

A stylized, dark grey and black graphic of a Space Marine helmet, resembling a M1 helmet, with various details like a camera lens at the top and ventilation ports. The helmet is centered on the page.

**‘Space Marines’
To Secure the Moon for All**

**A CONCEPT DEVELOPMENT &
EXPERIMENTATION CASE STUDY**

Preface



“Maybe we need a new force. We’ll call it the Space Force.’ And I was not really serious. And then I said, ‘What a great idea. Maybe we’ll have to do that.”

US President Trump, March 2018, announcing the formation of a 6th military branch: Space Force!

During the Cold War, the U.S. government was hell-bent on one upping the commies in any way possible. In the process, they came up with several outlandish plans, such as that time they proposed nuking the moon, interestingly enough a project a young Carl Sagan worked on.

This brings us to a project that unfortunately went into history’s dustbin: the U.S. Army’s plan to build a massive military installation on the moon. Known as Project Horizon, the impetus for the plan came when the Soviets set their sites on the moon. As noted in the Project Horizon report, “The Soviet Union in propaganda broadcasts has announced the 50th anniversary of the present government (1967) will be celebrated by Soviet citizens on the moon.”

On December 11, 1972, Commander Eugene Cernan and Lunar Module Pilot Harrison Schmitt landed the Apollo 17 on the surface of the moon and became the last two people to set foot on the moon. On that event, Cernan boarded the spacecraft after Schmitt and is officially recognized as the 12th and last man on the moon. Since then, no (hu)man has set foot on the moon again.

It is time that “We choose to go to the Moon” again.

Introduction

In the Concept Development & Experimentation (CD&E) Practitioner course, you will learn the NATO way for developing concepts and plan experimentations in a hands-on manner. The NATO method and tools might be similar to or very different from your national approach. In this course, we want you to focus on applying the method explained in the handbook¹ and therefore we work with a case study on a military topic. Real-life topics are too broad to be useful or may lead to unintentional turf wars between experts. That is why we came up with the imaginary scenario 'Space Marines' as a second case study².

This case study is about developing concepts for capabilities for an imaginary NATO force under SpaceCom to defend a moon base in the future. As nothing is known besides the information told in the story and some basic knowledge about the moon, your assumptions on the way things could be are as good as ours or as of your colleagues. In need of a decision, you can decide yourselves or ask one of the instructors. To proceed with learning by doing, it may be necessary to hit the so-called 'I believe button' and continue.

Enjoy the story and the course.

Air Force Major Patrick VAN HOESERLANDE
Concept Developer
Office: +1 757-747-3621
Email: Patrick.vanhoeserlande@act.nato.int

¹ You can download a copy of the CD&E handbook via www.act.nato.int/publications.

² The first case study is 'Operation Concrete Forest.'

The Moon Rush



In July 2018, at the Brussels Summit, Allied leaders recognised that space is a highly dynamic and rapidly evolving area, which is essential to a coherent Alliance deterrence and defence posture, and agreed to develop an overarching NATO Space Policy. Less than a year later, the NATO defence ministers agreed such a policy. And in December 2019, Allied leaders welcomed the recognition of space as a new operational domain – alongside air, land, sea, and cyber. “This can allow NATO planners to make requests for Allies to provide capabilities and services, such as hours of satellite communications,” concluded the Secretary-General. He added that NATO has no intention to put weapons into space, and the Alliance’s approach to space will remain fully in line with international law.

That was about 5 years in the past and things have changed since then. Not long ago, a robotic mission discovered traces of transuranium elements, which are, in general, extremely expensive. These elements typically are man-made because on earth, it is costly to isolate the

trace amounts of transuranic elements that exist naturally. For example, californium is estimated to cost around \$2.7 billion per 100 grams.

Seeing the potential economical benefits, a joint American-European moon mission was launched to investigate further the location of the discovery. This mission not only confirmed the find but also located the ore deposit on the dark side of the moon. After analysis of the data, a group of experts decided that mining the deposit was doable and profitable, although it would take at least three months drilling through hard rock to get the ore ready for extraction. The mining activities necessitate an almost permanent presence for several years.

Although there was a huge effort to keep the expert conclusion out of public fora, once in the open, the news of the discovery travelled the globe at lightspeed. New space alliances were born and the hunt for space talent was open. The USA, Russia, Europe, China, India... all had successful missions to the Moon in the past and were eager to be the first with a settlement on our natural satellite.

A second scrutiny of the data with one of the most powerful Artificial Intelligence software revealed additional rare elements with endless possibilities. The AI concluded that there was an 81.50 % chance of finding anti-elements within pockets of transuranium. Anti-elements, which technically are pure elements with no need for purification, are way more expensive than regular elements. In 1999, NASA gave estimated a figure of \$62.5 trillion per gram of antihydrogen.

Antimatter can be used as a power source, a propellant, or an explosive for a weapon... by annihilation through

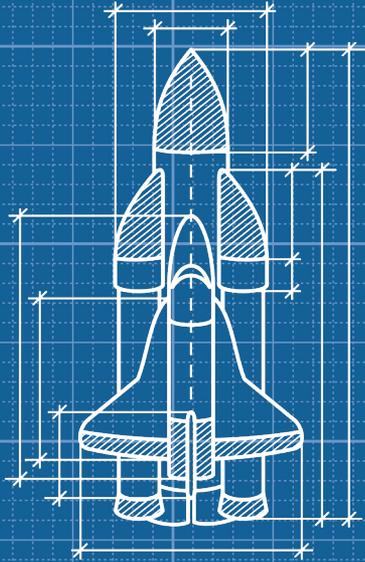
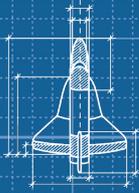
the conversion of exactly equal masses of antimatter and matter. Such a collision releases the entire combined mass-energy, which for 1 gram is about 9×10^{13} joules or 20 Kt TNT, the equivalent of the Hiroshima atomic bomb. This conclusion ignited an overwhelming international moon rush.

No wonder, this skyrocketed the economic potential of an expensive, semi-permanent moon expedition. Thus came several tycoons into play giving the different initial multinational alliances enormous financial boosts. The first organization digging up these elements would become a political and economical, global power. Any organization with enough financial resources could be the one. The race was not about getting a man or a woman planting a flag on the moon but building the first installation near the site and sticking around permanently.

The first alliance with a permanent base on the moon could claim the entire moon or at least the exclusive economic rights for the exploitable area. If they did that successfully, any move by others to reach the moon or the claimed area could be considered an aggressive act, effectively making the moon off limits to the others unless they are willing to risk war back home. This was deemed to be a potential disaster for the world economy by the democratic nations. Of course, certain alliances might do none of these things and allow others to mine the moon too. But this was not a guarantee. The director-general of the new Euro-American Space Agency stated that,

“We do not believe that this generation of democratic citizens is willing to resign itself to going to bed each night by the light of a privatized or dictatorial moon. The riches on our closets neighbour are there for all humankind.”

ET LUNA NON NISI DIMIDIUM VIA



At the end of his speech, the director asked NATO, the most successful alliance in history, for protection of Moon Base Chi³.

In September, the Heads of State discussed during the Space Top in Houston, USA, this request and concluded that assuring the free moon exploitation would contribute to global peace and security. Along the lines of the statement made during Project Horizon, the SecGen declared that,

“Clearly NATO would not be in a position to exercise an option between peaceful and military applications unless we are there first. In short, the establishment of the initial lunar outpost is the first definitive step in exercising our options to assure a Moon for all.”

The media accused NATO to swing open the door for the weaponization of the Moon, albeit for purely defensive purposes, neglecting that other nations were already developing those options.

During the following annual CD&E conference⁴, SACT proposed to reinforce NATO’s Space Command with CD&E project teams to develop concepts to defend the international moon base. The NAC and the MC approved the proposal and tasked HQ SACT to assemble such teams to solve the issue at hand.

Being asked to join these teams, you have travelled to HQ SpaceCom and after a good night’s sleep, you are ready to start. Today, you will be briefed by the Com HQ SpaceCom on your task.

³ Moon Base Alpha was the name of the colony in the tv show ‘Space: 1999’ and could not be used. Moon Base Omega sounded a bit fatalistic and was not withhold either.

⁴ For more Info on the CD&E conference, please visit www.act.nato.int/cde-conf.

Welcome to NATO HQ SpaceCom

Not recovered completely from the long travel, some of your team members are still struggling with jetlag. A good cup of coffee would have helped, but you and the rest of the team, after some security measures, are guided into a small meeting room. The room is not unlike other briefing rooms in NATO although the walls tell you that you are in space command. On the wall in the back, you detect the headquarters' crest. Against a dark blue background, it prominently features a bright moon with three stars above. A white trail headed by a pointy shape passes in orbit the moon. The upper left corner features the traditional NATO Compass Rose. Above the crest you read "Et Luna non nisi dimidium via". The Moon is only halfway.



“Attention!”

General Joanna Koenig, the commander, enters the room.

“Please be seated. Welcome to our HQ. We are pleased that you are here, and we expect a lot of you. The coming months, or even years, we have the task to prepare NATO for one of its most important missions.”

Quite a start of the project. She continues by giving an overview of the latest developments in the race to the moon.

“Our political leaders have requested us to prepare NATO to defend the international Moon Base Chi.”

The general walks to a rolled-up map and prepares to open it.

“This is what we have now.”

With some dramatic effect, she let the map unroll. It is blank. Silence.

“Indeed, we have a blank sheet. Nobody in the world has experience with what we, ladies and gentlemen, need to accomplish. But we will do it. We have to. However, we are not the only ones attempting this. Others, with less noble motives, are trying the same.”

With the scene set, she gives the floor to the COS who explains the project.

“Ladies and gentlemen, I am General Zach Quinto and the COS of this HQ. Our task is to develop a concept to defend the moon base. We know that the mission will lift off in eight years. We must be ready to deploy our defences no later than the first flight. That

means if we take two years to develop the NATO concept and support it by the necessary experimentations, we have six years for implementation. That is all we have, and it should suffice.

To increase our breadth of possible approaches, we will work parallel with several teams on the same challenge. We have the resources to do that and it is the surest way to success.

Colonel Rick Berman, the J5 and programme lead, will give you Info about the moon base. Colonel, they are yours.”

The commander and her COS stay in the room. A sign that this programme has indeed high priority.



“Moon Base Chi”



“Good morning. Welcome to our HQ. As told, I am Colonel Rick Berman and the lead of this programme. In that function, I have a direct link with the Euro-American Space Agency. This is what we know so far.”

PowerPoint slides show up on the screen.

“The agency will build the moon base. Various scientific laboratories will be included, as well as a recreation room, hospital unit, housing quarters, and a section made for sustainably growing food. This food will augment frozen and dehydrated foods supplied from Earth. The base will be able to self-sustain for two weeks of normal operations and double that time in an emergency. Everything will be there, but it will not be the Hilton.”

Some laughter in the room.

“Beyond the core base itself, a moon truck capable of transporting astronauts, including moon miners, and equipment around is proposed. Water, oxygen, and hydrogen will ultimately be provided from the ice on the moon itself, not only sustaining the

astronauts but potentially providing any needed fuel for rockets, again to help facilitate transport back home to Earth. A big part of the base will be the drilling equipment and an ore treatment and packaging facility. It is deemed necessary for a team of 20 people to be permanently stationed at the base.

Although NATO soldiers are not included in that number, we estimate that we will need a section size group to defend the base. During an internal brainstorming session, we came up with the following names for these soldiers.”

The slide show names like Milky Guards, Galaxy Guardians, Moon Rangers, Star Troopers...

“Our commander opted for Space Marines and that is the name we will propose to the NAC.”

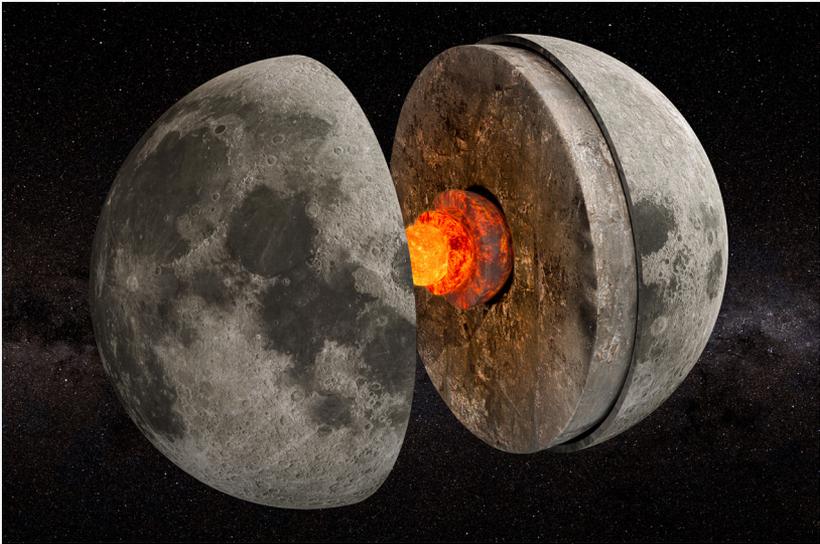
The next slide shows 30 container-like boxes, numbered chalk 01 to 30. 25 of those boxes are painted white, the others dark blue.

“The 30 boxes are a first estimate of what can be launched to the moon in the span of a few weeks. The whole base must fit in the white chalks. We have negotiated 5 boxes for base defence. These boxes are exclusive for our military capabilities, all the real life support for our Space Marines will be provided by the moon base.

Questions?”

After entering into some detailed questions, an intelligent-looking civilian joins the stage. She introduces herself as an expert in space travel and expeditions. Her first slides summarize some basic facts about the Moon.

- The Moon is a dusty ball of rock, measuring 3,476 km in diameter, roughly a quarter of the size of Earth.



- Its surface is home to mountains, huge craters and flat planes called 'seas' made of hardened lava.
- It takes 27.3 days for the Moon to travel around the Earth and complete its orbit.
- As the Moon travels, it rotates on its axis, just like our planet. It takes roughly the same amount of time for the Moon to make a full rotation as it does for it to complete its orbit. This means we only ever see around 60% of the Moon's surface from Earth! The part that faces Earth is known as the 'near side' and the other, the 'far side' or 'dark side'.
- The temperature on the Moon varies from super hot to super cold! When the Sun hits its surface, temperatures can reach a scorching 127°C. But when the Sun 'goes down', temperatures can plummet to around -153°C.

- The Moon's gravity is weaker and only one-sixth of the Earth's gravity.
- Water is available in the form of ice trapped within dust and minerals on and under the surface and in on areas of the lunar surface that are in permanent shadow.
- The Moon orbits Earth at an average lunar distance of 384,400 km or 1.28 light-seconds. It takes about 3 days for a spacecraft to reach the Moon.

She continues to explain the challenges of prolonged space travel and a permanent stay on the Moon. Luckily, there is ample experience with polar missions, not dissimilar with the current moon base project. A moon expedition might be a challenge, but the chances for success are good.

“As with everybody in this HQ, I am available for questions about the space part of this programme. You know where I work.”

The J5 stands up.

“No questions? Please, let us have a coffee before we brief you on your task.”



Your Task

There is a lot of chatting during the break. Some have difficulties to get a grasp on all the information. Or is it the jet lag? You feel quite confident. You are not here as a space subject matter expert, but as a concept developer/experimenter. The topic may be challenging, but you know your job.

After the coffee break, some attendees have extra questions about the status of the moon base and the limitations of space travel. The COS closes the Q&A round and concludes with a short repetition of the task.

“Your task as a team is to develop a capability concept supported by the necessary experimentations to defend the mining operations at Moon Base Chi within the time given. Is that clear?”

No more questions? OK. General, a last word?”

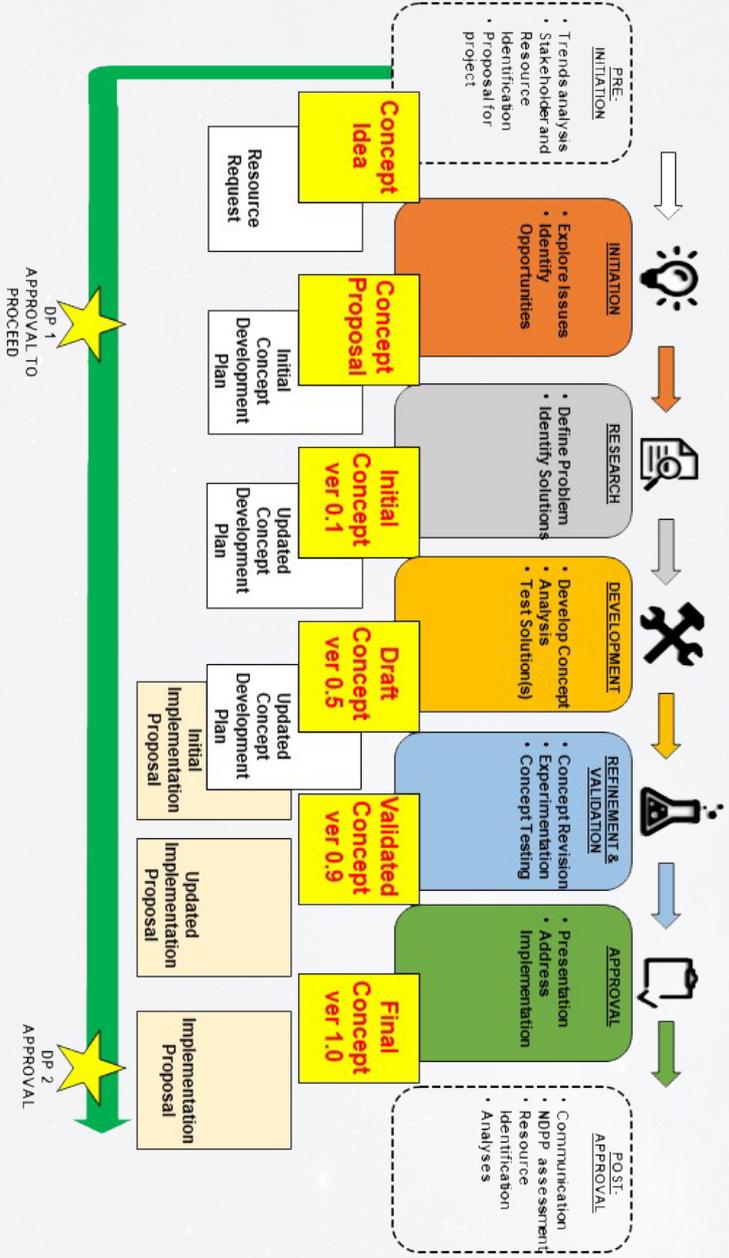
The commander takes the floor and before sending the teams to work, she says:

“Ladies and gentlemen, although I have proposed the name ‘Space Marines’, I do not believe that soldiers on our Moon are the best approach. The solution is to put intelligent and remotely controlled robots on the surface from the very start of the operation. Humans are made for exploring space, not for living in it.

If there are no further questions, I wish you, no, us good luck and I hope to see some results soon. Work hard, but don’t forget to take time to enjoy our HQ and its surroundings. Good luck everybody.”

NOTES

IMPLEMENTATION



YOU HAVE A **PROBLEM** AND NO **SOLUTION**?

We can help you to solve your problem and turn your solution into a capability. **How?**

You can find extra information on our **CD&E website** on <https://cde365.transnet.act.nato.int/>

The ACT Transformation Network Portal (**TRANSNET**) is an open, unclassified network environment requiring additional permissions <https://portaltransnet.act.nato.int/>

You can use our **handbook** as your guide. The handbook is available on <https://www.act.nato.int/publications>

You can get an introduction on CD&E through our **online course (ADL 201 Introduction CD&E)**.

You can attend the in-house NATO **Concept Development and Experimentation Course (ETE-ET-21371)** at NATO School Oberammergau, or request a session by our mobile training team.

You can exchange views and ideas with other attendees during our annual **CD&E Conference**.

You can ask us for advice, an introduction or support via ConceptDevelopment@act.nato.int

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