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The Moon Village and Space 4.0: The 'Open Concept' as a New Way of Doing Space?

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ABSTRACT

This article discusses the Moon Village concept within the context of the increasing momentum to return human beings to the surface of the Moon. The article follows a dual objective. Firstly, the Moon Village is probably the most misunderstood among the plethora of ideas to explore the Moon scientifically and commercially. The article is therefore intended to explore what the Moon Village actually is. Secondly, the article explores the strengths and weaknesses of the Moon Village. The article is divided into three sections. The first section reviews the current Moon projects of public and private space actors, including the United States, Russia, China, SpaceX and Blue Origin. It sets the scene for the argument that the Moon Village has entered global discourse on space within a positive political environment. The second section discusses the premises of ESA chief Jan Wörner's Moon Village concept, putting forward that the Moon Village is intended as an open concept rather than as a concrete plan. It is a process rather than a project and it is meant to initiate a global conversation on humanity's future on the Moon. As such, the world café is an appropriate metaphor to illustrate the idea behind the Moon Village. In the third and final section a SWAT/PEST analysis is conducted to assess the feasibility of the Moon Village, highlighting that one of the major opportunities of the project is to promote international cooperation. The article concludes by supporting the institutionalist hypothesis that the Moon Village is arguably a translation of the ESA system to the global level, as participation is voluntary and as it builds on the strengths of each cooperation partner. As such, the Moon Village is indeed a new way of doing space on the global level.

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During the first decades of the 21st century, humanity's approach to space has undergone significant changes. The European Space Agency (ESA) has referred to these changes as Space 4.0 [12]. The first space era dealt with astronomical observation,

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whereas during the second space age, nation-states sent objects and people into outer space. The third space age was marked by cooperation between national space agencies and culminated in the construction of the International Space Station (ISS). Space 4.0 is characterised by opening space to private and academic organisations and individuals. In terms of space exploration, recent discourse has been dominated by a debate on whether the focus on future human space travel should lie on the Moon or on Mars. Since 2005, there has been a tendency in favour of the Moon, although plans for future human Moon and Mars exploration have been pursued simultaneously. Nevertheless, Bush's Constellation programme and Obama's subsequent Space Launch System (SLS)/Orion programme have put NASA on course for returning astronauts to lunar orbit in the 2020s. Most recently, the Trump administration has expressed its intention to land American astronauts on the Moon by 2024. China's Chang'e programme aims at a sample return mission before the end of the decade, and Russia has signed a cooperation agreement with the US to build a space station in cislunar orbit. At the same time, private enterprises such as SpaceX and Blue Origin are attempting to make lunar exploration economically self-sustainable, with Elon Musk aiming to launch tourists to lunar orbit in the near future. As Stoica confirms, "all prominent space agencies are focusing their near term efforts on the Moon" [38].

ESA too has contributed to the debate between the Moon and Mars having made a decisive turn towards the Moon. ESA chief Jan Wörner's idea of the 'Moon Village' makes the Moon the next goal of international collaboration in space exploration. However, being firmly rooted in the Space 4.0 paradigm, the Moon Village is conceptually very different from the SLS or Chang'e 5. During an interview which forms much of the empirical basis of this article, Wörner described the Moon Village as an open concept, which is merely meant to facilitate cooperation. Participation in the Moon Village is not limited to nations and space agencies, but to private companies that may not even necessarily hold an expertise in space matters.

So far, academics have paid very little attention to the Moon Village concept. Wörner's idea has been tremendously misunderstood, and even space policy experts continue to refer to the Moon Village as an attempt to colonise the Moon. This article, therefore, has three targets. First, it places the Moon Village concept within the increasing international momentum for returning to the Moon. This will be accomplished using a discussion of the advantages of going to the Moon rather than Mars; whereupon, the most important contemporary projects for returning to the Moon will be briefly summarised. Second, being based on an interview with Jan Wörner, the article intends to provide an overview of what the Moon Village actually is and how it came about. Rational choice and institutionalist arguments will be presented to explain the Wörner's motivations behind the Moon Village. The world café metaphor is then used to illustrate that the Moon Village is a process rather than a project. In the future, it will serve as an umbrella for different projects rather than as a managing organisation. Third, it evaluates the feasibility of the Moon Village using a strengths, weaknesses, opportunities, and threats (SWOT)/political, economic, socio-cultural and technological (PEST) analysis. This provides insight into the strength and weaknesses of Wörner's proposal.

1. The new race to the Moon

The Moon has become popular again. All major space agencies as well as several commercial actors with credible space ambitions have set their sights firmly on the Moon. After briefly summarising the most important arguments used in the Moon/Mars debate, this

section will outline some contemporary lunar projects, highlighting that interest in the Moon is indeed experiencing a renaissance.

1.1. Moon or Mars?

In her 2017 book, *The Politics and Perils of Space Exploration*, Linda Dawson highlights how the debate between the Moon and Mars has shaped recent discourse on the future of human space exploration. Indeed, whichever target is chosen as a destination for human exploration, the agency carrying out this project will necessarily become path dependent [5]. The infrastructures required for landing and sustaining human beings on the Moon and on Mars are quite different. Although both NASA's SLS and SpaceX's Falcon Heavy would theoretically be capable of landing humans on the Moon [2], neither rocket could be used for human missions to Mars. Permitting the latter would require building an altogether new rocket, which including the design phase may easily take up to 15 years (e.g. Space Shuttle, see Ref. [3]; 13). As the result, space agencies' discourse has been shaped by the idea that the Moon may serve as a "launching platform to deep space", as the lower lunar gravity makes it easier to transport heavy, crewed payloads deep into the solar system [10]; 72). Nevertheless, this approach is arguably naïve, as it ignores the technical difficulties required in getting to the Moon in the first place, apart from the current technical infeasibility of building a lunar spaceport. As a result, it is meaningful to briefly summarise the main arguments used by both sides of the Moon vs Mars argument, as this helps illustrate why the Moon has recently been favoured as the prime target destination.

Jan Wörner, Director General of the ESA, puts forward several arguments for focussing on the Moon rather than Mars. First, he claims that the Moon is "not as well researched as Mars" (personal communication, 20 November 2017). Arguably, the historical political interest in the Moon was mostly based on geostrategic rather than scientific considerations. Second, the Moon could be used for scientific research, for example, by building a radio telescope on the lunar far side. Such a device would be able to conduct radio astronomy without interference by human-made objects, which may provide unprecedented insight into origins of the universe and the search for extraterrestrial intelligence [6,13]. Galan et al [15] are proposing the construction of an optical telescope on the far side of the Moon for detecting exoplanets in our interstellar neighbourhood. Third, Wörner views the Moon as a testing ground for technologies needed for deep space exploration. Specifically, he refers to *in situ* resource utilisation (ISRU), where local resources are used to produce basic materials needed to sustain a Moon base (cf [29]). Another argument for the Moon as opposed to Mars is that a Moon programme may "spur investment from the private sector" [29], which is less likely in the case of a Mars mission, given the higher cost.

In his book *The Case for Mars*, Robert Zubrin, founder of the Mars Society and creator of the Mars Direct plan, provides several arguments against going back to the Moon. First, he puts forward that "we have, after all, been to the Moon six times," implying that yet another Moon landing would not warrant the investment [39]. Second, the examination of lunar geology is "trivial [...]" in comparison with the questions of the origins and fundamental nature of life that would be addressed by the human exploration of Mars" [29]. The third major reason he puts forward against returning to the Moon addresses the question of American pride: "one wonders what it says about America if the highest aspiration of our space program is to repeat a mission it accomplished a half-century before" [29]. Apart from that, as was mentioned previously, the idea of the Moon as a testing ground for the technologies needed to get to Mars may be based on false assumptions. As Davis argues, the technologies required for resource extraction from lunar and

Martian rocks are very different [8]. Moreover, the landing equipment required to get to Mars differs considerably from lunar space vehicles, as the former would have to work in the Martian atmosphere.

Zubrin's arguments for a human mission to Mars rest primarily on the planet's potential for colonisation. He puts forward that "in contrast to the comparative desert of the Earth's moon, Mars possesses veritable oceans of water frozen in its permafrost" (2011, xxv). He highlights further that Mars is abundant in all the resources needed for setting up a permanent settlement such as carbon, nitrogen, hydrogen and oxygen. Moreover, Mars possesses a "24-h day-night cycle and an atmosphere thick enough to shield its surface against solar flares" [8], xxvi. Apart from the points Zubrin mentions, Mars is arguably more interesting as a scientific target, because it is more likely to harbour life than the Moon (see Ref. [20]).

Jan Wörner argues the case against sending astronauts to Mars primarily on ethical grounds. Wörner argues that it is "ethically problematic to send someone away for two years without any opportunity to receive medical treatment" (personal communication, 20 November 2017). Nevertheless, there may be other, even more practical reasons against sending humans to Mars. Citing a NASA scientist, Davis emphasises that there are a number of technologies that still need to be developed before humanity travels to Mars and that their development "may require several miracles" [8]. Apart from that, the greater distance between Earth and Mars implies that there would be a communication delay lasting between six and 40 min. Apart from the fact that Mars astronauts would inevitably have to take many decisions without consulting Earth-based experts, this communications delay greatly increases the risk involved in Mars mission, as emergency interference from Earth would often be impossible. A final argument against sending humans to Mars relates to economics: it is simply cheaper to send people to the Moon rather than to Mars. Given the budgetary constraints the space agencies of Europe and the United States find themselves in, it may be politically impossible to acquire the funds necessary for a Mars mission, whereas a trip to the Moon is more feasible (See Table 1).

While there are good arguments for both the Moon and Mars, what ultimately matters most is how well these arguments resonate with policymakers. Recent years have been marked by a discourse that involved the idea that the Moon will function as a stepping stone to Mars (e.g. Ref. [26]). Nevertheless, as was pointed out earlier, it is at best questionable whether the technologies tested on the Moon can simply be copied on Mars. Moreover, according to a Planetary Society Report, to "fund any executable human exploration program, NASA must end its large financial commitment to operating the International Space Station" ([17]; 10). Should the ISS eventually be replaced by another international programme, a trip to Mars is almost certainly off the table under the current financing framework. A choice between the Moon and Mars

ought to be made, and given the higher cost and the higher risk of a Mars expedition, the Moon may "ultimately represent a more compelling political destination" [8].

1.2. Traditional space actors' lunar plans

Since the inauguration of Donald Trump, the US has firmly shifted its focus in human space exploration to the Moon. In December 2017, Trump signed a new American Space Policy Directive which states that the "United States will lead the return of humans to the Moon for long-term exploration and utilisation" [30]. In March 2019, US vice president Pence tasked NASA with landing humans on the Moon by 2024 "by any means necessary" [7]. The current plan involves the construction of the SLS, which is to become the most powerful rocket ever built. It will enable the United States and Europe to send astronauts beyond low Earth orbit for the first time since the Apollo era. The current schedule would send an uncrewed Orion capsule into orbit around the Moon in late 2020, although this date has changed many times in the past. A series of SLS launches would then be used to build the Gateway, a habitable space station in orbit around the Moon [24]. Apart from an opportunity to test the life support systems required to keep humans alive beyond low Earth orbit, the Gateway will eventually serve as the mothership for lunar landings, using a yet-to-be-designed lander.

The 5-year plan to put human beings back on the Moon marks a significant change from the indecisiveness of previous NASA human exploration programmes. It has the potential to generate American path dependency by necessitating investment in infrastructure that can only be used for lunar missions. Nevertheless, it ought to be stated that the feasibility of the plan is questionable. It appears unlikely that a human-rated lunar lander could be built within five years, considering that it took approximately 10 years to build the first Space Shuttle and more than 15 years to build the SLS (which is still a work in progress). As Dreier writes, "there is no functional heavy-lift rocket, no functional spacecraft for deep space, and no lunar lander even under formulation" [11]. Nevertheless, Trump's space directive represents a clear reorientation of American space ambitions, and it is arguably the first time in recent US space policy that a choice was made between the Moon and Mars.

Like the United States, China is also pursuing a space policy that is aimed at eventually landing humans on the Moon. In 2019, China spectacularly became the first country to land a probe on the far side of the Moon. The Chang'e 4 probe was part of the Chinese Lunar Exploration Programme, which consists of a series of robotic launches to the Moon. The Chang'e 5 mission is scheduled to carry out the first lunar sample return since 1976 [1]. A sample return mission demonstrates the technical ability to land on and launch a vehicle from an object in space, therefore laying an important foundation for future crewed missions. Nevertheless, according to a

Table 1
Arguments for and against sending astronauts to the Moon/Mars.

	Moon	Mars
For	<ul style="list-style-type: none"> - Less explored than Mars - Ideal location for testing ISRU - Close to Earth - Radio astronomy on the far side of the Moon - May spur investment from the private sector 	<ul style="list-style-type: none"> - Opportunity to investigate the origins of life - Similarities to Earth (24 h day, seasons, atmosphere, etc.) - Abundant local resources
Against	<ul style="list-style-type: none"> - Has already been visited six times during the Apollo era - Lunar geology is already well understood - Repetition of an accomplished task is not a 'great achievement' - ISRU works differently on Mars 	<ul style="list-style-type: none"> - Not feasible with current technologies - Ethical problem of sending astronauts away for two years - Communications delay makes mission too risky - Too expensive

ISRU, in situ resource utilisation.

January 2019 press conference, China's next steps involve the construction of a robotic research station at the lunar South Pole. Space journalist Andrew Jones describes the idea as "likely similar conceptually to ESA's 'Moon Village' concept" [19]. This is because the station is intended to be open to international partners, although China has so far been hesitant to have partners involved at critical stages of its exploration efforts. In the past China has also talked about potential lunar missions, including the construction of a human moon base [18]. US vice president Pence has described the US as being in a space race with Russia and China [31]. Nevertheless, while China's robotic exploration programme is very concrete and hitherto highly successful, China's crewed mission proposals remain relatively vague. However, what is clear is that China has its sights firmly set on the Moon.

Finally, Russia also maintains plans to send cosmonauts to the Moon. In the near future, Russia's space agency Roscosmos will cooperate with ESA to relaunch the Luna programme, which had enabled the Soviet Union to orbit around, land on and collect soil samples from the Moon between 1959 and 1976. The ESA and Roscosmos will cooperate on the Luna 27 mission, which will send a lander to the far side of the Moon. The new Luna-Glob programme has the goal of building a robotic Moon base by 2030. This will be enabled by the Angara-A5V rocket, which is currently on the drawing boards [34]. So far, Russia has launched two Angara rockets in 2014, the A1 and the A5. All rockets of this series will rely on the same engines and first stages, but as opposed to the A5, the A5V requires a hydrogen-based upper stage, whereas the A5 relied on kerosene [27]. Nevertheless, the 2014 launches show that Roscosmos is serious about the rocket and the basic hardware for the heavy-lift vehicles required for transport to the Moon is becoming available. Transport of humans to the Moon is thought to take place using the Ryvok capsule, which is a fully reusable shuttle between the ISS and the lunar surface. In the 2030s, Russia is planning to upgrade its robotic base to a human base, with up to ten cosmonauts operating on the Moon simultaneously. In 2017, Russia announced its participation with the NASA-led Gateway, which may undermine the Ryvok programme, as the ISS is no longer needed as a launch platform [33]. Possibly Ryvok will use the Gateway as a launch platform instead.

1.3. Private actors

A turn towards the Moon can be witnessed not only among the world's most important government space agencies but also among the increasing number of private space actors, most notably SpaceX. Elon Musk's well-known rocket company has been pursuing ambitious plans to colonise Mars. However, since US president Trump's decision to prioritise lunar missions, Musk has put forward that SpaceX rockets may as well as be used to build a base on the Moon [23]. This shift in Musk's attitude is probably due to the fact that SpaceX relies on government contracts as its primary source of income. To maintain the US government's support, it was necessary to somewhat align SpaceX's exploration and colonisation strategy to that of NASA. Nevertheless, even before Trump's announcement, SpaceX was preparing to use its recently tested Falcon Heavy rocket to propel a crewed Dragon II capsule on a free-return trajectory around the Moon. This mission mimics the previously mentioned maiden flight of the SLS/Orion system. Until February 2018, SpaceX had intended to use Falcon Heavy for manned missions to cislunar orbit [28]. This plan has since been cancelled, with more attention being given to the development of Big Falcon Rocket (BFR), which is meant to be used for landing on the Moon and Mars [14].

Apart from SpaceX, Jeff Bezos' space company Blue Origin pursues very ambitious plans to permit American astronauts to return

to the lunar surface. While NASA currently has no concrete plans to build a lunar lander, Blue Origin's Blue Moon lander would enable an SLS-based human mission to the Moon. Bezos has plans for such a mission for the mid to late 2020s. If SLS is unavailable, Blue Origin could also use its New Glenn launch vehicle, which is scheduled for its maiden flight in 2020. The dimensions and payload capabilities of the New Glenn rocket are comparable with those of the Falcon Heavy. Blue Origin's ultimate goal is to build a human colony on the Moon [9].

2. Europe's lunar plans: the Moon Village

The previous section outlined two facts. First, momentum is gathering to bring human beings back to the Moon's orbit and surface. Not only have the space agencies of Russia, China and the United States decided for the Moon and against Mars, but several actors are simultaneously developing, building and testing Moon rockets. SLS, Falcon Heavy and New Glenn could all launch humans into lunar orbit, and given the development of a lander, they could all enable humans to land on the Moon. Indeed, the path dependency these developments have brought about is very difficult to reverse by any US government. Since the Apollo era, the chances for a human return to the Moon have never been better. Second, while the aforementioned outlined programmes are carried out by very different actors, they all share one essential characteristic: they all involve plans, mission architectures, concrete, preset goals and large-scale financial investment. The Moon Village is radically different.

In terms of space exploration, the ESA is probably the second-most important space actor after NASA. Naturally, ESA has thus not remained quiet on the Moon/Mars question. Indeed, Jan Wörner's Moon Village proposal represents ESA's contribution to this debate. The Moon Village is characterised by its neat fit with the contemporary momentum in human space flight policy as well as by being utterly different from all other proposals hitherto discussed. As will be shown in this section, the Moon Village is not a traditional space programme, but rather an open concept, which will be explored using the analogy of the world café conference. Arguably, it is precisely this feature that may determine its chances for success.

2.1. Understanding Jan Wörner's lunar dreams

The Moon Village concept is undoubtedly the brain child of ESA director general Jan Wörner. However, since Wörner's idea began making headlines in 2015, the Moon Village has arguably remained the most misunderstood currently discussed concept for lunar exploration. The Moon Village is thus often understood to as a European attempt to build a moon base or a lunar colony. Stenzel et al. describe the Moon Village as a project intending to "enable a group of humans to live and work for a certain period of time on the surface on the moon" [40]. In an article on additive manufacturing, Labeaga-Martínez et al. state that the "aim of [the Moon Village] project is to establish a Moon colony" [41]. As shown, these descriptions arguably miss the central point of Wörner's vision.

To better understand the Moon Village, it is meaningful to explore what motivated Wörner to pursue his idea. Indeed, based on an interview with Wörner that was carried out in November 2017, it will be argued that he was motivated by scientific, political and organisational considerations. As such, the emergence of the Moon Village concept differs significantly from the emergence of past visions for space exploration. The most widely known interpretation of the American decision to launch the Apollo programme, for instance, is that Apollo was a means of competition with the Soviet Union at the height of the Cold War [22]. Although

other explanations have been offered [21], none of them cite the institutional culture of NASA as the underlying motivation behind Kennedy's decision. In the case of the Moon Village, however, it may be argued that the concept's architecture is not only the result of 'rational choice' but also that it is an outgrowth of ESA's cooperative approach to space exploration.

Wörner has publicly declared his scientific interest in the Moon on many occasions. In a blog post on the ESA website, Wörner describes the Moon as "an archive of Earth's early history" [32]. He views the far side of the Moon as a potential site for a "radio telescope [...] to stare deep into the Universe without any interference from human made signals" [32]. Apart from that, as mentioned previously, Wörner argues that "if you want to fly deeper into space, there are many technological challenges that you can try out on the Moon" (personal communication, 2017). He specifically refers to ISRU, which can be tested "perfectly" on the lunar surface [32]. Wörner further highlights that the Moon is less explored than Mars and more reachable than the Red Planet. This explanation for Wörner's interest in the Moon Village is closest to the rational choice approach, which has been used to account for Kennedy's decision to go to the Moon.

Politically, Wörner wanted to come up for a project for fostering international cooperation. As such, he views the Moon Village as a social experiment and a "hope for society" (personal communication, 2017). In the interview, he explicitly stated that it would be unwise to export Earth's political divisions and structures to the Moon:

"I am also interested in the geopolitical aspect, in working internationally, beyond borders and boundaries of thought, without re-erecting material and psychological fences" [32].

Wörner expressed his strong disapproval of "suggestions" to build "fences and walls" on the lunar surface to protect "national interests" [32]. From his point of view, "replicating national interests on the Moon [...] would be the death of this development [of space exploration]" [32]. Wörner sees the Moon Village as an "opportunity for space science and a chance for society to try out something different" beyond "the capitalist or the communist solution" [32].

Finally, Wörner was motivated by his pursuit to experiment with new ways of project management in space. In fact, he would reject the term 'project' with reference to the Moon Village, and he would argue that the Moon Village requires no 'manager'. Up until the present day, ESA has carried out projects and programmes. ESA projects have budgets, aims and schedules. All involved actors have clearly defined responsibilities. These projects are either government funded or the result of public-private partnerships. Wörner hopes that the Moon Village will be the first example of a new type of endeavour he calls the 'open concept', which he defines as follows:

"It is not a single project. It is not something, where schedules are clearly defined. It is not something, where I define every step. It is not something, where partners are clearly defined. It is not something, where all interfaces are regulated. But it is an open platform, an open idea, that different actors can participate in" (personal communication, 2017).

This can be interpreted in different ways. According to Wörner, the Moon Village is thus an example of Space 4.0. While the American term NewSpace refers merely to the privatisation and commercialisation of space travel that began during the 1980s,

Space 4.0 is a wider term that encompasses further developments in the space sector. As was discussed in the introduction, Space 4.0 finally refers to

"a time when space is evolving from being the preserve of the governments of a few spacefaring nations to a situation in which there is the increased number of diverse space actors around the world, including the emergence of private companies, participation with academia, industry and citizens, digitalisation and global interaction" [12].

This poses the challenge of integrating the space sector with the economy as a whole, which involves providing opportunities for actors of all kinds to become involved with space-based projects. Wörner thus intends for the Moon Village to become a means to multiply and diversify the actors involved with space exploration.

Despite Wörner arguing that the Moon Village is different from past ESA 'projects', his statement that the Moon Village "is an open platform, an open idea, that different actors can participate in" (personal communication, 2017) is remarkably reminiscent of the ESA culture in general. ESA is an international organisation that is based on the cooperation of different national governments. It is not an exclusive organisation and exists side by side with European national space agencies. ESA is open to participating in other space agencies' projects as a junior partner. The organisation itself is thus firmly geared towards cooperation. Moreover, ESA funding is made up of the member states' mandatory contribution as well as of optional programmes, which member states may or may not sign up to. This is similar to the Moon Village's principle that participating partners do not have to be involved with all aspects of the Moon Village, but only with those elements they consider useful. This arguably underlines that the Moon Village is a translation of ESA culture to the international level. As opposed to the rational choice approach that is typically used to explain the emergence of the Apollo programme, an institutionalist point of view may be better suited to explain the emergence of the Moon Village concept.

2.2. The Moon Café

As opposed to the American, Russian and Chinese lunar plans, the Moon Village cannot be understood as a project. Indeed, Wörner intended to convey the basic meaning of his idea by calling it a Moon 'village' instead of a Moon base or even a Moon colony. According to Wörner,

"a village is something that is not decided upon by a government. When I think of a village on earth, a village emerges when different actors say, 'this is a nice place'. Here we could set up a common settlement. Here we can found a community. Here we can live together and support one another" (personal communication, 2017).

From Wörner's point of view, a village is a conglomerate of interests rather than a structured project. Nevertheless, it is debatable whether his definition of a village corresponds to contemporary reality in the Western world. New villages and settlements are usually the result of government planning. Different parts of new villages are zoned for particular purposes, and the infrastructure is laid out by planning agencies. Wörner's notion of the village seems to stem from a prebureaucratic era when human settlements emerged organically without central planning. Indeed, his idea resembles patterns of colonisation in North America or

Siberia. Despite this, Wörner emphasises that the Moon Village is not a human colony, stressing that

“this is not colonisation, and I will tell you why. Earth is too beautiful to leave it for long periods of time. I want to see the person, who truly, from the bottom of their heart, decides that they don't want to live on Earth anymore. Anyhow the Moon is no good for an alternative. Neither is Mars. Life in cans, in space suits, everyday [...], I simply can't imagine that there are sensible people who truly aspire to that” [12].

Wörner is clearly sceptical about humans colonising the Moon and space in general.

Wörner refers to the Moon Village as an open concept. The idea of the Moon Village is intended to gather together the diverse groups and actors that have an interest in lunar operations. These operations may take place on the surface and in orbit around the Moon. They may involve robots and humans, and they may be carried out for commercial and scientific purposes. Therefore, there are no ESA plans regarding the specific architecture of the Moon Village or the types of activities that will be carried out on the Moon. The first step towards the realisation of the Moon Village was Wörner's effort to popularise the idea among potential stakeholders. Thereupon, these stakeholders were invited to sign a declaration to announce their interest in being part of the Moon Village. The next step involves a survey of all actors that have signed the declaration. In this survey, the actors are asked about the elements of the Moon Village they can provide and about the infrastructures they will need:

“For example, someone might say, ‘I want to break down water into hydrogen and oxygen on the Moon, I have the competences for that, but I need someone to get me there.’ Or someone else says, ‘I want to try out a scientific instrument, but I need a rover that will carry it around to different places on the Moon.’ That's why we're doing a survey: what do you want to provide, what do you want to do, what do you offer and what do you need” (personal communication, 2017).

According to Wörner, one company has already offered to provide transport to the Moon for a set price.

In this sense, seeing the Moon Village concept as a particular type of world café may be a useful metaphor to prevent further misunderstandings [4]. A world café is a method of hosting conferences with an open outcome. It usually involves a large room with different tables hosting different conversations. The conversation topic at each table is determined by a brainstorming process at the beginning of the conference, where ideas for conversation topics are put forward by the conference participants. The most popular suggestions are assigned to particular tables. The conference participants may then move from table to table, engaging in the conversations they find the most interesting. Only the table hosts remain at fixed tables to moderate and document the conversations. At the end of the world café, the table hosts present the conclusions of the discussions that were held at each table. The world café is very useful for fostering creativity and gathering ideas.

There are several similarities between world cafés and the Moon Village. First, while a world café may be organised by persons or institutions with particular interests, they do not exhibit hierarchies, as there are no audiences and no presenters. This approach is shared by the Moon Village. Wörner foresees no particular role for himself or even the ESA in ‘building’ the Moon

Village, merely viewing the Moon Village as “Europe-inspired” [35,36]. Indeed, in the interview, Wörner and I engaged in a semantic discussion on how to describe his role in the realisation of the Moon Village. Wörner sees himself as a broker or facilitator, but not as a project manager or coordinator. The word ‘facilitator’ is often used by world café organisers with reference to the table hosts. When I pointed out that any village on Earth has a mayor, Wörner stated “It is my hope that we will grow beyond that, that we won't need it” (personal communication, 2017). Beyond accepting a set of standards and regulations to allow for the mutual compatibility of technical equipment, Wörner sees no need for coordination. Furthermore, he does not view ESA as the leading actor in setting up the Moon Village. He displayed great enthusiasm for the American, Russian and Chinese plans to return to the Moon, affirming that “if it allows the international community to work together, I gladly remain in the shadows. [...] A village requires no leading power” ([36]). Another similarity between the Moon Village and world cafés is that both represent an invitation to an audience that may have an interest in a particular goal, in this case, carrying out projects on the Moon. Wörner spoke of a wide range of actors that are interested in lunar operations, including both government and private-sector stakeholders. Third, like the current Moon Village survey, the outcome of a world café is undetermined. Like the Moon Village, a world café is a collective brainstorming exercise rather than a project management meeting. It is a process, rather than a project. Given those similarities, it may be meaningful to refer to the current state of discussions on the Moon Village as a Moon Café.

3. Feasibility of the Moon Village

To test the feasibility of the Moon Village, this section will subject the idea to a SWOT/PEST analysis. A SWOT analysis is an organisational management tool designed to test the strengths and weaknesses of a commercial endeavour. A SWOT analysis is essentially carried out by listing the strengths and weaknesses of a project alongside opportunities and threats within unpredictably exogenous parameters [25]. To structure the analysis, the SWOT model is combined with a PEST analysis. In a PEST analysis, the political, economic, social and technological factors determining the success or failure of a project are evaluated. For the purposes of analysing the feasibility of the Moon Village, the social dimension is left out, as this variable was intended to predict the success of business strategies.

Several strengths are apparent from the Moon Village's internal properties. Politically, the Moon Village is potentially successful because it does not require immediate funding. This was confirmed by Wörner, who told me that when he presented the Moon Village concept at the ESA Council, the member states did not discuss it:

“That's because when they meet, they have two days to focus on defining the budget for the different proposals I have provided. They argue and they talk about how much money for what project. And because I said right away that this project doesn't cost any money, it wasn't discussed. But that's not a problem. That's not a problem because it's just not a project. It is an open concept” (personal communication, 2017).

An ESA concept that requires no funding is by default popular among the member states. Economically, it is one of the strengths of the Moon Village that it builds on government funding as well as private investment. While I showed previously that the Moon

Village has no immediate costs, components of the Moon Village (such as possibly the ESA Orion Service Module) do of course require public funds. However, these component projects are not explicitly part of the Moon Village, and their funding is secured through international commitments and internal budgetary agreements. Moreover, the success of the Moon Village does not depend on a single project, as several actors are simultaneously producing the technologies required for the realisation of Wörner's idea. Indeed, as Foing points out, current lunar lander missions "will constitute a Robotic Village on the Moon" [37]. Technologically, the strength of the Moon Village stems from its ability to pool the technological resources of the world's space actors, including government agencies and private enterprises.

Despite the evident strengths of the Moon Village, it also exhibits several clear organisational weaknesses. Politically, despite the humble word 'village', the Moon Village does at first glance appear to be an attempt to colonise the Moon. European space policymakers traditionally lack the ambition of their American, Russian and even Chinese counterparts. While the Moon Village is not limited to grandiose plans to build a Moon base, being open to robotic exploration, the meaning inevitably conveyed by the concept's title may act as a political deterrent. Moreover, while Wörner stresses that the idea's inherent lack of hierarchy is meant to overcome Earth-based structures, any successful project does require a certain amount of leadership and coordination. This also relates to the Moon Village's economic weaknesses. A project that lacks concrete budgetary requirements is arguably incompatible with the structured funding acquisition process of ESA and other space agencies. However, this problem may be mitigated if one takes into account that the Moon Village is not a grand scheme, but rather an amalgamation of different projects which may follow standard budget allocation procedures. Technologically, it is one of the weaknesses of the Moon Village that ESA lacks its own rockets and capsules for facilitating human space flight. However, this argument is weakened by the fact that there are many potential ways to transport humans to the Moon, including NASA's SLS and SpaceX's Falcon Heavy rockets. SLS is a project that ESA supports, although the privately built Falcon Heavy may be used for ESA missions.

In terms of exogenous factors, there are many variables that may contribute to the success of the Moon Village. Politically, the Moon Village clearly rides on a wave of increasing international momentum to return human beings to the surface of the Moon. As discussed in the first section of this article, a consensus is emerging that a mission to Mars should be preceded by a mission to the Moon. Moreover, the ISS will eventually require replacement, and a Moon base seems like the next logical project requiring international cooperation. Moreover, the Moon Village is not regarded to stand in competition with other Moon projects, as it potentially pools the numerous plans for lunar exploration. It is one of the economic opportunities that the Moon Village will consist of several mutually independent projects. Wörner has stressed that "there may be a few things you have to have an agreement on, but no more" (personal communication, 2017). This implies that actors may proceed relatively independently with their own projects, merely placing them within the overall scheme of the Moon Village. This reduces the vulnerability of the Moon Village to economic downturns in particular countries. Technologically, the Moon Village's feasibility benefits from the several projects simultaneously producing the technologies required to get to the Moon. New Glenn, Falcon Heavy and the SLS could all transport humans to the Moon. Similarly, Orion and Dragon 2 could both bring astronauts into orbit around the Moon. If one programme fails, the overall Moon Village concept may nevertheless continue.

The primary political threat to the Moon Village is the geopolitical environment. First, Wörner has to convince the member states of the merits of the Moon Village. Although it may currently require no funding, the projects it entails will be very expensive. The construction and upkeep of infrastructure in lunar orbit or on the surface of the Moon is very expensive, requiring regular funding comparable only with the ISS. The Moon Village, therefore, depends on the mercy of its benefactors. Second, although I have stated that the SLS/Orion programme as well as Falcon Heavy/Dragon II programme may facilitate the Moon Village, neither programme currently places itself under the Moon Village umbrella. Although Wörner stresses that he is willing to remain out of the spotlight if this brings about international cooperation, the Moon Village is still a European idea. If it were successful and if the name 'Moon Village' was maintained, ESA and Wörner himself would gain a significant amount of prestige. It is unlikely that the United States is willing to participate in such a prestigious programme without being the leader. If the US, Russia and China play a role in the Moon Village, its name is, therefore, unlikely to remain once the 'world café' phase of the concept is completed. The success of the Moon Village is, therefore, critically dependent on Wörner's ability to convince ESA's international partners that they should collaborate. Economically, like any major space programme, the Moon Village may fail, if there is a major global economic downturn. Finally, in terms of technology, the Moon Village concept rests on several untested technological innovations, such as lunar ISRU. There are no long-term studies on the effects of lunar dust on the human body, and it is difficult to shield the human body from the radiation experienced on the Moon (see Fig. 1).

4. Conclusion

In this article, it was shown that there is an increasing international momentum to return astronauts to the Moon. The Moon is closer to Earth than Mars, and getting to the Moon does not depend on the development of hitherto nonexistent technologies. Most importantly, a lunar programme is much cheaper than a human mission to Mars. Within this context, the feasibility of Jan Wörner's Moon Village proposal is increased. Given the need to replace the ISS in the medium-term future and given that the Moon Village is

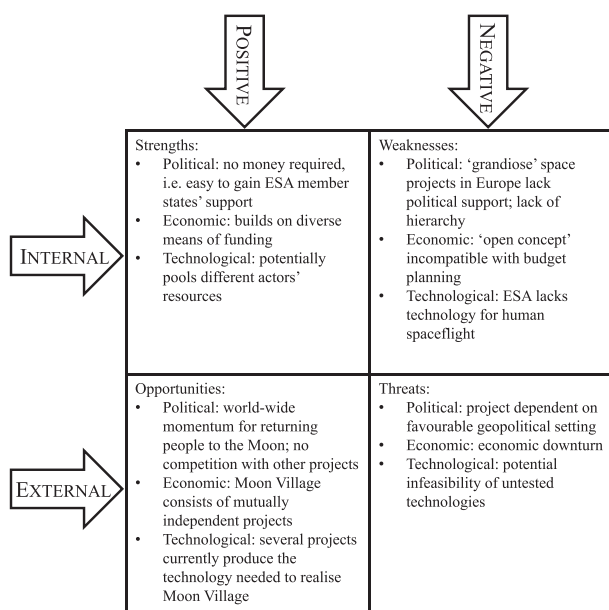


Fig. 1. SWAT/PEST matrix for the feasibility of the Moon Village.

merely a platform for all sorts of different projects, it is likely that Wörner's campaign will at least meet some success.

But is the open concept of the Moon Village a 'new way of doing space'? This article's answer would be 'yes', as the evidence lends support to the institutionalist hypothesis that the Moon Village represents the potential translation of the ESA system to the global level. For ESA projects, it is not required that every single member state participates, and according to the geographical return principle, those member states that do participate are certain to have their investment returned into their own national economies. Similarly, the realisation of the Moon Village does not require the participation of all actors in all of its elements. Moreover, resources are not pooled, but operations are merely carried out without a loose set of parameters and under the umbrella term 'Moon Village'. As such, the Moon Village cannot be compared with the ISS which requires far more coordination. The ESA system has proven to be very resilient, and the existence of the geographical return principle is a powerful reason against the inclusion of ESA into the EU family of institutions (see Ref. [16] on the EU/ESA debate). The institutionalisation of cooperation in space cooperation on a global level may be an important contribution towards the maintenance of balance on the international system.

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