plasma physicist) explained that the aurora borealis is indeed the footprint of our atmosphere, and this footprint is made visual and reachable through explorational activities. The mystique of the aurora, he elaborated, is the consisting of magnetic coordinates and magnetic time, and therefore, "it cannot be tied by mathematics" (Professor 2020), which makes it even more mystical. The desire to preserve some of the heavenly mystique is not only achieved by the symbolic activities that the public can engage in (as with the local visitor centre), nor only by explorational activities. The vigorous body of the celestial dancer herself, sometimes, reach out during cold and dark winter days to the lucky viewer, and the mystique is thus also upheld by the cosmic theatre itself. Experiencing the aurora through diagrams and instruments, is different to laying down in the cold winter snow, gazing up towards the moving shapes and colours she performs. The aurora borealis per se is unchanged, but aspects of her presence differ in these two kinds of experience (see chapter I and II). As the lecture approached its end, the professor presented the audience with a cosmic light and sound presentation on a big screen. The colours of the aurora were introduced as the body shape of a ballet dancer wearing a skirt; a cosmic dancer, dancing at the pace of the magnificent blue-green and purple-ish characteristics of the northern lights. And the cosmic sound is best described as an unidentifiable crackling, as if someone is playing with aluminium foil. The lecture ended with the professor describing the aurora borealis as a "drama played out in five acts, put into motion by the solar winds, colliding with Earth's atmosphere."[42] The aurora borealis comes into life because of solar storms that send out charged particles that come "…crashing into the magnetic fields of Earth…" (Carlowicz 2010).

Andøya's proximity to the polar cusp and the aurora oval makes this place the perfect *window to the universe,* as I have described in chapter I. This is especially true when scientists want to investigate how electrons and atoms attach to and detach from each other, to manifest visually in different colours and shapes. This knowledge is unpacked by the curious operator, which is included in the human-machine-interaction, using mediated instruments, as sounding rockets launched from Andøya Space Centre (see chapter III). Because of its location, the local space centre can "offer international researchers an orchestral position" (Brekke and Egeland 1994: 9, own translation), right under the northern lights. However, it is the combination of scientific methodology, curious imagination and accepticism[43], that makes this "precious word of science" (Scientist 2020) available to human interpretation, and thus fills the universe and aurora borealis with cultural meaning.

4.2 Calculating the shapes of cosmos – Where is my origin as Stellar Dust?

> There's about a quarter section of the trajectory where you are shadowed. So [*sic.*] there's absolutely no solar light on you. The only light that comes to the spacecraft is from stars out there in the universe. We found that there were millions of times more stars we could see from that vantage point than you can looking through the atmosphere here on Earth. There were so many stars that I couldn't even find my brightest stars which I use for navigation. They were completely washed out by all the starlight in the universe. And that makes you really think about what is the universe. What is it all about?
>
> *Al Worden, Apollo 15 mission* (Davenport and Vitkovskaya 2019)

Rockets, satellites, Lidar- and radar measures, and the telescope, are used to detect and unpack knowledge relating to celestial bodies that are still not fully understood. All these instruments must be included in a human-machine-interaction for the curious operators to produce meaning about celestial phenomena (see chapter II and III). Tools such as these are seen as instrumental mediators, which again means, the tool (instrument) enables the conveyance of something

[42] The professor explained this act as; Frequency one – the still aurora borealis. Frequency two – the aurora borealis building up. Frequency three – the explosion. Frequency four – the dying aurora. And frequency five – the pulsing aurora; turning on and off.

[43] Accepticism is an emic word used to describe a wholesome positive approach to scientific methodology. Emphasising that imagination and scientific questions need to be risky, in the way that science fiction is risky (it pushes science and the technological development forward).

"previously hidden or unsuspected features of the world into view" (Ihde 1979: 28), as with the insides of the aurora, or the picture of Earth taken on a mission to the lunar surface – The *Blue Marble*. Continually engaging in activities with these tools, make terrestrial boundaries stretch further and further beyond their own physical limits. Always stretching beyond terrestrial boundaries, enabling more detailed exploration of the universe, presenting the world with more and more comprehensive visualisations of Earth seen from the outside, are changing how human beings relate to Earth and the universe.

Heidegger (1977) argued that the greatest conquest of humankind would be to create Earth as a picture. What then happens when pictures are created beyond terrestrial boundaries, like for example Mars or the Moon? If creating the world as a picture ought to be humankind's greatest conquest, then, visualising celestial phenomena, planets and galaxies could be understood as a *new frontier*[44]. Looking deeper into space from satellites in orbit creates questions of curiosity, and as NASA astronaut Al Worden emphasised, "What is it all about?" Similarly, when the astrophysicist discovers new wonders of the universe, he also discovers new questions such as, "Where is my origin?", "Where is my origin as stellar dust?", "What happened on Mars?", etc. These questions generated by the interaction between scientific curiosity and the development of new and more advanced instruments and tools. Human beings' continual engagement with outer space and new discoveries of the universe make our presumptions of the world come into view, and therefore change our perception (Geertz 1993, 2005; Wadel 1991; Zimmermann 2015) of celestial phenomena, and thus ourselves. Homo faber (Ihde and Malafouris 2019) and the Artisan (2000) makes, and uses, tools and instruments to answer existing questions about the universe, and discovers new answers, that, in turn, provoke new wonders that successively prompt even more questions.

Since the beginning of history, humans have always had an exceptional appetite for exploring new places and phenomena that are unknown and foreign (Smith 2019). Looking out from space to see deeper into it, and presenting detailed pictures of Earth seen from the outside, is changing our perspective of Earth as our 'home'. Earth seen from the outside creates a vision of 'home' as a collectively shared place called Earth. For example, the first Afghan astronaut, Abdul Ahad Mohmand (crewmember on a Russian mission in 1988) explained how his perception of 'home' changed from space, and how seeing Earth from space makes us think

[44] Frontier's is understood as dramatic and ground-breaking industrial, environmental, and social developments. As for example the industrial revolution and the beginning of the space age back in the '50s. Today's space endeavours are more advanced and reach further out in the universe, therefore I argue this to be the *new* frontier, rather than *final* as some chose to call it.

globally, “When you are on Earth, you think about your country, your motherland, about its borders, about your embassy… in space, you see that your home is the Earth… Earth is our common home” (Davenport and Vitkovskaya 2019). To see Earth from above and “not seeing it from the ground is important for our knowledge” (physicist 2020), because it allows us to go to space to bring new knowledge back to the terrestrial ground.

From the local space centre, launching weather balloons to see, launching rockets to see, firing laser-rays to see, using radar-parks to see – these are all mediated tools working with homo faber (Ihde and Malafouris 2019) *to* detect something. Whether it is to detect objects or phenomena out there in the atmosphere or universe, or to discover something that can be brought down and used as a resource on Earth. Satellites enable measurements to a greater extent than before. Old theories are tested, and some confirmed with the use of these kinds of mediated tools. For example, Dr. Birkeland’s famous *Terrella Experiment* (cf. chapter III) was first confirmed when humans were able to take detailed measurements in space (several decades after the first theories of the northern lights and Earth’s magnetic poles). Thereby, the mystification of space is undressed and reproduced through new discoveries, that in turn create new questions, “so in that sense we are going to make more and more discoveries about the universe” (Physicist 2020), piece by piece, through every single activity.

It is through the process of poetry and prose that the scientific and emotional attachments to the universe manifest, as described by my informants. Turning to an inwards perspective is attaching rather than detaching the understanding of what it means to be human in the contemporary space age. Valentine (2016) discusses a *recontexulisation* that occurs when humans view the world from outside, and argues that this is important to recognise, especially when considering the consensual notion of what it means to be human “limited by a planetary horizon” (*ibid.:* 513). When local space activities on ASC unpack celestial bodies, as the insides of the aurora borealis - which is not seen by the naked eye - the electrons and atoms inside it are taken into to the experience of the operator or scientist using mediated instrumentation (Ihde 1979), like sounding rockets and Lidar-rays. Simultaneously, the dancing aurora is both seen and experienced through several human senses, without using instruments other than the human body. However, experiencing the dancing aurora by gazing up at the black winter sky is not the same as experiencing it from the inside, from within her building bricks. The perspective of experience is completely different, but the phenomenon is the same. As an example, one informant told me about the night his grandmother passed, whilst he was driving home from the rocket range:

> I saw something weird. It was the northern lights, but it was shaped as a kind of rectangle, it was like it was showing herself as a port, or some sort of gate. At the time I didn't know yet that my grandmother had passed, but still today I do think this visual picture on the sky, meant something.

After this story, he continued to retell many different stories he had heard about the aurora borealis. The Eskimos for example, saw the aurora polaris as a doom or gate to the otherworld, and that the shimmering could be the dead walking over to the 'other kingdom'. And others "in the east"[45] had seen it as a premonition of something awful and scary, that prompted disease or war. This made him conclude that, on that particular night, the aurora had shown him a sign, actually told him in its own way that his grandmother had passed away.

Not all the locals I conversed with had an inner 'space nerd', just hanging around waiting to leave the planet on the first available space vessel. However, surprisingly many expressed their enthusiasm to leave our precious planet at the first opportunity. One operator jokingly expressed, "I'm more ground, ground, heheheh, ground based," whilst a another expressed loudly when asking if he would take the opportunity to be a crew member on a vessel going to space "RIGHT AWAY … Yes! Absolutely."

Even though the childlike fascination for the universe didn't apply to all informants, a fascination for the ability to develop new technology in order to open new boundaries, or for translating old technology into new space activity uses, was commonly shared. Through space activities new boundaries are opened for conquest. Breaking terrestrial boundaries, by going further and further into space, makes the question of resources arise. Questions such as, how can exploring the extra-terrestrial and other planets benefit humans living on Earth? Moreover, the exploration of outer space is seen as "man [*Sic.*] trying to carve out a new path for his [Sic.] own survival" (Pirni 2016: 1), and not necessarily on his or her own planet.

When conversing with an operator about the translation of old military technology into space technology, she shared her view of taking knowledge back down to Earth:

> It is important to figure out what we can, and I mean, it's not that important for *me* to move to Mars, but I do believe that we have a lot to learn by exploring. We do learn a lot … about ourselves and the origins of our planet. And maybe, on a couple of things, we can learn

[45] It is rare to experience the aurora borealis from equator and the East, but sometimes in extreme eruptions it can be seen. However, not in the typical colours that we see in the north, but in red and yellow. Aristoteles (1952) presumably talked about the northern lights in his *meteorologica*: "Wherever then conditions are most favourable this composition burst into flames when the celestial revolution sets in motion… if it extends lengthwise only, then we see the so-called torches and goats and shooting stars" (*ibid.:* 31). And when "the motion is upwards, downwards or sideways according to the position of the exhalation…: (*ibid.: 35*). These descriptions are almost identical to descriptions of the northern lights today, however the colours vary.

> what's gone wrong on other planets. And, where we can see, ok, maybe some of those same patterns are about to be repeated here. But we *can* affect them, and then maybe we can learn something from it.

In many ways 'looking out – looking in' is a calculated and preventative measure for doing 'better' on Earth. At the same time, Norway (as a space nation) is committed through the *Copernicus*[46] agreement to do bring knowledge back 'down'. Exploration does not only provoke interest through grand *Humans in space* narratives, but it also provokes new questions that drive technological development for the future of space explorations. However, development does not always point to the creation of new instruments and tools. At ASC and the Arctic Lidar Observatory for Middle Atmosphere Research[47] (ALOMAR) they are using old military-technology that has been translated into space technology. The ALOMAR facility has been standing there (on top of the laser-mountain, as some locals call it) since 1995, and some of the instruments were originally developed for military purposes. A Lidar-operator at the observatory explained that some of this technology was going to be used for 'some war stuff', but eventually some scientists discovered that this technology was equally good for scientific space research (back in the nineties), and now "we can actually see the same. We can use the same technology in space, and we can see how we can convert what we have on the ground to space technology" (Physicist 2020).

The tool, for example the rocket, is not a technological determent, it is through the interaction with the tool-user and his or her curiosity that possible transformations occur. The rocket is taken into and included in homo faber's (Ihde and Malafouris 2019) 'skilled system' (Ingold 2000), with vast opportunities for movement and action, as described in chapter II. The rocket is thus taken into the tool-users' social universe, and thereby endorsed with cultural meaning.

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[46] The Copernicus agreement is an Earth Observation agreement between ESA, the EU-commission, The European Environmental Agency (EEA) and other member countries, like Norway. The collaboration has as its main focus to observe 'nature', environment and climate changes on Earth (Norwegian Space Agency 2016).

[47] The ALOMAR station is a ground-based facility for atmospheric research, located on the top of Ramnan mountain on Andøya. The facility was built in the early nineties, through a European collaboration. "The observatory features an iconic and easily recognizable shape designed to minimize the effects of wind to privde an optimum environment for lidar instrumentation. The beams can reach over 100 kilometers, and some can be tilted several degrees" (Andøya Space 2021).

4.3 Urge to explore - Perceptual views: Wherever I lay my hat is ‘home’

> … longing is captured in the image … a person pointing toward a star understanding Earth’s relation to other worlds. Conceiving of planets as worlds and determining how many there are and if any of them, are like our own situates Earth in a lager cosmic context. . .
>
> *Messeri 2016: 22*

As Ihde (1990) points out, at some point in our lives, we have all looked up into the starry sky and become filled with wonder. The mystique is still up there in the heavens, no matter how much the atmosphere and universe are unpacked and transformed into meaning and new knowledge. The urge to explore what is not yet detected is an urge for a “bringing into presence of that which was previously either unnoticed or undetected” (Ihde 1979: 47). Celestial bodies do not go unnoticed by the observer; they are rather undetected bodies of wonders that we don’t know much about.

Human exploration is not something new and exclusive, activated by the space age; humans have explored new places for as long as we have records. Exploring could in such a view be understood as human forms of adapting to new environments and climates (Smith 2019). In the way that “… a polar bear parka and sealskin boots are material adaptions for early native explorers of the Arctic” (*ibid.:* 9), from the contemporary space centre in the sub-arctic, the material adaption has taken another form, through extension technologies (like for example sounding rockets), or adaption technologies. Adaption and exploration represent more than an “‘innate will to explore’” (*ibid.:* 10), they are also stretching planetary boundaries further and further into space. This, in turn, changes the way in which millions of people relate to the cosmos and the celestial phenomena and objects out there. For example, before humans with their material culture (Morphy 2010) began to settle down on Mars (Opportunity Rover, Curiosity Rover and Mars Rover), Mars was just another planet out there in our solar system. However, today, Mars is a planet that humans are mapping and exploring with their instruments. The exploring and mapping out another planet, in order to someday establish a human space colony, is changing what it means to be human, and presumably what humans in the future can call their ‘home’.

Conversing one afternoon with a local air-trafficker, he shared his view of human movement histories, arguing that it is in our ‘nature’ to explore, “if not we would still be living in Africa today. We are talking about major population movement histories, through the history of time … and any species that stagnate become extinct” (Air-trafficker 2020). And similarly, as Smith (2019) argues, to understand the contemporary human urge to leave our precious planet to voyage into the universe, we need to understand how population movements, and social and cultural adaptions, have survived in foreign and new harsh environments in a historic context, as with the example of arctic explorations and development of the polar bear parka (Smith 2019). At the same time, we must pay attention to how these forms of exploration have dramatically changed in the last century, with increasingly more human engagement in the extra-terrestrial.

Worldmaking is no doubt a consequence of exploration, be it ancient population movements, the industrial revolution or 'modern' space activities. One important difference in contemporary times is that we have ability to reach out to people across social groups, and nation-states, in a more extensive manner than before, thanks to the development of communication satellites. To provide an empirical example, one evening in May 2020 an informant and I watched the historic launch of SpaceX and NASA's Dragon 1 spacecraft. The operation was to send two astronauts from the Kennedy Space centre (NASA) on the Florida coast, to the International Space Station (ISS). The event was streamed live, and thereby made possible to follow in real-time from (almost) all corners of the world. In this sense, my informant and I were not watching this event alone: ten million people across the globe were watching it with us. The stream displayed how many people were presently watching. The ability to observe, in real-time, how many people came, left and stayed to watch the stream, created the feeling of 'we are watching this launch together'. The launch was historic, not in the sense of the vehicle or the technology in itself; the design and used technologies were stated by another informant to be "past-fiction," nothing extraordinary or anything new. This informant was not impressed (at all) by the Dragon 1 launch, as the vehicle was simply the same as older space vehicles, with only a few small adaptions in instrumentation and space suit design. Nevertheless, what made this launch historic, was, according to several locals, the collaboration between a commercial (SpaceX) and governmental (NASA) space agency. Moreover, making the launch globally accessible is another way to demonstrate Western prowess over technological (Redfield 2000) instruments throughout the world. At the same time, making a launch accessible, and presenting it as a night of entertainment, produces curiosity for space exploration.

Throughout my fieldwork, several locals shared their fascination for space activities and exploration of the universe. Some even to referred to Andøya as a future *Romøy* (space island), "where there's only like, eh, nerds that live and work" (Computer Scientist 2020). And some shared their fascination for leaving the planet in a space vessel. Similarly, Valentine (2016) was surprised when several of his interviewees answered affirmatively when asked if they would be willing to leave the planet in a space vessel; "'… let's go somewhere else and see something new!'" (*ibid.:* 520) one girl had responded, another one shared; "'I would [go] because I want to be an explorer or pioneer'" (*ibid.:* 521). I was equally surprised when some of my respondents answered in a similar fashion, "no doubt, right away!," and another said "… one needs to sacrifice for the bigger picture…" Valentine emphasised that this does not necessarily mean to leave our earthbound and social commitments on the ground, nor is it a "decontextualized detachment" (*ibid.:* 521) from Earth, but rather, a radical new way of thinking about what it means to be human in other planetary places (*ibid.*). A conversation topic that I encountered time after time concerning Andøya, was people's feelings of an inherent and sometimes innate fascination for space and the universe, "I am kind of born into it, I have been walking in the space centre since I was borne… so it's innate, the interest is constant" (Computer Scientist 2020). Much of this fascination was communicated in reference to the infinite size withheld by the universe, because there is "still so much, we don't know about *it*" (*ibid.*). Moreover, and in the near future, when the new launchpad for small satellites will be ready to launch bigger rockets, the planetary boundary from the sub-arctic is going to stretch further out and into the universe than it does today. Enabling bigger rockets to launch, explorers on Andøya get the possibility of exploring further than sounding rockets permit, and, in that perspective, the operators, scientists and other explorers will, using bigger rockets with more instrumentation, increase their ability to experience new aspects of objects and phenomena in space. A strong notion of Andøya as a future *Romøy* was shared when chatting about explorational activities in a Norwegian context:

> It is the only space station, or as good as, we have in Norway… and if humans are like we think, that we are going to explore all sorts of things, then, in the end, we are not only going to be on this planet… we are going to explore as far as we have the possibility to.
>
> *Informant 2020*

Turning back to the astronomers' romantic approach to the universe and how everybody and everything share fundamental ingredients of existence, it was emphasised that if we do not dream big, we don't go forward, and, hopefully, by building a bridge between the natural sciences and culture "we can have something of future interest" (Astronomer 2020).

4.4 Summary chapter IV

As described and explicated throughout this chapter, local activities like rockets launches are not the only conditions that contribute to how space activities change the way humans relate to Earth and the universe. The intent has been to show how explorational space activities and the curious and imaginative human being is both important for exploration. More precise, dreams and urges to explore is an underlying condition for explorational activities and that exploration and new knowledge about celestial phenomena change and aspire new urges and dreams about the universe. It is through scientific methodology and the use of tools and instruments that a mediated interaction between celestial objects and operators manifest. And it is through the human-machine-interaction and curious imaginers that the tool-user may enter a cosmic companionship (Messeri 2016) with, for example, the aurora borealis, the Moon, or the red planet, Mars. It is described how old technology is translated into new uses to answer questions about the universe, and new technological instruments are developed to answer new questions that need instrumentation and tools that currently don't exist. Understanding this hermeneutically (Zimmermann 2015; Geertz 1993), we are making discoveries that consider human senses, dreams and curiosity as equal parts of space related activities. For every activity, for every new discovery, the boundary of Earth is stretched little by little further into the universe.

Stretching boundaries, unpacking new knowledge of what was previously unknown, contributes to changing the perspective on how humans relate to Earth and the universe. This worldmaking is made possible using instruments which "function as a necessary condition for its knowledge gathering" (Ihde 1979: 68), and in the act of asking new question of the universe. For example, the aurora borealis can be experienced from different aspects. It can be seen and sensed by the whole body whilst gazing at its theatrical performance on the black winter sky. At the same time, to visualise and learn about the aurora borealis from the inside or outside, rockets are launched to measure and detect what the human eye and body cannot see or sense for themselves. In this way, gathering technologies as mediated instruments opens the possibility for the operator to experience beyond his or her physical body, which in turn produces meaning about these celestial bodies under examination. The aurora borealis is thus mapped, unpacked, detected and made available to a potential meaning-making and the production of new knowledge.

The "… instrumental mediation transforms the shape and distance of the world" (*ibid.:* 47), like the picture of the *Blue Marble*. This was not simply a visualisation of the globe, but more significantly it invoked an "early environmentalism" (Boes 2014: 158), and a new "planetary consciousness" (*ibid.:* 159). In comparison, informants were interested in sharing their view on the importance to use space activities as a means for bringing knowledge back down to Earth, especially by exploring other planets to see if some of those same patterns are happening on Earth today, so that we may hopefully do something about this. Or by using satellites to monitor Earthly environments, for example to track the deforestation of the Amazons, or to see how the oceans are changing. NASA astronaut Mike Foale (Davenport and Vitkovskaya 2019) gave an example. When he was on ISS in 2003, he could see a black spot over the Middle East, as if the whole region had been swallowed, he called down to Houston and asked if something terrible had happened in Iraq, Houston answered back that nothing had happened. Foale could not shake this bad feeling and therefore showed the black spot to one of his crewmates, and he also agreed that it looked like something terrible had happened. A second time they called down to Earth, but this time to Moscow. First the operators in Moscow confirmed that nothing had happened in Iraq, but after just a couple of seconds the operator told them to hang on, before the operator responded, "Maybe some rebels. They've been attacking oil rigs" (*ibid.*), and this caused this huge black hole of smoke. This episode clearly shows that seeing Earth from space with the human eye[48], may enable the observer to detect things going on, on the ground, before people on the ground themselves are able to detect it, and thereby the Earthly perspective changes.

Launching rockets and shooting laser-rays into space to ask questions about ourselves points to human curiosity that stretches beyond terrestrial boundaries. However, developing instruments that can go further and further out into the universe points to a human mastery over not just the Earthly forces, but a will to mastery of the furious forces of outer space as well. In the epoch we now live, which some call "… the Anthropocene, our very planet becomes a medium for human inscription" (Boes 2014: 160), and thereby, the human condition (Arendt 1998) changes, because new objects are being revealed and placed in relation through exploration. Simultaneously, unpacking the universe does not remove the mystical powers it possesses, because the wonderment one individual can experience when gazing at the dancing aurora borealis, or starry winter skies, is not withdrawn[49] by scientific exploration and the production of new knowledge. The proximity of the universe, and the accessibility of tools like the rocket, "retains the 'near-distance' of machine mediated experience" (Ihde 1979: 10)

[48] Material culture as satellites is understood as 'human eyes' extended by the use of instrumentation.
[49] Not a zero-sum game.

between the operator and the celestial phenomena the operator, scientist or student investigate.

The constant pull between heavenly objects, space activities, embodying practice, unpacking, mapping, detecting, making close, and efforts to conquer, are all parts of what I, in this thesis, call *worldmaking*. This worldmaking is founded upon specialised knowledge of instruments and the possibilities they offer for interaction, the curious mind and scientific knowledge about atoms and particles, by unpacking them and formalising them into human frameworks. In this view, a "geophysical agency on a planetary scale has become part of the human condition" (Boes 2014: 163), and so challenges what it means to be human in the contemporary space age. Asking questions like, 'Where is my origin as stellar dust?', and 'Where is this worldmaking happening?', are questions driven by curiosity, that function as conditions for explorational activities in outer space.

Exploring the starry skies with different instruments, like rockets, laser-rays and radar-parks, makes distant objects come close, and creates a new proximity that penetrates social life (Hoeppe 2012). Bringing distant objects into the realm of human experience (by proximity), strengthens the cosmic relation the observer can experience with celestial objects. This is what Helmreich (2012) elaborates as *extra-terrestrial relativism* – a relativism that renders a connection between the 'subject' (terrestrial) and the 'object' (extra-terrestrial). This is understood as a knowledge about life that is "… imagined as relative to a "nature" whose full character we do not yet know" (*ibid.:* 1130). Moreover, this 'relative' condition is unpacked in the act of worldmaking activities in outer space. It is a constant pull between above, inwards, up and outwards – launching, seeing, imagining, reading telemetry, asking questions, and developing new technology, or translating existing technology.

The use of rockets and other 'visual gathering tools' to investigate the insides of electromagnetic waves, or the aurora borealis, discovering how electrons and atoms move, is in fact an extended act of seeing what the human eye itself is not able to detect without using tools. Following (Ihde 1979), this is how the extension of the operator's, astronomer's or child's experience, occurs using mediated instruments. In this sense, the urge for exploration is not only inherent or innate, but also driven from a perspective of uncertainty – not in the perspective of fearfulness, but uncertainty driven by the imaginative curiosity that coexist with scientific knowledge. This is especially the case with those *space nerds* 'hanging around', waiting to hitch a hike with a space vehicle to explore the universe. Not in the sense of exploring the universe through ground-based instrumentation, or a rocket, but a sense of exploring that brings the whole body out into space, and thereby using the body as the main[50] instrument for experience.

Space travel is dangerous, and one might not come out of it alive. But still, some of us, with an inherent urge to explore, finds the thrill of it more important. The human urge for exploration which is described throughout these pages, is not something exciting and new, taken into social realm by *romfarten*. Rather, as Smith (2019) argues, these urges have always been a part of the human condition (Arendt 1998). However, the way they unfold is different when considering space activities. They take different material forms, and are different in that explorational activities move beyond terrestrial boundaries. However, human adaptions to new ecological[51] and cultural places have always been a part of historic population movements. And "… as humanity matures and explores encountering new phenomena, even new questions will be posed" (*S*mith 2019: 166), and therefore, I argue, it is important to recognise that exploration is not a new phenomenon, emerging in the space age; rather, the physical boundary of exploration have (dramatically) changed with the space age. Moreover, as the plasma physicist emphasised, as long as we explore, we will continue to make new discoveries, not just about ourselves as earthbound humans, but about space as well.

The seemingly inherent, innate – the unpacking and the urge to explore are woven together with the perspective of prose and poetry, building a 'nexus' between culture and the natural sciences, and is thus a strong symbolic union in the process of worldmaking. It is only when these activities and new knowledge are disseminated to the general public (like for example with the visitor centre, Spaceship Aurora) that this worldmaking manifests in the social sphere. Symbolic features are strong meaning holders, because symbols need to convey multiple meanings to make sense (Langer 2002). They must communicate a relation between action and the symbol. With the example of the mission to Mars at the visitor centre, the mission itself serves as a strong symbolic notion for human exploration of outer space and another planet – however, at the same time, human prowess over technology and the forces of 'nature' (Redfield 2000) are integrated parts in these symbolic forces. In these empirical examples, the desire to share with the general public is emphasised as an important condition for local space activities. It is argued to be especially important to share a fascination and

[50] This is juxtaposed, because humans cannot survive in space without existential technologies, and thereby, they cannot experience outer space on their bodies without space suits and spacecraft that shields them from deadly radiation.

[51] When the American Space Programme drove geology to the Moon, the lunar environment was re-categorised to be compared with extreme environments on Earth (like deserts, caves, seabed's, etc.). This in turn conceptually convert the lunar environment into a familiar ecological place that human beings can encounter (Messeri 2019).

interest with younger generations, so that more youngsters (hopefully) become interested in the natural sciences, and thus want to study towards becoming part of a new generation of explorers.

Cultures and societies change with technological developments, and it is through wonder questions and curiosity, like, 'Where is my origin as stellar dust'? and the coexistence of local and global space activities that ultimately change how humans relate to Earth and the universe. When one question is answered, new questions arise, this contributes to more activities, and this is turn continues to revolve in a circular hermeneutic movement (Zimmermann 2015). Through the act of seeing Earth from the outside, and by converting knowledge back down to Earth, an environmental consciousness (Boes 2014) arises. Moreover, what was previously interpreted as a 'home' divided by countries, nation-states, continents, religions and social groups *is* changing in the pace of local and global space activities. Seeing Earth from the outside creates a feeling of Earth as our collective 'home'[52], that we share, regardless of nation states. As the astrophysicist emphasised, 'this is our home, and that is the only place that make sense for us to be'.

Lastly, the conception of ancient population movement histories echoes in our talk of leaving our precious planet in a space vessel, thus challenging the anthropological discourse to reconsider the sociality surrounding "borders and limits" (Pirni 2016: 3). Human consciousness does not cease to exist at the horizon of Earth's atmosphere. Rather, human imagination has for several centuries voyaged outside of terrestrial boundaries and into the dark and mystical cosmos. Nevertheless, what's different in the contemporary space age is tools, instruments and 'gathering technologies' (Ihde 1979) making it possible to engage with the universe in new ways, thus enabling new discoveries, provoking new questions, perspectives and imaginations of the infinite cosmos. This happens through the interplay of local and global space activities, as well as in the minds of men and women. As this thesis argues, space activities contribute to *changing* how humans relate to Earth and the universe. Furthermore, homo faber (Ihde and Malafouris 2019) and the artisan (Ingold 2000) are just as paramount to space activities (see chapter II). The curious mind of the scientist, the eager child with the binocular, the excited guests of the visitor centre, and the bridge between the natural sciences and culture, cannot be

[52] Earth as a universal shared space for all human beings is not something new activated by contemporary times. This view "derives from the Greek word *Kosmopolitēs* ('citizen of the world')" (Kleingeld and Brown 2019). Philosopher Diogenes is the first known to discuss the notion of a world citizen, in "the fourth century BCE" (*ibid.).* Diogenes argued that he was not only a citizen of the world, but more strikingly, he said "I am a citizen of the cosmos" (*ibid.*). In that perspective, the notion of 'world citizen' is perhaps making a re-entry in the contemporary space age.

disregarded when examining explorational activities in outer space. Moreover, symbolic gestures from commercial, governmental, local and global actors, all play significant parts in this *worldmaking*.

In the next chapter, we are leaving the imaginative and curious human (ready to leave the planet in a space vessel), in order to examine how actors, environmentalism, *Green* space and secondary effects are all consequences of local space activities.

Chapter V

Exploration, Exploitation and Space junk - This is not my junk

In the last 60 years, parts of interplanetary space have become filled with human material culture in the form of functioning and non-functioning satellites, upper rocket stages, probes, landers, modules, organic human remains, orbital debris and 'space junk'.

Gorman 2005: 86

This chapter examines the actual consequences of space activities, and looks at how local and global space activities contribute to littering, conflicts and new perspectives of thinking about the environment, as well as environmental issues. Outer space is not a singular or detached *place,* 'out-there', rather, it exists in connection with social values and factual dangers for everyone on Earth. The local space centre on Andøya is enrolled in a web of various (commercial and governmental) actors, both locally and globally. In this chapter I shall examine more closely how different actors are distinguished through perspectives of exploration and exploitation. The explorational side of actors is considered as the scientific part, seeking new knowledge about the Earth and the universe. By contrast, the exploitational side of actors is considered as the business and profit-oriented part. The push and pull of this binary pole is important when interpreting how worldmaking manifests through governmental and business space related activities, and how they create local tensions and conflicts. Interestingly, the local space centre is a private and commercial business enterprise, fully owned by the Norwegian Government[53].

What unfolds throughout this chapter is a growing environmental consciousness. A perspective that brings to the fore an anxiety for past, contemporary and future human littering on Earth and in orbit. Space junk, 'green' rockets, actors, and secondary social consequences are empirically explored throughout this chapter. Space activities create areal conflicts, environmental consciousness, and a substantial amount of waste. These issues, I argue, have a significant social impact on how people relate to Earth and the universe.

[53] ASC is fully owned by the Norwegian Government; 10% owned by Kongsberg Gruppen ASA, which is owned 50.001 % by the Government (The Norwegian Ministry of Trade, industry and fisheries), and 90 % owned by The Norwegian Ministry of Trade, Industry and Fisheries. Andøya Space Centre is categorised by the Norwegian Government as a category three company with political goals defined by the governmental sector. The goal is to strengthen Norwegian research and high-tech business (næringsliv) (The Norwegian Ministry of Trade, Industry and Fisheries 2019; Kongsberg 2021).

5.1 Actors – The difference that make a difference

So, as I told you before with the analogy, we are on the floor here and say, okay, let's put space down to Earth. It is simple, it's the same, let's call space the surface of Earth and we are in a town. And there you have houses, and you say, 'this is space, and each house now represents a satellite'. A lot of houses (pointing around in the room), a house, a house, a house, and they share almost the same technology, the same technology has been used to solve these houses… One of the houses is a bank another a school and another a culture centre. Can you say that this is the same? No. The purpose is what's important.

Astrophysicist 2020

Conversing with local operators, scientists and fishermen revealed that actors, science, imagination, curiosity, environmental consciousness are all conditions that somehow play equal parts in the space 'industry'. And as the astrophysicist explained, it is the difference between actors that is important: their purpose for being in space matters. Moreover, a distinction between explorational and exploitational actors was emphasised as an important distinction to consider and be acquainted with. For example, the European Space Agency (ESA) is entangled in mostly explorational and knowledge-producing space activities, whereas, by comparison, SpaceX is more occupied with exploitative and profit-oriented space activities. On that account, it becomes apparent that space is not just a singular, detached place, 'out-there' floating around in the universe, entirely unbounded from Earthly social relations and commitments (Valentine 2016). In fact, every contributor takes part in filling outer space with social and cultural meaning (Gorman 2019). Outer space is, for every activity, brought increasingly into the social realm – through continuous unpacking, mapping, and categorising of new places outside terrestrial physical boundaries. As anthropologist Peter Redfield (2000) argues, "When concentrating on space, one encounters place" (*ibid.:* 183), and placemaking is here understood as an act of producing meaning in a particular location. The *terra nullius* – the place belonging to no one – that previously was considered as "a true 'wilderness'" (Gorman 2005: 88), is now being 'domesticated' by human material culture (Morphy 2010) and cultural values in the space age.

In tropical French Guiana, Redfield (2000) emphasises that, at the local space centre in Kourou, culture stands "… against Nature, imperial technology against wilderness, a contrast of extremes" (*ibid.:* 247). By comparison, at the local space centre on Andøya, the wilderness of outer space stands in opposition to former military technology and local cultural practices, and as well as the forces of terrestrial and atmospheric 'nature'. Asking a local scientist about this 'singular' place called space, he explained that, unfortunately, with the ongoing 'space-race', we witness several actors with similar objectives when going into space, and instead of collaborating the approach is more individualistic. Every actor, every big nation, they all want to show that they can do it themselves. So instead of 'taking the bus together, everyone drives their own car', launching their own things. The problem, he continued, is that, in contemporary times when we talk about space, we say 'space this and that', 'space technology', and 'space activities', and by doing so, space is presented as a global – and even a positive – thing, common to everything in space. Consequently, everyone, every actor, just says, "it's space, let's go ahead!" (Scientist 2020). In that sense, the important point is how these diverse actors want to *use* space. Various actors launch instruments such as rockets and satellites, and the technology they use is very much the same. The difference lies in their objectives and purposes. For example, with the beginning of the space age (with Sputnik in 1957), space was mainly used for military purposes. It was a race between "… capitalism vs communism" (Gorman 2019: 11) and about who managed to control the "… narrative of space" (*ibid.:* 11). However, in the contemporary space age there is more transparency, more collaboration, more actors – and more civil objectives, as opposed to demonstrating military and national prowess.

Enabling us to examine and understand the purpose of 'the use of space' is crucial when seeking to empirically investigate human engagement with the universe. The previously mentioned astrophysicist explained his understanding of this distinction between actors in space:

> We are developing again different things, because we have satellites put in there by the European Space Agency, by NASA, by JAXA[54], which are experiments from exploration with big E, and what I mean is that this is for science, for solving questions that scientists have, and then need to create a telescope to Space, and experiments that goes to Mars to try to solve these kits. Questions like; what is the black hole made of? What about the big stars? What is going on behind the galaxies? What is this, all these questions. They flourish, and the answer to these questions provokes further questions; Is it water on Mars?

The scientific group of actors were described as the smallest group and were communicated as *big E*, whereas the biggest group were presented as the business part. However, both these groups, as shown in previous chapters, are dependent upon each other: they benefit from each other's activities. The business actors, often commercial (NGOs) were communicated as *big capital E*, orientated towards economical profit. These are commercial actors like, for example, SpaceX and Boeing. During the conversation with the astrophysicist, he shared his frustration related to these actors' lack of scientific curiosity:

[54] Japan Aerospace Exploration Agency. Japanese equivalent to ESA and NASA.

> … it's not curiosity, there are no questions, there is no saying, ohh what about 'this' (speaking with a theatrical voice), 'we have to solve this question', what happened on Mars? What happened on Jupiter? What is Pluto? What does it look like? How do we understand exo-planets? No, there is nothing about it, 'let's make business and new networks of internet', because it's going to provide profit.

Returning to the analogy of taking space down to Earth, the technology for 'solving' these houses is the same, but at the same time, if one of these houses is a bank and another one is a school, there is a significant difference in their use and purpose. For example, Elon Musk and SpaceX, aims for the stars when planning for a human settlement on Mars, in contrast to ESA, which has a more explorational approach, asking questions such as, has there ever been water on Mars? Or as the astrophysicist asked, what happened on Mars? The technology that is needed to travel to Mars is the same, but the purpose is strikingly different.

The ALOMAR ground-based Lidar-installation is a science facility for basic atmospheric research (cf. chapter IV). The operators and scientists use an array of instruments to remotely measure for example wind and temperature, 150 kilometres up into the atmosphere (through the troposphere, stratosphere, mesosphere, stopping in the lower thermosphere). These measurements are stored in big datasets, some of which are around twenty-five years old, and the scientists usually bring the instrumentation to the station themselves. The operators working permanently on the station maintain the instrumentation daily, and international scientists commute when needed for their research. An operator explained that the ALOMAR station is in fact no more than a service provider for scientists. The station was built in the early '90s because of a lack of ground-based measures during rocket launches. Laser measures help assure researchers that the scientific phenomena they want to investigate is there, "if not you could risk firing several millions without hitting the right conditions" (Lidar-operator 2020). For example, with the northern lights, as a scientist you need to be certain that an eruption is about to happen before firing anything into the skies. This, in turn, is a preventative tool for controlling potential economic loss during already costly projects. Moreover, as "Space research is a costly activity" (Almklov *et. al.* 2020: 222) it is important to minimise economic risk. This is understood as a precautionary measure to ensure accountability in space operations (*ibid.*). Through international collaborations called the *Esrange* and *Andøya Special Project*, Norway, Germany, Sweden, Switzerland and France have committed through ESA to fund the ALOMAR station yearly. Excluding Norway, these other collaborating countries contribute 30 million Norwegian Kroner annually for covering operating costs on the mountain station. Since "basic research does not earn us any money" (Operator 2020), the ALOMAR facility depends on these collaborations for income. However, when for example the Americans come to carry out atmospheric research, it becomes a commercial service since they are not a part of the special project agreement. It's still science and similar research, but when the station facilitates for actors (for example military customers or NASA) outside this agreement, the economic situation changes from consortium to commercial.

Moreover, there is a third actor to (briefly) consider: the local space centre's military customers. These services are provided by Andøya Test Centre (ATC), a subsidiary of ASC. ATC facilitate military institutions testing weapon systems in a 'testscape'[55] ranging on "25 000 square kilometres and includes open waters, littoral zones and land areas" (Andøya Space 2021). This, naturally, is not communicated in the same extent as other space related activities like student and scientific rockets, as the nature of military operations is usually very discreet. Andøya space centre with its "… already established infrastructure… enables Andøya space to perform complex tests of weapon systems" (*ibid.*) (see location in chapter I). When conversing with locals and an operator at the space centre, it was communicated that it was not uncommon for military personnel from the local military base to change occupations, from the military service to space operation. Military competence is acknowledged as a good resource in space operations; therefore, it is not unusual that former military personnel on the island change careers and join the ASC 'family'[56]. Military personnel was said to possess desirable characteristics for local space operations, for example the ability to stay calm during delicate operations, act with authority and follow procedures.

The CEO of the local space centre elaborated on how ASC conform to the bigger and more global picture. He explained that space is becoming one of the most important branches in private and governmental industries around the world. Consequently, the importance of exploring the benefit of satellites, navigation systems and atmospheric science is increasing. The geological coordinates of Andøya prompt a good opportunity to do science and experiments that could "help us say more about the sun, northern lights and how that is connected to Earth" (CEO 2020). It was emphasised that ASC's approach is a more Norwegian one than for example NASA's.

The local space centre is a commercial venture owned by the national government, and

[55] Testscape is the available ocean, land and airspace areal that Andøya Space Centre have been dispensed by national governments.
[56] More than often when talking with employees working at space centre, they referred to the workforce as a 'family'.

therefore creates organisational and governmental bonds beyond national borders and organisational sectors. A control room operator explained that most of these bonds are thus commercial, and that those companies are often privately owned, comprised of complex ownerships structures – both international owners and nation-states. Put differently, these could be comprised of sub-owners and groups that are difficult to have a detailed overview over. Such ownership structures can impact legitimacy in the public eye, thus causing industrial and communal conflicts.

5.2 The social contract and secondary effects

> The space centre is a political sector and owned by the government, so in that we truly have a responsibility towards making contributions that would benefit both science and business. We also have a social mission to make our work and knowledge accessible for other societal organisations, and to the public.
>
> *Informant 2020*

The local space centre being owned by the Norwegian Government implies the presence of a social contract. Jean-Jacques Rousseau (2001) explains the social contract as a mutual understanding, between state and society, of the state's monopoly on violence. However, in this case, the mutual understanding is between the space centre and the local community (especially the north-west side of the Island, where most activities take place). However, some legitimating measures are needed for local inhabitants and businesses, and especially for local fishermen. Nevertheless, the social contract does not imply (in this case) a state monopoly on violence (*ibid.*), rather it implies a monopoly on confiscating particular areas of ocean, airspace and landscape. Some of the activities can, according to the CEO, bother the local community, but at the same time they have a responsibility to increase science and scientific explorational knowledge.

During a rocket operation, the space centre requires that no fishing fleets or other shipping traffic will be in the alerted danger area, and, at the same time, they need full control over the area to ensure that there are no accidents. Additionally, they need to control the road between the capital village and the next (cf. chapter III). So, during a launch the space centre confiscates ocean areas, airspace, and the road connecting these two villages. The CEO communicated that the local community response is predominantly positive, and that the locals seem proud of the activities performed at space centre. On the other hand, he, like several others, emphasised that the biggest potential for conflict is with the local fishermen: they are not always happy to delay their fishing activities. Therefore, maintaining a good dialogue between the space centre and the local fishermen regarding launching activities is important. Some operators did not acknowledge this as a conflict, some did, and others announced it more as a communication failure between the space centre and the local fishermen. In addition, the fishers' autonomy to occupy their field is challenged, posing a conflict when a particular launching activity demands confiscation of ocean areas. A launch can never be planned down to the minute – weather conditions and scientific conditions need to overlap perfectly before the Principal Investigator (PI), or Range Control (RC) are to initiate anything being fired from the pad (cf. chapter III). The weather window and launcher setting are calculated and set to nominal before every launch. And as described in chapter III, at T- 08-00-00, nominal settings are adjusted to actual, to perfectly mosaic the weather condition. However, "it's not very often that we block the fishing field itself" (Physicist 2020), but they may have to go through the danger zone to get to their fishing fields, and thereby they are kept out of their fields. The local physicist explained that ASC try to keep their activities outside of the fishermen's primary work hours:

> So, if we can launch at night, we launch at night. But when it is scientific rockets, they are depended on the science conditions, and if this is a phenomenon that only happens during daytime, then, we have to launch at daytime.

At the same time, these are two actors that have a long history on the island, the space centre has been there since 1962, and therefore feels a prerogative claim on the area. On the other hand, the fishermen have been there for several hundred years, so they feel entitled to claim the ocean, or at least their fishing fields. Additionally, time is considered an important component to this potential for conflict. If, for example, a launch has a fourteen-day period where data is continually measured, monitored, and calculated for the right scientific conditions, a detailed launching plan is difficult to communicate to the fishermen. At the same time, the weather window and the scientific needs to mosaic before anything can launch (see chapter III). During this fourteen-day period, measures could indicate that science and weather conditions are good and that a launch may take place within the next six hours. This period is also a source of frustration, because a rocket does not launch for five-six hours a day – it takes less than thirty minutes from firing until the rocket splashes into the waters. This notion of time and time constraint makes it difficult to give clear-cut and detailed information to the fishermen, consequently they are kept out of their fishing fields indefinitely. Accessing the webpage of the local space centre during a rocket operation, a notification on top of the webpage appears, communicating that a danger area is established, and that a rocket is going to be launched. Additionally, a map over the danger area is shared with the public via the webpage (see *photo.* 3-4).

Photo 3. Danger area established for rocket operation.

This picture alert visitors on the website that a danger area is established, and that a launching operation is about to take place (Andøya Space 2021).

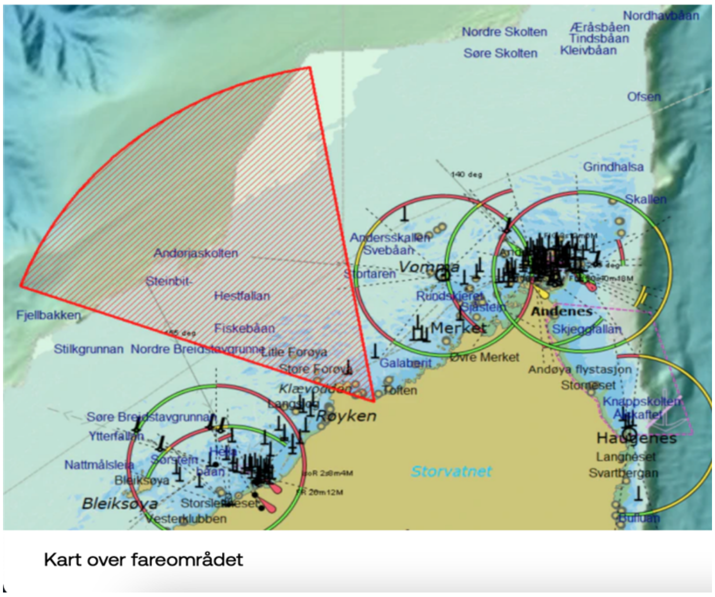

Photo 4. Danger and alerted area during rocket operation.

This picture show a detailed map over the established danger and alerted area that is established during a rocket launch, one day in April 2021 (Andøya Space 2021).

These figures show where this specific operation's danger area is located, which is a student rocket, hopefully to launch one day in April 2021. Under the map ASC write the coordinates of the danger area and informs that it stretches five nautical (metric) miles out into the ocean. They further inform that a student rocket, most likely, will launch between 8am and 6pm local time, and most likely fire after 11am and before 3pm. They also encourage maritime traffic to be aware of the area, and to be helpful in keeping the area traffic-free. Direct contact information (telephone numbers and maritime channels are shared) to the space centre is also shared on the webpage. The website also informs that the road between Andenes and Bleik will be closed for fifteen minutes during the fire; however, emergency vehicles are allowed to pass through by appointment with the Road Guards (RG) (Andøya Space 2021).

Launching activities thus create secondary effects, especially for the local fishermen. Not being able to go out to their fishing fields and not being able to plan their activities for a period of fourteen-days has a direct consequence on their income. Some label this a *de facto* conflict from the fishermen's perspective. "Yeah, I mean it affects me in a very high degree. They chase us from the ocean… I mean, they have confiscated the entire fishing field" (Fisher 2020), one fisher elaborated, quite frustrated. This disrupts the fishers' labour condition, affecting the individual human condition[57]. Following Arendt (1998), and her theory of the threefold human condition, labour is "life itself" (*ibid.:* 7); it is what people do to survive and sustain material needs, and, as the fisher emphasised, being 'chased' from the ocean, has a direct effect on their livelihood, "because I do not earn money when shored" (Fisher 2020). The fisher elaborated about dialogue meetings between the local fishing committee and the space centre, and from this perspective it was not presented as a failure of communication, rather as top-bottom arrogance, "'yeah, we hear you, but we do not comply with it', they do what they want" the fisher stated, rather defeatedly.

Talking to an employee at the space centre regarding this conflict (at the end of my fieldwork), the positivity from a couple of months prior was more or less gone. He explained that if all departments were to grow into the sky (metaphorically), the overall repercussion on the fishers would grow too big. For example, at the moment, the cooperation between the fishers and the space centre is good, since the fishers keep their fleets outside of the danger

[57] Arendt (1998) relates her writing about the human condition to Karl Marx's writings, however she separate herself from Marx's ideological orientation regarding labour, and labour as the condition that move society forward. Moreover, Arendt's threefold theory of the human condition – labour, work and action – I found inspiring to think with encountering local fishermen and their frustration regarding launching activities.

zone during operations. However, the problem is, if, for example, ATC[58] grows too big, the fishers' pressure could become too big, at which point they might become unwilling to cooperate at today's level. If we interpret the local space centre as the powerful (considering their dispensation from governmental authorities to confiscate ocean and airspace), the local fishermen are then reduced to the powerless (Eriksen 2010). Moreover, the fact that the fishers cooperate on more or less voluntary grounds, implies that the power in the powerless condition could, in the form of protests or an unwillingness to leave the alerted area, "give lasting changes in the distribution of power" (*ibid.*: 153, own translation). Put into other words, if the fishers chose to oppose cooperation during space operations, the space centre has no authority to force them out of their fishing fields.

There seems to be an implicit superiority inherent in the power to determine ocean and airspace for conquest and confiscation, considering dispensation given by national governments. The potential for conflict will increase with the establishment of the new European Satellite Launcher, which will cause more frequent operational activity at the local space centre. The satellite launcher will be bigger than the existing rocket pad. Rockets are going to be bigger, meaning more debris and junk, making the danger zones bigger. The establishment is approved by the national government and local municipality, and the new launch pad is under construction at this time of writing. The new launcher is to be placed in untouched landscape further south on the island. Nevertheless, conflicts and tensions occur, and especially in relation to the new launch-site. An international fishing reception will be affected, as the launcher will become its new neighbour. Some fishers believe that this will the end for this reception, especially if word gets around to international fleets that it is difficult to shore there. This, naturally, creates tension towards several parties. When word gets around to the international fleets, that it is difficult to shore, they will probably choose another reception with easier access, one local fisher expressed. Fishing receptions are dependent on the income from foreign boats, so the potential conflict is expected to increase with this new establishment. When the fishermen are requested to stay ashore during activities, the impact is high on their behalf. It's a direct impact on their livelihood. As one fisherman explained, they are dependent upon, mostly, the same weather conditions as the space centre during launch operations. And as far north as the island is located, the weather conditions change quickly, possibly to the extreme. It was explained that the fishermen work best with no more than a gentle breeze whilst

[58] ATC is one of several departments at the space centre. Other departments that operate in launching or testing activity, can also impact the overall pressure of the local community and fishermen.

carrying out their fishing activities. Similarly, the local space centre can't launch rockets if there is more than a small breeze (see chapter III).

5.3 Space Junk – Green rockets and green space

> When they say green and when we talk about the green solution it is not a so bad solution. I mean, of course, there are some propellants that are dangerous and contaminating, and others that are dangerous but not so contaminating. A little better. And then we go to the best situation, let's say we have the green situation, that does not mean that we don't have any impact, an impact zero. An impact zero is if you do not launch.
>
> *Scientist 2020*

Environmentalism is stretching more and more beyond the physical boundaries of our planet. Waste and littering have been discussed in anthropology for several decades, and Mary Douglas with her excellent book *Purity and Danger* (1984) is probably the most used theorist regarding perspectives on waste – the unclean. What is waste, and which objects are considered 'matter out of place' (*ibid.*), is a perception constituted by cultural, social, structural, and religious values (*ibid.*). Additionally to Douglas, I chose to follow Drackner (2005), Reno (2014) and Gorman (2019) when examining waste like space junk and oceanic littering. Cultural Archaeologist Alice Gorman, also known as *Dr. Space Junk* (2019), elaborates how junk and waste is a matter of perceiving usefulness (see also Drackner 2005) to people. Moreover, Dr. Space Junk explains that in the present era, the Anthropocene, "human activities such as industrial waste, plastics, radioactive spikes from nuclear weapons and power plants, and changes in the distribution signatures of carbon, nitrogen and oxygen" (*ibid.:* 78), have moved off the surface of Earth and out into space. Waste as in space junk is not just a useless or meaningless collection of metallic objects floating around in space (or in our oceans), it is also a means of focussing human awareness regarding contemporary and global littering issues.

As new places in outer space are continually filled with material culture (Morphy 2010), and the continuous instrumental unpacking of space brings space closer to Earth (metaphorically and conceptually). The human condition (Arendt 1998) is at the same time expanded out from terrestrial boundaries. Meaning, for every new discovery or presentation of objects in the universe, the relation humans previously had to those objects changes. Changing the relation between human beings and objects in space is in fact changing what it means to be human, and thereby the human condition (*ibid.*). Permitting a new understanding of the extra-terrestrial, that in turn evokes new perspectives on environment and environmentalism.

From the late 1950s, with the beginning of the space age, increasingly more places have been explored and mapped beyond planetary borders. This was the beginning of not only the Earthrise era (Lazier 2011), but also the awakening of a new "planetary consciousness" (Pratt 1992, cited in Boes 2014: 159). A green narrative and factual concern for orbital littering is taking more and more place in the contemporary space age debate; both locally on Andøya and globally. Eriksen (2016) emphasises that "human domination" (*ibid.:* 17) over Earth's natural resources in the Anthropocene is increasing at the pace of contemporary life. Human domination is stretching beyond the physical limits of our planet. We are moving out of Earth's atmosphere with orbital lanes, satellites, launching people onto the Moon, people living in Space on the ISS, and we have already sent our material cultures to Mars and other planets.

Through exploration and exploitation in and of outer space, humans become more separated from 'nature' than ever before. 'Nature', accordingly, has been reduced to a fragile object without intentions (*ibid.*), and consequently technological (planetary and non-planetary) prowess over 'nature' melt society and 'nature' together. During my fieldwork several conversations ended up concerning humans and their trash. This was not expressed as an isolated local problem, but a problem that in combination with all space related activities becomes major. When littering takes place, not just locally and occasionally, but happens globally and frequently, it becomes a cultural problem. However, going to space to see Earth has impacted individuals, local environments, and governmental and international organisations across the world, and thus it has impacted the work in trying to establish global policies for environmental issues on Earth, and space use (Olson and Messeri 2015) has appeared on the agenda.

On Andøya, people were conscious of junk and littering problems. Almost every weekend people gathered around the island to pick the waste and junk that had washed ashore on the island's many beaches. Adults, youngsters, teens, children – every generation – contributed to the garbage picking, making the waste issues a multi-generational issue. The local Facebook page for beach clean-ups was continually updated with new pictures of people sharing their waste-findings.

Soon, with the establishment of the satellite launcher, the sub-arctic is one step closer to facilitating orbital views from Andøya. Giving humans eyes from above "involves a self-reflexive interchange between scientific and cultural practices" (Parks 2000: 12), and thus legitimates more launching activities. The information that satellites measure and make available for operators, "can only be understood in the relation to human cultures and experiences" (*ibid.:* 12). However, it is the control-room operator or the scientist that produces meaning from the information that the satellite brings back down to Earth, and it is the engineer or technician that builds the instrument that is preparing the satellite to 'see'; extending human eyes through instrumental mediation (Ihde 1979).

Anthropologist Stefan Helmreich (2009), in his book *Alien Ocean*, elaborates on microbiological seas and the emergence of a blue-green capital, where the ocean is valued as a living organism with renewable resources, thus opening it to exploitation, presenting it as "blue-ocean strategies, in which the immensity sea stands die unlimited resource…" (*ibid.:* 129). Similarly with a blue-green capital in microbiological seas, contemporary satellites are more frequently used for communication and economic profit. Nevertheless, outer space is still not fully explored (and as it is continually increasing, it will never be). But, at the same time, outer space is positioned with the possibility of humans discovering new resources to benefit from and exploit. Thus, when thinking orbit and outer space economy, developing satellites that could take a re-entry, and evaporate when they are 'dead', is not perceived as a 'technological' issue. Nor is it merely an environmental issue – it is an economical issue, even though these perspectives are a part of a *green space* narrative.

Developing technology that can make dead satellites re-enter another orbital-line or be pushed into a 'junk-orbit' as some locals called it, is going to cost more. However, if the problem with space junk is ignored or left undealt with, it will be problematic to launch more satellites in orbit, as well as launching other things that must fly through it get out into space. Gorman (2019) addresses the *Kessler Syndrome,* where the worst-case scenario is, if humans continue to launch so much stuff out into orbit and the universe, that "a cascade of random collision creates so much debris that Earth is cut off from space… At is most extreme, any space vehicle trying to leave Earth would be smashed into smithereens" (*ibid.:* 129). This is a paradox right here: In order to make money, one must launch. But developing orbit-cleaning technology costs money, and not cleaning will eventually lead to the inability to launch – "… if you have a small piece, and the velocity is so high there, and if it impacts your satellite, it can destroy it" (Scientist 2020). These paradoxical issues with littering are creating environmental anxiety for the Earth's present and future. At the same time, "you can't change the range to the atmosphere" (Scientist 2020).

The question of waste and who owns the waste is not simple. Definitions often differ and "experts do not always agree…" (Drackner 2005: 177). Taking into consideration that a rockets drops evaporated engine-steps, splashing rocket metal down into the ocean, makes me follow Drackner in defining waste – space junk – "as *something* that is discarded by *someone,* implicating uselessness" (*ibid.:* 177). However, as mentioned above, the notion of *what* is waste and what is not, is a cultural and social question, and as the famous quote goes, 'one man's trash is another man's treasure'. Moreover, being able to view Earth and Earth's atmosphere from the outside, seeing a singular globe, makes the problem of space junk not the problem of another neighbourhood or another city (as Drackner illustrates in his article), but illustrates how it is a collective problem for the entire human population (cf. the example from the Afghan astronaut looking down at the Middle East in chapter IV). Chatting one day with the astrophysicist about these issues of space junk, he explained that these questions of space junk, without a doubt, are coming. Especially when local and global activities are increasing. He stated that people will begin to ask where is this junk going? "… is it going to the ocean? and we say 'yes'. And people don't like it. I understand that people don't like it. I don't like it either" (Astrophysicist 2020). Therefore, compromises must be made, because we cannot have a zero-impact space 'industry', that equals a zero-launching industry. One legitimating action that is taken globally is the act of launching Earth observation satellites, for taking knowledge back to the terrestrial ground. Legitimating by using these observations to understand, "how the forest is being burned and how vegetation is sick, and then you produce a small amount of junk. Okay, but you get a lot of positive outcomes, so the balance is positive" (Astrophysicist 2020).

In an environmental perspective, the friction between economic cost and profit is considered just as important as environmental profit. On the one hand a perspective of acting sustainably[59] with consciousness is prevailing, however on the other, the economic perspective is of paramount importance. Being conscious of environmental issues is one of the hallmarks in the Anthropocene, meaning that people are becoming more and more aware of how their way of living is damaging the planet. The Anthropocene is often portrayed as culture standing above 'nature', and it "… is rarely used jubilantly…" (Eriksen 2016: 18) because it indicates "… the growth ethos of capitalism…" (*ibid.:* 18). An environmentalist and 'planetary consciousness' regarding space activities is what, in this thesis, I emphasise as a *Green Space* narrative. Green space is about legitimating launching activities and increased (business) activity beyond the physical boundaries of Earth, in orbit and space. Going to space to see Earth to help us understand what is going on here seems to legitimate some amounts of junk.

[59] From the emic point of view, the term sustainable was used to refer to a way of not 'harming' the ecologic environment too much regarding space activities. However, this term is often used in everyday language as a buzzword, without explicit content or definition what it actually points to.

The act of going into space to see Earth, as we have seen in previous chapters, is continually re-appearing in different themes and topics when conversing about space and human activities in space. For example, talking about how satellite-data could be used to produce new knowledge about earthly changes, and monitoring what is happening with the forests and the oceans, questions considering space junk often appeared. This 'new' planetary consciousness has been invoked globally, and international policy makers are trying to regulate the use of orbit and space (Olson and Messeri 2015) in order to have some sort of control over what is going up there, and to try to track what is actually there. As one operator at the mountain observatory (laser mountain) explained, "… we know where live satellites are, and a great chunk of the space junk, but the biggest issue is what we don't know anything about" (Physicist 2020). However, the local space centre cannot promise that they will not contribute to create more space junk, because that would risk killing off all their activities. Moreover, the technology that already exists locally, for example the Lidar-instrumentation, could be translated into new uses, in the first instance to track and detect space junk with laser-rays. So, the first move, locally, is to contribute to localising undetected space junk, and "… from there, develop technology to, yes, to shoot it down, kind of" (Physicist 2020). However, it is not only satellites that creates this junk, but everything that is launched up into orbit and universe creates waste and junk, for example, exhaust fumes from rockets (Gorman 2019).

The local space centre, as mentioned above, is a commercial actor, and their business model depends on customer growth – to increase and develop activities and to gain economical profit. The commercial, the environmental, the scientific and the explorational is juxtaposed and ever present. They depend on each other's activities and thus benefit from the interest of general society. At the same time, as the psychists emphasised "we do not announce ourselves as a space junk facility either," that would be tantamount to cancelling all local activities. From the emic point of view, and considering that the local space centre is a business enterprise, the overall outcome must be balanced in a positive environmental direction, to continue with launching activities. Exploring abilities to reuse rockets is something they are working on, or at least some parts of the rocket, like for example the payload hotel[60]. In order to make space activities greener, the local space centre is waiting for the international space society to come together and take a coherently unified responsibility for space junk. One local jokily said that nobody wants to pick up somebody else's junk. Moreover, "… you cannot make a green rocket. But you can have a greener rocket" (Psychists 2020).

[60] The payload hotel is the metal container that carries the scientific instrumentation inside to rocket.

Talking to respondents about space junk and the possibilities of developing new – or translating existing – technology that enables future operations, while at the same time keeping in mind the increasing number of extra-terrestrial operations, there did not seem to be any shared understanding of our time witnessing a new space race. However, it seemed to be a commonly understanding that: If we're not there just yet, we are very close. Moreover, the contemporary space age and the coming 'space-race' brings about both positive and negative junctures for the future. The positive outcome, as mentioned, is that knowledge is taken back to Earth, resulting in increased environmental awareness. The negative outcome is that space junk is the most dangerous waste humans have ever made (Gorman 2019: 118), and posits a factual danger for all human beings. In many respects, with the establishment of the new space port, locals, employees, and local media were preoccupied with the notion of being first in achieving this establishment, not wanting to be surpassed by, for example Scotland. In comparison with Redfield's (2000) Kourou, Andøya could provide Europe's biggest launching facility for middle-atmospheric and orbital research, launching small satellites. Establishing this satellite launcher, was in fact communicated as a race; a race to be first, to win the contracts. Consequently, this is not about the knowledge and wonder questions (as discussed in chapter IV), it is about capital, growth and contracts.

Going back to the analogy about nobody taking the bus, but rather driving their separate cars – the space junk problem will naturally grow if people don't share the bus. One employee strongly emphasised this aspect, "and what are we supposed to do when all these private actors begin to launch things?" (Informant 2020). Without proper policies for the space use, it is feared that humans will just continue to bring their littering and political problems out into orbit; our social and environmental issues on Earth are reproduced and taken into the universe. It was shared by several locals that it is important to establish international rules for the use of space. For example, who is to decide what is allowed and what is disallowed in space? Especially considering outer space as a *terra nullius,* where "the exploration and use of outer space shall be carried out for the benefit and in the interest of all countries and shall be the province of all mankind [*sic.*]" (United Nations 2021[1967]).

A local man was questioning our species' intelligence when chatting about space junk, naming the present as a 'junk-age'. Firstly, we cannot take the junk back down to Earth – we are already struggling with where to store it here. Secondly, it cannot be in orbit either; but the economical stake is too high – nobody profits economically from cleaning junk, he emphasised. At the same time, with today's consumerism, a zero-waste situation is equally impossible. He continued, reasoning about human beings and our cognitive abilities, "if we are so intelligent as we declare to be, then we must simply develop and design better solutions that decrease both planetary junk and orbital junk" (Informant 2020). And if it is as Eriksen (2016) emphasises, that "… environmental organisations and NGOs live in a parallel universe" (*ibid.:* 41), it could, presumably, take time before space junk becomes part of the collective global agenda. However, with policy makers addressing the issue, and as the astrophysicist emphasised, it is an emerging question. Talking and worrying about space junk is, however, is not the same as doing something about it: junk is still up there, and the amount is ever increasing.

Another thing to seriously consider when thinking about space junk is the kinetic powers beyond planetary boundaries. If someone or something – people or unmanned vessels – are going to voyage through the atmosphere, crossing these orbital lanes, then there is a factual danger of hitting something. Thus, a vessel hitting something self-destructs into space junk. The velocity is potentially enormous in space, so the "kinetic potential becomes gigantic… and this lowers the chances of, yes, a mission accomplished" (Air-trafficker 2020). Human lives can be lost. Vessels and million-dollar projects can evaporate just in a glimpse of a second[61]. The concept of space junk is a question of risk, and "a risk can turn into a problem" (Drackner 2005: 177).

An overall implication seems to be, that Earth junk and space junk need to be dealt with simultaneously. Several locals expressed their worries about humans and their junk. One fisher especially stressed that if we are unable, as human beings, to take care of our own planet and our own planetary environment, we cannot, and it should in fact be illegal to keep sending our humanmade junk into space. Considering the "uncertainties surrounding current knowledge" (Douglas and Wildavsky 1982: 4) and subjective "conceptions of risk, there is no way to get everyone else to accept" (*ibid.:* 4) the same calculations of acceptable risks considering environmental issues. The same fisher was clearly frustrated over "those silly rules, that 'this is not my junk, I will not pick it up'. They won't handle China's junk and stuff like that" (Fisher 2020). This problem with defining who owns the waste, or how to consider this and that waste, depends on the perception shared between individuals or social groups (Drackner 2005). Junk in outer space or in orbit is not something that penetrates the daily life of humans, but popular media is increasingly highlighting it.

Locally they sometimes find rocketry debris that has shored on one of the many island

[61] This is comparable to Røyrvik and Almklov's (2012) article, which focuses on the Norwegian oil industry. The article discusses how the industry calculate and predict various kinds of risk in explorational activities on the Norwegian continental shelf, to reduce potential risks. They address how the industry calculate *consequences, probability* and the loss of *human lives*, and thereby calculate the acceptable risk for particular operations. Because an accident in the industry have the potential to become catastrophic.

beaches. Living on a sub-arctic island brimming with animal life, spectacular mountains, miles and miles of marshlands, an island covered numerous white sandy beaches, perhaps makes the individual environmentalist more pronounced than for example in a bigger city, where junk is a common sight. At the same time, living in such surroundings and having a rocket range as a neighbour may also provoke the novel environmentalist to awaken. A local fisherman wrapped his environmentalism up in a few clear sentences, "… in the epoch that we are living in now, and just have begun to be conscious about the enormous impact humans have on ecosystems. I mean, we just have to stop it" (Fisher 2020), and this is the dark footprint of the human-made Anthropocene.

5.4 Summary chapter V

In this chapter the intention has been to show how space activities are more than launching rockets, firing laser-rays, and dreaming about emotional connections with the particles and atoms in the universe. Space activities have real consequences for locals living on Andøya, and people living on Earth in general, these consequences also contribute to a change in how humans perceive the world and the universe. Breaking down the mystique of the universe into actual social and cultural responses such as environmental consciousness, conflicts, and the capitalist ethos (Eriksen 2016) are, as described throughout these pages, fundamental to understanding the complexness of *romfarten* as a social phenomenon.

The distinction made between explorational and exploitational actors show that the universe is not a placeless place floating around in the black cosmos, detached from earthly and social commitments. The seemingly singular universe is in fact a place attached (Valentine 2016) and immersed with cultural values (Gorman 2005, 2019). And as the house analogy showed us, it is the difference that makes a difference. It is the purpose that is significant for empirical examination; A school and a bank is similar in construction, but their purposes are different. The same technology is used to build these 'houses' (satellites, and rockets) but it is the purpose of being in space that a novelist anthropologist like myself finds of empirical value. Moreover, what these actors launch, is put together with similar instruments and tools, but it is their *use* that is important (Parks 2000; DeLoughrey 2014). The pull between these actors is a reciprocal pull, whereas the capital-orientated help create interest and raise investments, the scientific perspective makes discoveries about objects in the universe, thereby enabling knowledge production (see chapter III and IV), which in turn can contribute towards new –

exploitable – discoveries. New discoveries prompt new questions, and those discoveries are crucial for questions such as: is it safe to travel to Mars? How can humans live there? The continuous reciprocal pull between exploration and exploitation contributes to push physical and metaphorical boundaries 'above' and beyond Earth's horizon.

In the same way archaeologist Gorman (2019) finds dusty cable ties of scientific significance; a sign of how life was lived (*ibid.*), I too find waste and space junk as a sign of life. How people react, respond, talk about, act towards and how actors navigate in outer space is of empirical significance in anthropology. For example, for every scientific rocket that is launched, a new part of the northern lights could be detected, space weather is tracked and measured, and soon local Lidar-rays may track and map the position of unknown space junk. The 'Graveyard-orbit' (*ibid.*) is brought down to the ground, and thereby "we become uncomfortably aware of the fate of our waste" (Hawkins 2003: 40). The impact humans have on places outside of Earth's boundaries is increasing with every activity, and thus relations with objects in outer space change and enter into the micro and macro social realm (Johnson 2020) of the space 'industry'. Moreover, space activities and the ongoing space race are creating more environmental anxiety for the future, especially when considering something as common as waste and junk.

Redfield (2000) describes that the "connection between space and the environment is not entirely new" (*ibid.:* 174), and this is exactly what the European Space Agency (ESA) themselves (amongst others) do to legitimate their presence in outer space. ESA and Norway (and several other collaboration countries listed above) are obligated to use their technological prowess in space to observe Earth , and to the benefit of humanity. The *Copernicus* agreement and the Outer Space Treaty are attempts to fulfil this obligation. Using legitimating narratives, it is not easily detected if someone were to use space for their own national, commercial or capitalistic winnings. Who is to decide, allow, deny, or give dispensations for activities beyond Earth's boundaries? As the astrophysicist explained, questions about littering and waste are coming, which will bring with it questions concerning sovereignty and power of legislation. This, in fact, does imply a social contract that stretches between the whole human population, and all actors in outer space.

When ASC launch rockets from Andøya, and when Guiana Space Centre – *Centre Spatial Guyanais* – (CSG) launch satellites from Kourou, and when NASA launch space vessels from the Florida coast, they all demonstrate technological, economic, and imperialistic superiority in the contemporary space age. Combined, these actors display a "… technological triumph" (*ibid.:* 175), that, in turn, leads humans to conquest, and thus leaving nature "… to be rediscovered" (*ibid.:* 175). Considering space junk as a social and environmental problem that needs to be dealt with is challenging planetary limits and relational ontologies (Pirni 2016). Relational in the sense that the visualisation of the world as a blue marble (Lazier 2011), surrounded by garbage provokes a "near-distance" (Ihde 1979: 10) between humans and their littering activities in space, and thus on Earth. Space junk in orbit and humans on Earth, "stand in fixed relationships to each other and together form a single whole" (Durkheim and Mauss [1969]1963: 81), space is on that account, *humanmade.* Humans are launching their material culture (Morphy 2010) into orbit and the universe, and thereby space is brought into the cultural life of humans living on Earth. Humans change how planetary and non-planetary places are perceived and put in relation, through local and global space activities, provoking secondary effects locally and globally, thus creating new cultural challenges for the future.

When geology was taken to the Moon (Messeri 2014), it became filled with cultural and social meaning in new forms, and the same is happening with the extensive exploration of other celestial bodies in the universe, especially Mars. For every object or phenomenon that is mapped and made meaningful, the operator, scientist and astronomer take these objects into the social realm on Earth. The Anthropocene that is usually argued to concern earthly environments (Olson and Messeri 2015), is 'un-earthed' (*ibid.)*, and moved into a dark and calculated heaven (Redfield 2000). Launching, expanding, confiscating and conquering creates tension between the local space centre and fishermen. A feeling of powerlessness is shared among the fishers, stating that the local space centre chases them from their fishing fields, which results in an inability to support their livelihood. One of the operators feared that the activities would grow too large, consequently pushing the willingness of the fishers too far, resulting in repercussion too big to amend, in turn provoking them from collaboration.

Green space and green rockets share something positive, something that reduces the negative footprint of space activities. Green space is actually *per definition* not an option*,* as it would preclude any activity at all. However, green space, and green rockets, and other 'positivistic' measures are used to legitimate future and increased activities. Not thinking in a zero-impact perspective, rather thinking how to compromise and how to make the balance positive is sustaining the green narrative in local activities. Similarly, in Helmreich's (2009) *Alien Ocean* the microbial seas are not only a means of scientific exploration and discovery, but also a means of a *Blue-Green Capital* (*ibid.:* 127, emphasis added). A perspective that mobilises the ocean to become a "… spiraling symbiosis of production and reproduction" (*ibid.:* 128). The same is true for the exploration of outer space, when discovered, mapped and understood, the possibility for exploitation becomes prevalent. This is an important connotation, even though the space centre is fully owned by the Norwegian government, collaborating in special projects with ESA and other European countries on scientific development and knowledge production, they are still a commercial actor. Growth is innate in the business model, customer growth too, so discontinuing activities in order to accomplish zero-impact is not an acceptable solution, because that means cancelling all activities. However, as Gorman (2019) emphasised with the *Kessler Syndrome,* human activity in outer space could in the worst-case result in "no more spacecraft venture out from Earth… Bits of the solar system will drop out of our ken like phantom limbs we can no longer feel or flex (*ibid.:* 202).

The complexity of actors, the social contract, environmentalism, and planetary consciousness that this chapter describes, contributes to the body of what is called *Romfarten* (space industry). Only in combination with social values and local responses can we examine the *romfarten* from an anthropological perspective. Moreover, removing the focus on industry from the analytic perspective shows that it is comprised of human actions, and our belief in conquest, urges to explore, frustration, development of technology, racing for contracts and collaborating with locals, all this together make up this vast social corpus. The possibility of going to space would not have been possible in the first place, without the collaboration between the imaginative and developing, 'human-the-maker' (Ihde and Malafouris 2019) and the artisan (Ingold 2000); and these are the men and women living on Earth.

Through local and global activities, and the general public's response, space is filled with cultural meaning (Gorman 2005). The furious forces of terrestrial and extra-terrestrial 'nature' breaks down and collapses into culture (Eriksen 2016). The act of *un-earthing* (Olson and Messeri 2015) the Anthropocene is not only suggested, but completed through human engagement with outer space.

In the next, and last chapter, we shall revisit the main objective of this thesis and the main topics and summarise my empirical findings.

Chapter VI

6.1 Some final remarks

> [at]… a peninsula called Motu-tapu (Sacred Island), in Ra'iatea, was the canoe station of Ru and Hina… by which they [explored widely across the sea]… After exploring [all the Pacific] Hina's love of discovery did not cease. So [*sic.*] one evening when the full moon was shining invitingly, being large and half visible at the horizon, she set off in her canoe to make the moon a visit. On arriving there, she was so pleased with it, that she stepped into it, leaving to the mercy of the sea her canoe, which was never seen again.
>
> *Henry 1985 [1928]: 462-463, cited in Smith 2019: 1*

This thesis has investigated what anthropology can tell us about the social and cultural signification of the space 'industry'. What appears for many as a domain of merely technological development and scientific research, is in fact filled with cultural imagination, wonders and social values. The continual exploration of our atmosphere and outer space is indeed *changing* the way in which human beings relate to Earth and the universe. Moreover, moving the anthropological locus towards local space activities, like student rocket launches, has unveiled how the rigid procedures which ensure accountability in space operations in fact hold their own cultural logic (see chapters II and III). The fixation with controlling every step of a rocket operation, and allowing students to perform the different operational roles themselves, not only translates technical knowledge for another generation, but also facilitates the students *embodying* the feeling of actually *being* a 'space explorer' and 'space scientist'. And, as described in chapter III, the outcome is the education of a new generation of space explorers. At the same time, as we saw in the second operation, CaNoRock, when troubleshooting occurred, mutual trust between employees was important when the Pad Manager (PM) decided to take the rocket into the laboratory to investigate it. Nobody interfered or questioned the PM's expertise, thus rendering the decision unproblematic. At the local space centre on Andøya, interpersonal relationships are important in accomplishing a mission securely, despite that they are, in many cases, the opposite of the logic of standardisation and objectification procedures – as we saw with the ISS example, in chapter III. In other words, rigid systems of standardisation and objectification are techniques for ensuring that every action in a procedure is controlled, reliable and replicable. However, in various contexts, as described in this thesis, the artistic ability of the craftsman is very present in space activities. Moreover, we have seen how the modern distinction of art and technology (Ingold 2000) returns to its traditional understanding (cf. chapter II) in local space activities, because of the operator's ability to interact with the different parts of the system through his or her bodily movements, expertise, intellect, sensibility (Ingold 2000) and perceptions. The operator at ASC is not a mechanism on an assembly line. Rather, the operator I understand as the artful creative worker, homo faber and the artisan.

After describing two student rocket launches in-depth, chapter IV examined the imaginative human being, with its inherent urges to explore the unknown. Although the atmosphere and universe are continually explored and filled with material culture (Morphy 2010), the curiosity of scientists, asking rudimentary questions of the universe, is the bedrock of exploration. Several informants confided their fascination of leaving the planet in a space vehicle, and simultaneously they argued that humans are innate explorers. Stories of humans *being* the universe enables the conceptual possibility of positioning ourselves as earthlings in a cosmological companionship (Messeri 2016), with every atom, every particle, out there in the universe. From an anthropological perspective, it is interesting to investigate this concept, because, as we have seen, the notion of being (emotionally) attached to outer space, is not new. People, for as long as we have inhabited this precious planet, have related to celestial bodies, in particular the moon and the stars. Furthermore, the mystique of the universe has not been withdrawn by scientific exploration and knowledge-making activities. Phenomena such as the northern lights continue to fill local people with excitement and wonder. This chapter showed that efforts to share a fascination of the universe are important, building a bridge between natural science and culture. Efforts like giving children a pair of binoculars thus encouraging them to 'discover' the stars, and enabling visitors to become familiar with, and fascinated by, space activities at the local *Spaceship Aurora,* underlines this.

In the final empirical chapter, V, some of the consequences of space activities are discussed. In an anthropological investigation, it is important to acknowledge and examine how local people respond, react and perceive those activities. Launching activities 'interfere' with people's lives. For some it is entertainment (as we saw in the chapter IV, with the visitor centre), for others it is something to be proud of in the local community (being the only operational space centre in Norway, thus creating hundreds of workplaces); whereas others, like the fishermen, are negatively impacted by it. They are shored during launching activities, impacting their ability to support themselves. However, both the local space centre and fishermen claim their area, and this creates tension and frustration. This chapter also suggests that the orbital littering of space activities imply an environmental awareness. The issues of littering are becoming so substantial that numerous informants shared their anxiety that these activities will continue without any solution. This is not perceived solely from an isolated and local perspective, but from a global perspective. This points to a conception (cf. chapter IV) of the world as something shared between all the people living on it, rather than a place divided by nation-states, religions, social groups, or continents. Put differently, the act of seeing Earth from the outside, changes both terrestrial and extra-terrestrial relations and perspectives on what it means to be human in contemporary times. We have seen that when the notion of waste and littering creeps out from the shadows of the universe. Meaning that simulated pictures of junk-orbits and presenting Earth as a globe that is surrounded by waste moves the waste (metaphorically) out from orbit and into our view. Additionally, as Douglas and Wildavsky (1982) argue, the perception of risk is culturally conditioned, and therefore people will never agree on the level of acceptability when it comes to something as dangerous as space junk and oceanic littering. With continued orbital littering, and more humanmade junk out in the universe, the notion of the Anthropocene is moved beyond Earth's physical boundaries. In order to analytically encounter these issues of waste, we *need to follow the junk* – and that is, we must go into orbit and the universe.

As have been described in chapter V space activities are culturally conditioned, because both launching activities and exploration is made possible by human engagement with the universe. Engagement through what Ihde (1979) call 'knowledge gathering instruments' (*ibid.:* 16), like sounding rockets, Lidar-rays, radar-parks and satellites. Wherever human activities unfold, cultural concepts will always follow. And as Eriksen (2021) discusses; when concentrating on issues like for example the Anthropocene (that impacts all human beings), local and global perspectives must be combined. The same is true for space related activities, because these are activities that concern us all. Already in the beginning of the last century "… the Russian teacher and mathematician Konstantin Tsiolkovski (1857-1935)…" (Smith 2019: 2) wrote about the future of human beings voyaging and engaging with outer space. Tsiolkovski was in many ways a futuristic pioneer in thinking about human engagement with outer space, because he was more occupied with "… the notion of *humanity* in space and not technology" (*ibid.:* 3, emphasis added). This is compared to contemporary times, where "we commonly associate 'space exploration' with machinery, rockets, and computers…" (*ibid.:* 2). However, we must consider the tools (machine, rockets, systems of procedure, Lidar and radar-rays) as mediated instruments that is included in a human-machine-relation

Finally, space activities are cultural because it is the scientist, operator, and other personnel that engage and develop, procedures, formal languages for operation and proper ways to act as 'space operators' and 'space explorers'. And through interpretative processes new meaning and knowledge is produced by the tool-user about celestial phenomena.

I conclude as my main argument proposed, *Space activities (such as students rocket, Lidar and radar measurements) contribute to changing how humans relate to Earth, and to the universe. Every activity recreates the world, piece by piece*, from the Norwegian sub-arctic.

6.2 My contribution to the *Anthropology of outer space.*

Space activities are not only changing how people relate to Earth and the universe, but also what it means to be human in an extra-terrestrial context. Eriksen and Nielsen (2002) argue that anthropologists and other scholars are intellectually shaped by their present in their book *To the world's end and back* (own translation). I argue that in the contemporary space age we must go *beyond the world and back*, because we are filling outer space with our material cultures, social values, and hopes for the future, which, in turn, challenges what it means to be human in a terrestrial and extra-terrestrial context.

The *anthropology of outer space* is gaining more and more academic attention, resulting in thick ethnographies from all over the world. However different they may be, they all have one thing in common in conforming to the 'traditional' objective of anthropology, namely, 'what does it mean to be human?' By approaching the space industry as a social phenomenon, *Romfarten,* I detect and identify several cultural particularities which suggest the sensible and creative craftsman, which I discuss in the contexts of homo faber and the artisan. This is accomplished by focussing on embodied relations in rocket operations, but, at the same time, detailing the fascination for human engagement with outer space, and the universe, as it is revealed in the stories told by locals. From this, I argue that human dreams, and our urges to explore, are paramount for explorational activities.

Lastly, I identify an environmental awareness locally and globally, focussing on the actual consequences of space activities. My contribution to the field is thus both methodologically and theoretically novel. My aim has been to provide a new perspective for *what is means to be human in the contemporary space age,* on a local, terrestrial and extra-terrestrial scale. Though all of the different perspectives that I present throughout this thesis are already present in the discipline, I have not encountered ethnographies that combine them as I do[62]. Additionally, most of the contributors that I mention in chapter I, have a Heideggerian perspective on technology, or at least found their understanding on such a perspective. By

[62] The closest is perhaps Redfield's (2000) *Space in the Tropics.*

contrast, a perspective founded on the artful and creative craftsman is absent (to my understanding). I believe that the discipline may broaden its understanding by including this and similar perspectives. I hope that my contribution to the field will inspire both established anthropologists and graduate students to consider including similar perspective when anthropologically approaching a phenomenon so complex and filled with cultural values as *Romfarten*.

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