GAME MANUAL

BUZZ ALDRIN'S

SPM

SPACE•PROGRAM•MANAGER

ROAD TO THE MOON

matrix games

SLITHERINE

EPILEPSY WARNING

PLEASE READ THIS NOTICE BEFORE PLAYING THIS GAME OR BEFORE ALLOWING YOUR CHILDREN TO PLAY.

Certain individuals may experience epileptic seizures or loss of consciousness when subjected to strong, flashing lights for long periods of time. Such individuals may therefore experience a seizure while operating computer or video games. This can also affect individuals who have no prior medical record of epilepsy or have never previously experienced a seizure.

If you or any family member has ever experienced epilepsy symptoms (seizures or loss of consciousness) after exposure to flashing lights, please consult your doctor before playing this game.

Parental guidance is always suggested when children are using a computer and video games. Should you or your child experience dizziness, poor eyesight, eye or muscle twitching, loss of consciousness, feelings of disorientation or any type of involuntary movements or cramps while playing this game, turn it off immediately and consult your doctor before playing again.

PRECAUTIONS DURING USE:

- Do not sit too close to the monitor.
- Sit as far as comfortably possible.
- Use as small a monitor as possible.
- Do not play when tired or short on sleep.
- Take care that there is sufficient lighting in the room.
- Be sure to take a break of 10-15 minutes every hour.

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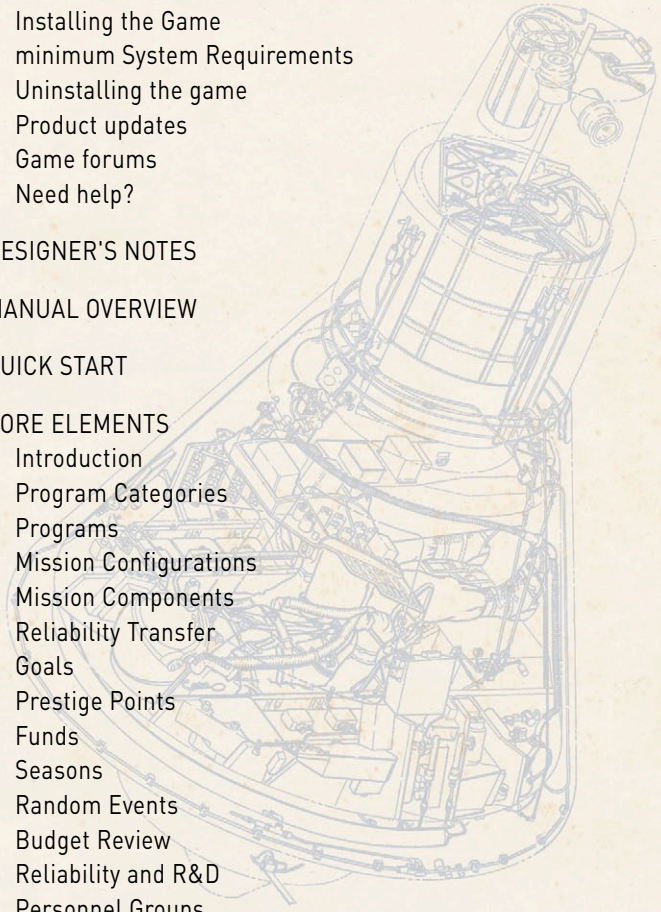


Thank you for Purchasing Buzz Aldrin's Space Program Manager™!

INTRODUCTION

Buzz Aldrin's Space Program Manager (SPM) places you in charge of one of three major space programs. As NASA's Administrator or the Soviet Space Program's Director, your goal is to make sure your country is the first to place a man on the Moon and bringing him safely back to the Earth. You may also choose to lead the Global Space Agency (GSA), a utopic international space agency that unites all the world's space programs with the goals of landing a man on the Moon, and ultimately establishing a permanent human presence across the Solar System and beyond.

Buzz Aldrin's Space Program Manager features both Campaign and Sandbox single player modes for all three space agencies. In addition to this, the game can also be played against other human players using Slitherine's PBEM system.

In Campaign Mode for either the US or Soviet Union, your goal is to be the first nation to land a man on the moon. Both factions offer a wide range of programs and options based on both real programs and others that were planned but never left the drawing board. The US and Soviet campaigns will allow you to experience the same tension that took place during the 1960s As a NASA Administrator, will you go for the historical 'Mercury' → 'Gemini' → 'Apollo' route taken by NASA in the 1950s and 1960s? Or will you attempt to land on the Moon using a variant of the Gemini spacecraft? As Director of the Soviet Space program, will you use the Soyuz 7K-LOK spacecraft coupled with the LK lander? Or will you develop the massive UR-700 booster and attempt a Direct Ascent on the Moon in order to plant a red flag on its surface? Buzz Aldrin's Space Program Manager features lots of

options to choose from, and it's up to you to decide which strategy to adopt in order to beat your opponent.

In Campaign Mode for the GSA, you will be given both the long term goal of achieving a manned Lunar landing before the end of 1973, along with periodic requests with short term objectives that need to be met. These short term objectives will grant you a prestige boost when they are accomplished and a prestige deduction when they are not. Some of these short term objectives might be aligned with your current strategy, whereas some others might require you to deviate from your plans in order to fulfill them. As Director of the GSA, it's up to you to decide whether you want to invest time and resources in accomplishing all the short term objectives or skipping some and take a prestige hit instead.

Sandbox Mode can also be played with any of the three available space agencies. Unlike the Campaign Mode, there are no clear objectives, so you can play without any external political pressure and choose to explore different options as you see fit. The only requirement is to keep your finances out of red numbers.

INSTALLING THE GAME

Please ensure your system meets the minimum requirements listed below. To install the game, insert the Buzz Aldrin's Space Program Manager™ DVD into your DVD-ROM drive. If you have disabled the auto-run function on your DVD-ROM or if you are installing from a digital download, double-click on the installation archive file, then double click on the file that is shown inside the archive. Follow all on-screen prompts to complete installation.

MINIMUM SYSTEM REQUIREMENTS

Operating system: Microsoft Windows XP/Vista/7/8,
Windows Server 2008/2003
Processor: Intel Core Duo 1.33GHz or faster processor (or equivalent)
Memory: 1GB for XP, 2GB otherwise
Graphics Memory: 256MB
Display Resolution: 1024x768 or greater
Hard disk space: 1.5 GB
Internet Connection (for Multiplayer only)

UNINSTALLING THE GAME

Please use the Add/Remove Programs option from the Windows Control Panel or the Uninstall shortcut in the games Windows START menu folder to uninstall the game. Uninstalling through any other method will not properly uninstall the game.

PRODUCT UPDATES

In order to maintain our product excellence, Slitherine releases updates containing new features, enhancements, and corrections to any known issues. All our updates are available free on our website and can also be downloaded quickly and easily by clicking on the Update link in your Game Menu or by using the Update Game shortcut in your Windows START menu folder for the game.

We also periodically make beta (preview) updates and other content available to registered owners. Keeping up with these special updates is made easy and is free by signing up for a Slitherine Member account. When you are signed up, you can then register your Slitherine products in order to receive access to these game-related materials. Doing so is a simple two-step process:

Sign Up for a Slitherine Member account – THIS IS A ONE TIME PROCEDURE; once you have signed up for a Slitherine account, you are in the system and will not need to sign up again. Go to www.slitherine.com and click the Login hyperlink at the top. In the new window, select Register NOW and follow the on-screen instructions. When you're finished, click the Please Create My New Account button, and a confirmation e-mail will be sent to your specified e-mail account.

Register a New Game Purchase – Once you have signed up for a Slitherine Member account, you can then register any Slitherine title you own in your new account. To do so, log in to your account on the Slitherine website (www.slitherine.com). Click Register a Serial under Resources near the top and then register your new Slitherine purchase.

We strongly recommend registering your game as it will give you a backup location for your serial number should you lose it in the future. Once you've registered your game, when you log in to the Members section you can view your list of registered titles by clicking My Page under Resources. Each game title is followed by its registered serial number.

You can also access patches and updates via our Downloads Section (http://www.slitherine.com/downloads) under Resources. Once there select the game you wish to check updates for, and then check the See more link. Certain value content and additional downloads will be restricted to Members Area members. So it is always worthwhile to sign up there.

Remember, once you have signed up for a Slitherine Member account, you do not have to sign up again at that point you are free to register for any Slitherine product you purchase.

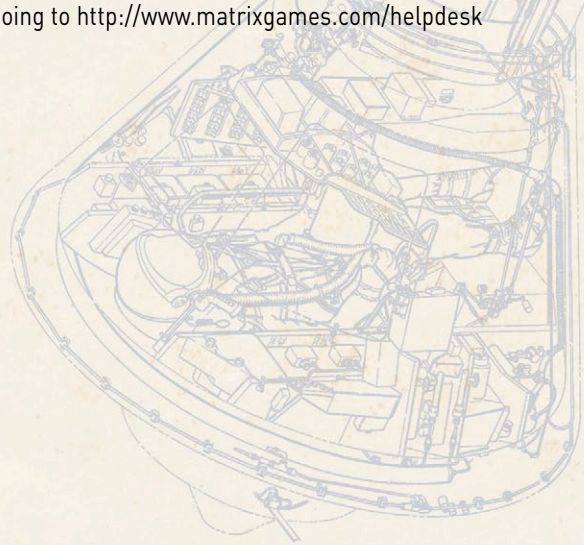
Thank you and enjoy your game!

GAME FORUMS

Our forums are one of the best things about Slitherine. Every game has its own forum with our designers, developers and the gamers playing the game. If you are experiencing a problem, have a question or just an idea on how to make the game better, post a message there. Go to http://www.slitherine.com and click on the Forums hyperlink.

NEED HELP

The best way to contact us if you are having a problem with one of our games is through our Help Desk. Our Help Desk has FAQs as well as a dedicated support staff that answer questions within 24 hours, Monday through Friday. Support questions sent in on Saturday and Sunday may wait 48 hours for a reply. You can get to our Help Desk by going to http://www.matrixgames.com/helpdesk



DESIGNER'S NOTES

Buzz Aldrin's Space Program Manager has been in development since early 2007. It originally started with the idea of making a simulation game focused on space exploration, where the player would assume the role of Director of a fictional space agency featuring programs from all the major space agencies. After running an Early Access Program (EAP) since October 2013 and gathering feedback from the community, its scope was revised and greatly expanded in order to feature the original vision plus a completely new campaign focused on the race to the Moon between the United States and the Soviet Union that took place in the 1960s and that ended on July 1969, after the successful splashdown of the Apollo 11 Command Module in the Pacific ocean. As a result of this, you'll now also be able to play the role of NASA's Administrator or Director of the Soviet Space Program in order to beat the other faction and be the first one to place a man on the Moon... and bringing him safely back to Earth!

Buzz Aldrin's Space Program Manager features dozens of elements based on real missions, plus a lot more based on plans that never left the drawing board drafted by both NASA and the various design bureaus from the Soviet Space Program. Great care has been taken in order display the various animations associated to each mission in an accurate way.

In real life, NASA is scattered throughout several space centers across the United States and the Soviet Space Program was composed by different design bureaus that competed among each other for funds and other resources. For gameplay reasons, several abstractions have been made. Nonetheless, I'm confident that the game will allow you to gain a better understanding of the space race and the events that transpired during that decade and, by watching the missions animations, you'll appreciate the complexity behind space missions. I hope you have fun by both recreating history and by trying out different approaches in your play sessions!

MANUAL OVERVIEW

Although it's recommended you do it at some point, you don't need to read this manual from cover to cover in order to be able to play Buzz Aldrin's Space Program Manager. If you want to jump straight into the action, please read the 'Quick Start' section, which will guide you through the first turns of a US sandbox game and cover all the steps required in order to launch your first mission. After you get some experience, we recommend you to read the 'Core Elements' section, which provides more background about the game mechanics. Even though is not strictly required to enjoy the game, the material presented in this section will allow you to understand the game better and enjoy it a lot more.

The 'Starting a Game' section covers the elements in the main menu along with the buildings located in the space complex. The appendixes provide more background information about the space race and an interview with Buzz Aldrin himself!

QUICK START

For Program Directors that wish to jump right in and learn as you go, this Quick Start guide will help you launch your first satellite into space!

After starting Buzz Aldrin's Space Program Manager you will be presented with the Main Menu. Along the bottom of the screen are five buttons: Single Player, MultiPlayer, Preferences, About and Exit.

Click on the Single Player button then choose the New Game button. This will bring up the Game Mode screen. Click on the 'USA Sandbox' button, then press 'Start'.

The game difficulty screen will appear. Click 'Normal', then press 'Start'.

You should now be on the Space Complex screen, which is the main screen from which you will manage your space program. A notification dialog will inform us that the space agency (NASA) has been established. After clicking the 'Proceed' button, the game will display a second notification dialog introducing your advisor, Dr. Wernher von Braun. Click 'Proceed' again. A notification popup will inform you about your current budget. Press 'OK' in order to close it.

As you can see, the Space Complex screen looks quite empty. That's because the space agency has just been established so, except for a few scattered buildings, the complex is mostly covered by empty lots. At the lower left side of the screen click on there's a magnifying glass icon. Clicking on it will highlight and number all of the existing and possible future buildings at the space complex.

Our goal is to launch a satellite into orbit. In order to accomplish that we will need to first open our very first program. Click on the Headquarters building (building number 3). You can also access this

building by clicking on the 'Folder' icon in the bar located in the lower section of the screen. You will see a screen that displays our solar system. Notice that Earth is highlighted and shows '0/11' under its icon. This indicates that there are eleven total possible programs associated with Earth and zero have been started. Click on the Earth icon. A list of five program categories will appear. We are interested in the first one, 'Earth Orbiting Research Satellites'. Click on its icon. You will now be given a list of four different types of satellite programs. Click on the first one, 'Explorer I'. A mission configuration screen will appear. We want to keep things simple for now so click on the first one, 'Explorer I'. An information window will pop up asking you if you want to start this new program and shows its initial cost and ongoing maintenance cost per season. Click the 'Yes' button to initiate the program. An information window will pop up informing you that the program is now open. Click the 'OK' button to continue.

Now that we have a new program open return to the Space Complex screen by clicking the 'Back To Space Complex' button at the lower, right side of the Headquarters screen. Once again click on the

Headquarters building. Notice that now the Earth icon is showing '1/11' or one out of eleven programs have been started. Click all the way back to the Explorer I mission configuration screen. Now that the program is open you can see an overview of it. You should notice that the mission summary is incomplete (indicated by the question marks) and some key components are still missing. Note that three Flight Controllers are required. Also notice that under Mission Components Required at the lower, left side of the screen there is a large '?' icon.

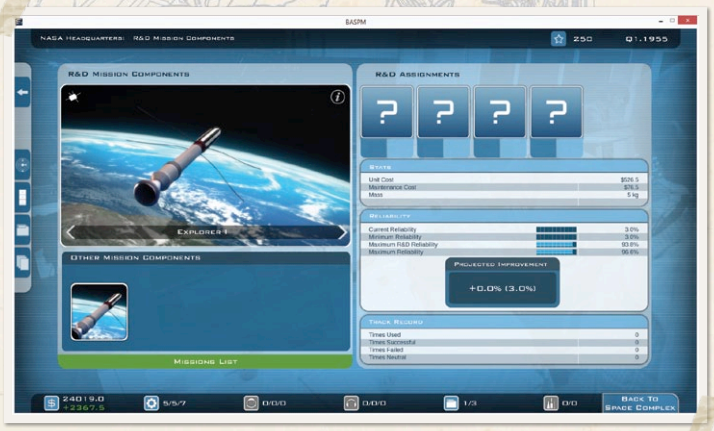
Click on it to see what else you're missing. You will be informed that in order to assign a rocket to this mission you need to start the construction of the Vehicle Assembly Building (VAB) first. The game will also allow ask you whether you want to be redirected to the Space Complex screen. Click the 'Yes' button in order to be redirected there and start the construction process.

At the lower, left side of the screen next to the magnifying glass icon you will see the Construction Mode icon (it looks like a crane). Click on it and a construction tape will appear at the top and bottom of the Space Complex screen, indicating that you are now in Construction Mode.

From the list of NASA buildings in the upper, right hand of the screen you can see that the Vehicle Assembly Building is building number 7. On the Space Complex screen building number 7 is shown to be an empty plot of land indicating that nothing has been built there yet. Click on the empty plot for building number 7. A pop up window will appear tell you about the VAB, how long it will take to build and how much it will cost. Click on the 'Build' button. Notice that the empty plot has now been replaced by a building under construction.

Remember from the Explorer I mission configuration screen we also need three Flight Controllers for this program. Since we are still in Construction Mode and you can only hire Flight Controllers from the Mission Control building, click on the empty plot for building number 4 and build the Mission Control Center. Once you are back to the Space Complex screen, click the Construction Mode icon again to go back to the regular mode.

Now that we have opened a new program we can also put a few of those five new employees to work! Click on the Headquarters building and select the 'Manage Payloads R&D' button. This is the Manage Mission Components screen. You can see our Explorer I space probe program screen. Notice



that the current reliability of the program is only 3% and our projected reliability is the same! If we are going to be successful we need to increase these numbers. At the top of the screen are four R&D assignment boxes.

Click the first one. You will be given a list of available personnel, sorted by skill level depending on the mission component type. For Explorer I, the type is 'Space Probes'. Click on the employee at the top of the list. Notice that the employee is now assigned to the Explorer I component. Our projected reliability is now expected to improve now that we have someone working on it. Go ahead and assign one more employee to the next empty slot. We'll need the other three employees to work on our rocket program. Once you have assigned the first two employees to the Explorer I payload return to the Space Complex screen.

That's all we will do for now. Go ahead and click the 'End Season' button at the lower right side of the screen. You will get a warning screen telling you that not all employees are assigned. That's okay for now so go ahead and click 'Yes' to end the current season. A new screen will appear showing you the progress you have made with the current reliability of Explorer I.

Click the 'Proceed' button, which will take us to the News screen. This screen will be shown at the end of every turn and will inform us about the most important events that took place, such as programs being opened, employees that have been hired or missions that have been completed. For the race to the Moon campaigns, it will also inform us about the events that are occurring on the other side. The News screen will tell you that you have opened the Explorer I program, started construction of the VAB and completed construction of the Mission Control Center. Click the 'Proceed button' and the click the 'OK' button on any information screens that appear.

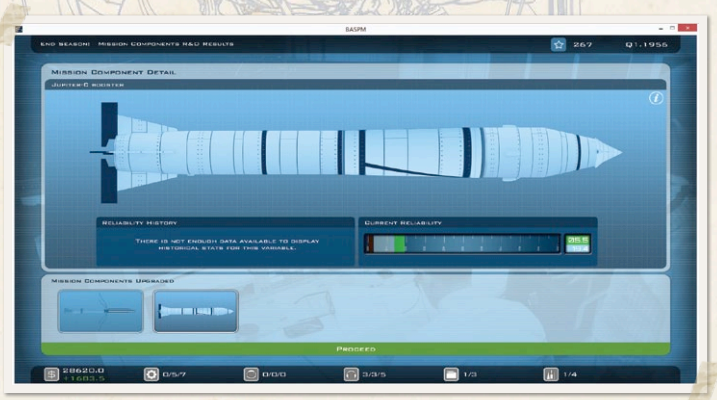
Now that the Mission Control Center is complete we can hire three Flight Controllers. Click on the Mission Control Center. You will be directed to the recruitment screen. The recruitment screen lists available candidates along with their personal information including skill levels. Since this is a quick start we won't worry too much about anything except filling the three empty Flight Controller slots. Go ahead and click on any three available candidates to add them as recruits. Click on the 'Hire Recruits' button and click 'Yes' to confirm the number and cost. Your new recruits will have to undergo basic training before they are ready so click 'OK' to confirm. The next screen will show your three recruits and at their status, in this case they are all three in training. Click 'Back To Space Complex', then Click the 'End Season' button. Ignore the warning about unassigned employees again by clicking 'Yes'.

Notice again that the reliability of the Explorer I continues to improve. Also notice that the VAB is now completed. Once you are back to the Space Complex screen click on the Headquarters building then click the 'Open Rocket Program' button. You can now open either of the two listed programs. Go ahead and click on the 'Open' button for the Jupiter-C booster. Click 'Yes' when asked to confirm and 'Yes' again to be directed to the Rocket Management Screen. You can now assign

those remaining three employee to research the Jupiter-C and improve its reliability. Assign all three just like you did for the Explorer I, then return to the Space Complex screen.

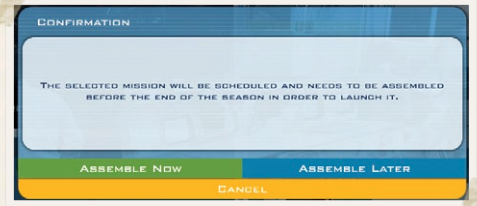
Click on the Headquarters building and then click on the Manage Programs button. Click on the Explorer I program. Now click on the '?' icon under 'Mission Components Required' again. You can now click on the Jupiter-C booster, since the rocket is capable enough of lifting our payload, that is, the Explorer I satellite. Go ahead and do so. You will be returned back to the Explorer I mission screen. Notice that you now have everything you need to schedule a mission! But look at your Mission Components Average Reliability. You could schedule a mission but with reliability being so low you probably wouldn't be successful (plus your Flight Controllers are still in training!). Click on the 'Assessment' button. Dr. Von Braun isn't so keen on your chances of success right now either and tells you so. Let's follow Dr. Braun's advice and go back to the Space Complex screen. Click the 'End Season' button again.

Notice now that when your Explorer I reliability is updated there is another icon under the 'Mission Components Upgraded' area. Click it and it will show you the update for your Jupiter-C booster.

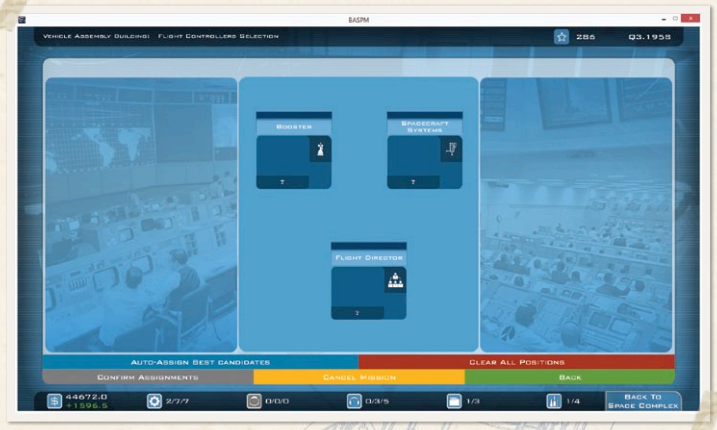


Click 'Proceed' and go to the News screen. It should show you that the three Flight Controllers have completed training and are ready to be assigned.

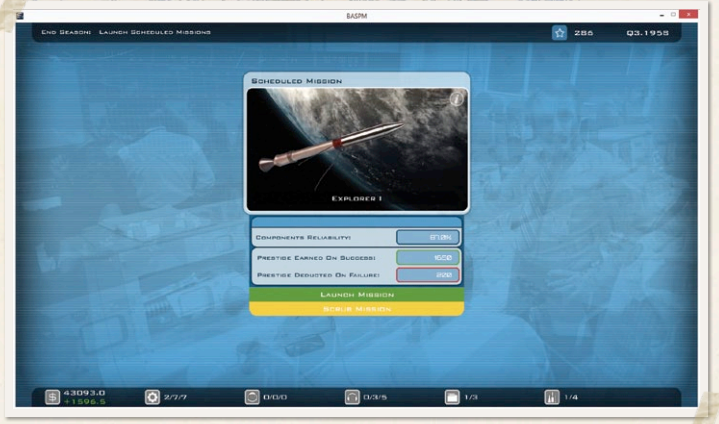
Now it's just a matter of how confident you are in launching your satellite into orbit. Go ahead and keep clicking on the End Season button until both of your Mission Components (Explorer I and Jupiter-C) are at or close to at least 90% reliable (in Campaign Mode you probably wouldn't want to take this much time but since we are in Sandbox Mode it's okay!). Once you are there click on the Headquarters, choose 'Manage Programs' and click on Explorer I. Click the Assessment button again and now Dr. Braun feels much better about your chances of success. Click on the 'Schedule Mission' button. When the confirmation windows opens click on 'Assemble Now'.



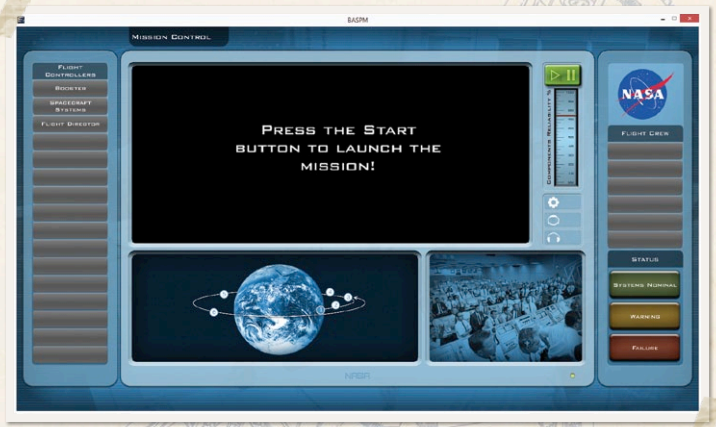
A summary screen will appear giving you information on cost and reliability. Click the Proceed button. The next screen is the Flight Controller selection screen. You can choose which position each Flight Controller will man. Clicking on each position will display a list sorted in descending order, showing the best employee for that role at the top of the list. Alternatively, you can click on the 'Auto-Assign Best Candidates' button. The system will start by filling the Flight Directors seats first with the most well-rounded employees and then will fill the remaining seats starting on the top left and finishing on the bottom right. Alternatively, you can manually assign some employees yourself and then use the auto-assign functionality in order to let the game do the rest.



You will receive notice that the mission has been assembled and the amount of funds you spent by buying the mission components. Click on 'OK'. From the Space Complex screen press the 'End Season' button. Once you get past the reliability screen you will be taken to the Scheduled Mission screen. You have two options, Launch or Scrub mission.



Click on the 'Launch Mission' button. You may now either skip to the outcome of the mission or watch the mission unfold from Mission Control. Click the 'Follow From MC' button. Once the mission loads, click the Play/Pause button at the top, right of the screen to start the mission.



You can pause it at any time. The mission will now play out in steps until the end. If a problem with the mission components occurs, then the Flight Controllers will step in and try to save the day. If you are successful, you will be shown how many prestige points you have earned and any goals achieved during the mission. Achieving goals makes it possible to open new types of programs and reduce the risk of suffering penalties when attempting more complex missions.

If you weren't successful, don't worry! This Quick Start only covered the bare minimum requirements needed to launch a satellite into orbit. In an actual game you could have increased your chance of success even more by sending your personnel to advanced training or opening other rocket programs. The good news is you now know enough about SPM to start your journey to the stars!

CORE ELEMENTS

INTRODUCTION

The following section covers the key elements behind Buzz Aldrin's Space Program Manager. Although many of them can be learned on the go by playing the game, we strongly suggest you to read this section at some point in order to gain a better understanding of the mechanics behind the game.

PROGRAM CATEGORIES

For each celestial body shown on the Headquarters screen there are a number of different programs that you can open. Programs that are similar in type are grouped into Program Categories. For example, if you're playing as the US, the Program Category 'Earth Orbiting Research Satellites' contains four different programs that all involve launching satellites into Earth orbit: Explorer I, Pegasus, Biosatellite and Orbiting Frog Otolith. The 'Lunar Probes' program category, located under the Moon in the celestial bodies screen, provides a variety of programs such as flybys, impactors and orbiters. Most

program categories, especially the ones that involve robotic probes, encompass a group of two or more programs.

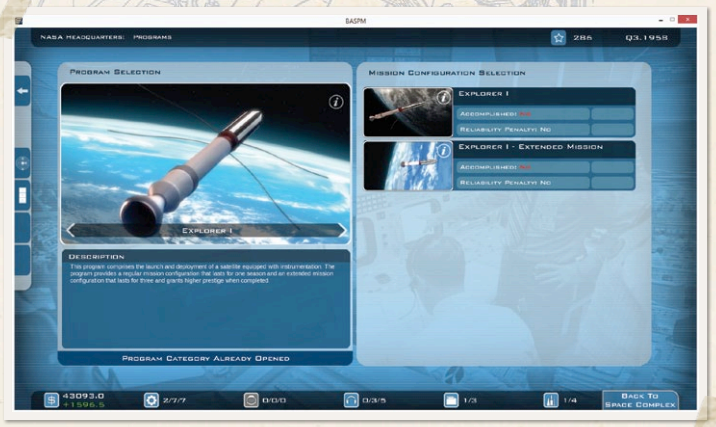
PROGRAMS

'Programs' feature a group of one or more payloads (e.g., satellites, planetary probes, manned spacecraft, etc) that can be launched on top of rockets. There are two types of programs: 'payload programs' (or just 'programs') and 'rocket programs'.

'Rocket programs' feature the launch vehicles used in order to deploy payloads in space, whereas 'payload programs' or 'programs' feature a group of one or more related payloads that, coupled with a rocket, are used in order to conduct missions. The following subsections provide more details on both types of programs.

MISSION CONFIGURATIONS

Each 'payload program' can have one or more Mission Configurations that allows you to use its payloads in different ways in order to achieve different goals. For example, the Explorer I program has one additional



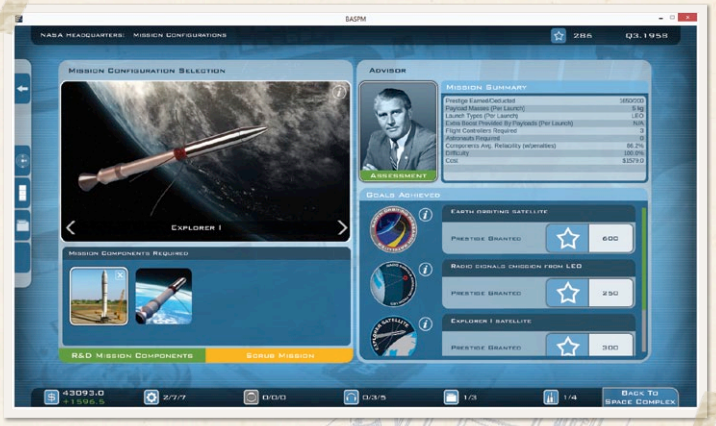
Mission Configuration that allows an extended duration for the payload. Extended missions beyond the scope of the 'regular' mission will usually grant extra prestige. Manned programs like 'Gemini' or 'Project Apollo test flights in Earth orbit' feature more than ten mission configurations.

MISSION COMPONENTS

Once a mission configuration has been selected, you must assign a rocket to it. All mission configurations have a fixed set of payloads and most of them will usually require a single rocket in order to be launched, although there are some that require two.

Mission components have an associated reliability, which influences the chances of success when they are used in a mission. Most mission components start with a very low initial reliability which, through R&D, can be increased to an acceptable level. Please refer to the 'Reliability and R&D' subsection for more details.

Mission components belong to one of the following five groups, please refer to Appendix D in order to get further information about some of the components that belong to each group:



Rockets: These are the vehicles that carry uncrewed payloads to outer space, such as unmanned satellites or planetary probes. Depending on their capabilities, they can be classified as 'Light', 'Medium' and 'Heavy'. Mission components that belong to this group are only suitable for carrying unmanned robotic spacecraft to space. Examples of mission components that belong to this group are Juno II and the R-7 Sputnik rocket.

Space probes: This group embodies both unmanned satellites and probes sent to explore other celestial bodies. Examples of mission components that belong to this group are the Sputnik satellite and the Mars Viking lander.

Human-rated rockets: Mission components from this group are launch vehicles that have been certified as capable of carrying human beings and, as such, they tend to be more expensive than their non-human rated counterparts. Notice that human-rated rockets can also be used to carry space probes, a strategy that can be useful in order to raise the reliability of the rocket beyond their maximum R&D level. Examples of human-rated rockets include the Atlas booster, the Saturn V booster and the N1.

Crewed spacecraft: This group encompasses all types or spacecraft that are capable of carrying human beings on board. Examples from this group are the Vostok spacecraft and the Apollo Command and Service Module (CSM).

EVA suits: These are the pieces of equipment that allow astronauts and cosmonauts to work in space. Examples from this group include the Berkut space suit and the Lunar Roving Vehicle used in the Apollo lunar missions.

RELIABILITY TRANSFER

Some mission components share a set of properties among themselves. When opening a new program featuring a new set of mission components, their initial reliabilities will get an extra boost depending on which other mission components you already own, along with their current reliabilities. Keep this in mind when planning your overall strategy. It's a good idea to open programs that contain components with a high reliability transfer in order to get the most out of your previous R&D efforts.

GOALS

Goals can be achieved by completing missions successfully. Successful completion of goals allows you to open new, more ambitious programs. You may also receive requests to complete specific goals by governments in the GSA campaign. Goals can be divided in two major groups: 'generic' and 'non-generic'.

'Generic' goals are those that can be accomplished by any space agency, and are the main point of reference when comparing the progress of two agencies. Examples of generic goals include 'Man in space', 'Man in orbit' and 'Manned lunar pass'. Being the first to achieve a 'generic' goal will give you a significant prestige boost over the opposing faction.

'Non-generic' goals are those that can be accomplished by just one space agency. Examples of goals that belong to this category include 'Soyuz orbital flight' and 'Apollo lunar flyby'.

Notice that, due to their nature, achieving some goals effectively grants you the achievement of more basic goals. For example, achieving a 'Duration Level III' manned flight will also grant you the 'Duration Level II' and 'Duration Level I' goals, if they haven't been achieved already.

Failing to achieve goals will impact the reliability factor of your missions. For example, if you attempt to perform a manned orbital flight of the 'Mercury' spacecraft without performing a manned suborbital flight first, you'll get a penalty that will decrease the overall reliability of your spacecraft. As Director of the space agency, it will be your call whether to proceed with the mission and risk a reliability penalty in order to take the lead in the race to the Moon or take a more conservative approach and accomplish all the intermediate steps first.

PRESTIGE POINTS

You can earn Prestige Points for successfully completing missions. You can also lose Prestige Points if a mission fails. The higher the number of Prestige Points you earn means more funding will become available to you in the next budget review.

FUNDS

You will earn funding based on the amount of Prestige Points you generate. Funding is used to the salaries of your personnel, opening new programs, upgrading buildings, maintenance, training and many other items. The Public Affairs Office building will give you an overview of your funding status.

FIXED COSTS

Running the space agency has a set of fixed costs that will be subtracted from your funds every season, so plan accordingly!

The checklist for fixed costs is as follows:

- ★ Personnel salaries from all three groups (i.e., SET, Astronauts/ Cosmonauts and Flight Controllers).
- ★ Buildings maintenance.
- ★ Active payload programs.
- ★ Active rocket programs.

SEASONS

Each game turn counts as one season, or one quarter of a year.

RANDOM EVENTS

Between turns there are many random events that may occur that can impact your space program. These events will be listed on the new screen. Random events can have either positive or negative effects on your program.

BUDGET REVIEW

There is a budget review every four years. This will determine how much funding per season you will receive for the next four years based on the number of Prestige Points earned.

RELIABILITY AND RD

The reliability of your Mission Components will play a crucial role in determining how successful your mission will be. You can assign SET personnel to research and develop selected components (i.e., rockets and payloads) in order to improve their reliability. SET personnel has a set of five skills, one for each mission component type (i.e., 'Rockets',

'Space probes', 'Human-rated rockets', 'Crewed spacecraft' and 'EVA suits'). Their skill level in the area that the mission component they are assigned to belongs determines the level of reliability improvement. You'll need to decide whether you want to have your employees specialize in one or two specific skills or whether you want them to be more 'generalists' and ensure they will make an adequate contribution on any type of mission component they get assigned to.

Note that there is a maximum reliability that each component can be improved to via R&D. In order to improve the reliability beyond this point, the component needs to be used in a successful mission. This is especially important for man-rated rockets and crewed spacecraft: it's strongly advised you perform at least a few unmanned tests before attempting a crewed mission in order to raise the components' reliabilities. As Director or Administrator of the space agency, it will be your call to decide whether you want to skip the intermediate steps in order to gain the lead or play it safe and take a more conservative approach.

PERSONNEL GROUPS

Personnel Groups are made up of the people you hire for your space program. Each employee is unique and has specific information related to them including salary, morale, age, learning capacity and skill levels, which can be improved via advanced training, a process that costs money and that lasts for more than one season, and whose exact length depending on the personnel group itself. All newly hired employees are required to spend time in basic training before they can be assigned to work.

Salary is the fixed cost that needs to be paid to the employee at the end of every season. The morale level measures how pleased they are with their job. Keeping your SET employees assigned

to a project and making your Flight Controllers and Astronauts/ Cosmonauts participate in missions will make their morale levels go up. Alternatively, if your employees don't have anything to do, their morale levels will drop on a per season basis and, eventually, they will leave the agency in order to look for better opportunities. Notice that keeping your personnel in advanced training will prevent their morale levels from dropping as well.

Employees' age determine how close they are from retirement. Each personnel group has different retirement ages, so plan your hiring strategy accordingly in order to keep a healthy amount of staff levels.

Learning capacity is a factor that influences how much skill levels go up after sending the employee to advanced training. The higher the learning capacity, the more results you'll get from an advanced training session. Learning capacity cannot be developed, so take this into account during the hiring process. A candidate with low skills and high learning capacity might be a better choice than a candidate with an adequate set of skills and a low learning capacity.

Advanced training can be set so that it gets performed once or on a continuous basis. The first method involves sending the employee for a fixed amount of seasons whereas the second method requires you to set a 'target skill level' for a given skill. The employee will then be sent to advanced training for as long as it's required in order to attain the target level. Employees can be 'pulled out' from advanced training any time in case they are required for an assignment. The results will be lower compared to the ones they would have achieved had they completed their training, and the costs for the training process itself won't be refunded.

There are three types of personnel available:

SCIENTISTS, ENGINEERS AND TECHNICIANS SET

SET personnel are responsible for researching and developing the components necessary to put together a space mission in order to increase their reliability. SET personnel have the following five skills, which match the existing mission components groups: 'Rockets', 'Space probes', 'Human-rated rockets', 'Crewed spacecraft' and 'EVA suits'. When assigned to a mission component, their skill level on the category group that the component belongs to will have a direct impact on the results of the R&D process.

FLIGHT CONTROLLERS

During a mission Flight Controllers work at specific positions in the Mission Control Center and monitor the status of the mission in real-time. At each stage or step of a mission there is a chance, based on component reliability, that something might go wrong. If it does, those Flight Controllers involved in said step jump into the problem in order to fix it and put the mission back on track. Don't underestimate the role of Flight Controllers in a mission. Even though striving for a high reliability in the mission components is crucial in order to increase the chances of success, it's also very important to keep a healthy staff of highly-qualified flight controllers that can be capable of effectively solving emergencies.

Flight Controllers have skills in the following five areas:

Propulsion: This skill is required by those positions involved with the use of boosters. They usually have a lot of weight during the launch of the mission.

Trajectory & GNC: This skill is required by those positions that are in charge of monitoring the trajectory of the spacecraft.

Spacecraft systems: This skill is required by those positions that monitor the internal systems of the spacecraft, such as electricity, environment and communications.

Crew And Payloads: This skill is required by those positions that deal with the crew itself (for manned missions) or the payload (for robotic missions).

Mission Operations: This skill is required by those positions that make sure that the mission is executing according to plan.

There's also a sixth skill named 'Flight Director', which is the average of the first five skills. All Mission Control rooms require at least one Flight Director (some of them require an 'AFD' or 'AFLIGHT', an 'Assistant Flight Director'). When something goes wrong in a mission step, all the flight controllers involved in it, along with the Flight Directors, step in in order to fix it. Thus, it's very important to have a small group of well-rounded employees in your staff so that they can be assigned to the 'Flight Director' slots when scheduling a mission.

ASTRONAUTSCOSMONAUTS

Astronauts and cosmonauts (or 'crew members') are the people who will actually make the trip into space. Just like the members of the other employee groups, they also have a set of skills:

Leadership: This skill reflects their capacity to remain calm under pressure and to use good judgment in order to make decisions. You usually want your Commanders to have an overall good Leadership in order to increase your chances of success.

Piloting: This skill reflects their capacity to actually pilot the spacecraft.

EVA: This skill reflects their capacity to work in space outside the spacecraft, either in Earth orbit, Moon orbit or in the lunar surface.

Science: This skill reflects the crew member's ability to perform science experiments effectively.

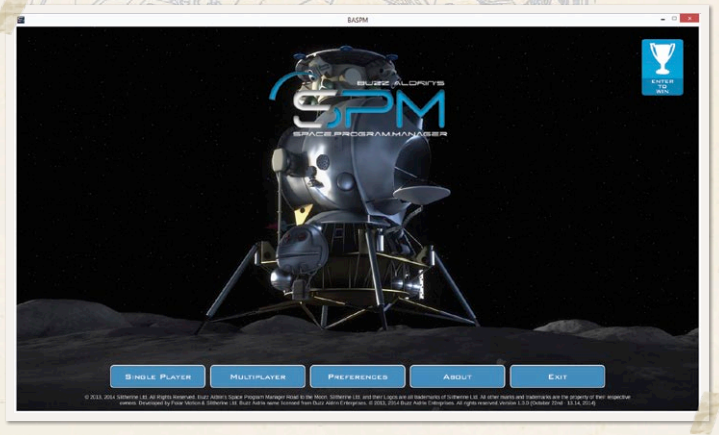
Fitness: This skill reflects the crew member's overall physical fitness. With spaceflight being such a physically demanding activity, especially during the launch and the re-entry phases of the mission, it's very important for all your crewmembers to possess an adequate level of fitness.

Members of this group are required to take a mandatory rest season after coming back from a mission, and during this period of time they cannot take any kind of assignment or be sent to advanced training. Keep this in mind when planning your launch scheduled, especially for those missions that require several crew members.

STARTING A GAME

START MENU

Upon starting the game you will see the Start Menu. There are five buttons to choose from:



Single Player – Start a single player game

Multi Player – Start a multiplayer game

Preferences – Configure sound and language settings

About – Game version and development information

Exit – Exit the game

GAME MODE

Select one of six game modes to play. Play either the US, Soviets or GSA in Campaign Mode or in Sandbox Mode.

DIFFICULTY LEVELS

Normal – Start with plenty of funding. Downgrades for mission components after a failed mission will be relatively low.

Hard – Start with standard funding. Downgrades for mission components after a failed mission will be moderate.

Buzz-hard – Start with a small amount of funding. Downgrades for mission components after a failed mission will be quite severe.

NEWS SCREEN

At the start of each season (turn) you will see a news report screen that lists a series of news briefs that concern your space program and, if playing one of the race to the Moon campaign, the news that concern the other faction as well. Pay attention to each news item, as there are many events that impact your program, both positive and negative.

SPACE COMPLEX SCREEN

The Space Complex Screen is the central management point from which you will control and manage your entire space program.

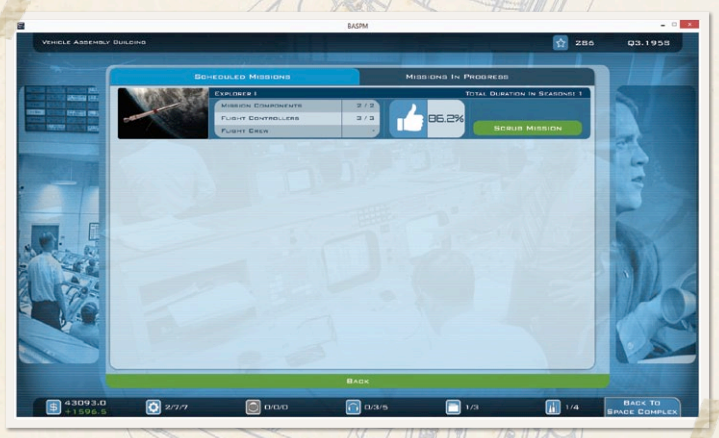
Depending on which of the three major space programs you choose to lead (US, Soviet or GSA), this screen will look different but have the same functionality. Each Space Complex will have seven building types, described below. At the start of the game your Space Complex will not have all of the building types available. You can build additional buildings by activating Construction Mode (by clicking on the crane icon in the lower left corner). The buildings that exist at the start of the game are very small facilities but can be upgraded (also from the construction screen) to increase their capabilities.

1) Display building list
2) Enter construction mode
3) Empty plot – building not constructed
4) Building index/location
5) Existing building
6) Game Setting Menu
7) End season button
8) Tape that indicates we're in construction mode

VEHICLE ASSEMBLY BUILDING VAB

The Vehicle Assembly Building is where your rockets and payloads will be put together for your missions and needs to be built before attempting to open a rocket program. The evolution state of the VAB determines the type of rocket programs that can be opened (i.e., 'Light', 'Medium' and 'Heavy') along with the number of rocket programs that you can keep opened simultaneously. Notice that in order to achieve a manned lunar mission when playing as the US, you'll need at least a 'Medium' rocket.

The VAB screen will display all scheduled missions and current missions in progress. Note that the construction of the VAB must be completed before you can attempt to open any rocket programs.



SCHEDULED MISSIONS

Displays a list of missions scheduled to launch along with number of components used and number of Flight Controllers and astronauts required. You can also scrub a mission from this screen.

MISSIONS IN PROGRESS

This screen shows all missions currently active. The total duration of the mission in seasons is shown along with how many seasons the mission has been under way.

PERSONNEL BUILDINGS

All employees groups (i.e., 'SET', 'Flight Controllers' and 'Astronauts/Cosmonauts') have their own buildings. Inside them, you can get an overview of the whole department (e.g., number of employees, average morale level, total fixed costs in terms of salary, etc), hire new recruits and get an overview of the individual status of each one of your employees.

By clicking on the 'Manage Department' button, you can provide a pay raise or pay drop to the whole department, which has a direct influence on the morale levels of the whole department. Just like in real life, providing a pay raise might help to boost employees' morale temporarily but, in the long run, if you're not running the organization in the right way, your employees will leave anyway. Notice that pay raises are permanent, so make sure you can sustain the increased costs before authorizing them.

The elements in the employees list can be filtered by using the buttons in the upper center area of the screen. From left to right, these toggle buttons allow you to include/exclude employees that:

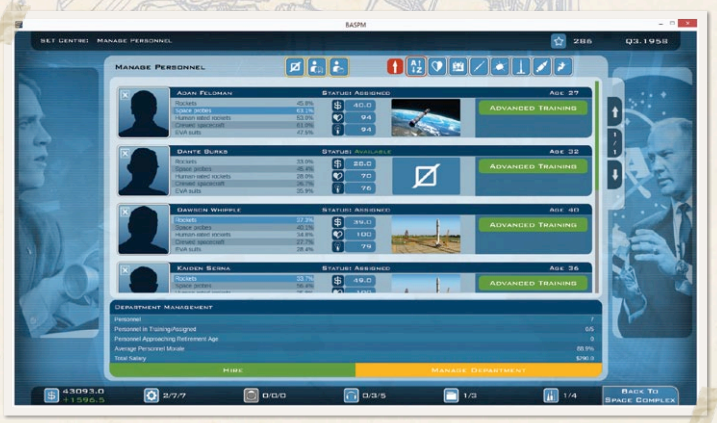
- Are available
- Are undergoing training
- Are assigned to a mission component (SET) or a mission (Flight controllers and flight crew members)
- Are taking their mandatory rest season ('Astronauts/Cosmonauts' screen only)

The screen also allows you to sort the elements on the list according to the following criteria by using a series of radio buttons. From left to right, these buttons allow you to sort the employees by:

- Alphabetic order
- Morale
- Age
- First skill
- Second skill
- Third skill
- Fourth skill
- Fifth skill
- Sixth skill (Flight Controllers only)

The arrow at the left of this group of buttons points up or down depending on whether the elements are sorted in ascending or descending order, respectively.

The evolution state of each employee building determines the maximum number of active employees. Upgrading the building incurs in higher maintenance cost, so plan accordingly.



HEADQUARTERS

The Headquarters building is where you open new programs, manage existing programs and manage payloads R&D. This screen displays the celestial bodies in our solar system with corresponding numbers that indicate the number of possible programs for it and the number actually opened.

The evolution state of the Headquarters determine the maximum number of payload programs that can be kept open simultaneously.

OPEN ROCKET PROGRAM

This screen lists of all rocket programs available in the game, even those that cannot be opened yet. If you meet all of the requirements to open a program it will have an 'open' icon to the right.

MANAGE ROCKET PROGRAM

From this screen you can assign SET personnel to research and develop a rocket in order to increase its reliability. Note that you can improve reliability only so much through R&D. Hardware must be

used on actual missions to improve it any further. All hardware has a set maximum reliability that can be achieved.

MANAGE PROGRAMS

This screen lists all programs that you have opened. Clicking on any program in this list will take you to its Mission Configuration screen.

MANAGE PAYLOADS RD

Similar to the Manage Rocket Program screen, this screen allows you to assign SET to R&D for the chosen payload in order to increase its reliability.

MUSEUM

The Museum is the building where you can review historical statistics about several areas from your space agency, along with the goals that have been achieved. It's also the place where fallen astronauts and cosmonauts are remembered and honored.

PUBLIC AFFAIRS OFFICE

The Public Affairs Office building contains an overview of your budget and prestige information. You can review your current budget including current funds and expenses as well as your projected budget for the next cycle. You can also track your total prestige points earned to date. For the race to the Moon campaigns, the Public Affairs Office also gives you the option to compare your current progress against the other faction by listing all the generic goals that can potentially be achieved, along with the date that have been accomplished by each faction.

CONSTRUCTION MODE

You can enter Construction Mode by clicking on the crane icon in the lower left part of the screen. Construction Mode is indicated

by the black and yellow construction tape that appears on the top and bottom of the Space Complex screen. Once in Construction Mode you can spend funds to build or upgrade facilities. To create a new building, click on the empty plot of land corresponding to the building type. You will be show how much it will cost to start construction and how long it will take to complete. Building maintenance cost is also displayed.

To upgrade a building, click on its existing icon. You will be shown information on how the upgrade will benefit your program, how much it will cost, how long it will take to upgrade and how much the maintenance costs will increase.

COMMON ELEMENTS TO ALL GAME SCREENS

All game screens feature a top and a lower bar. The top bar displays your current location, along with the number of prestige points and the current year.

The lower bar displays a series of clickable icons with stats. From left to right, these elements are:

Your current funds, along your net income. Clicking on the associated icon will take you to the Public Affairs Office.

The amount of available SET employees, the total number of SET employees in your roster and maximum capacity for SET employees. Clicking on the associated icon will take you to the SET center.

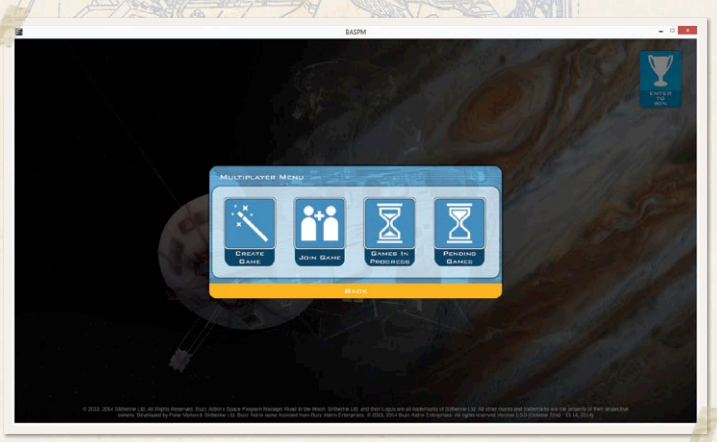
The amount of available Astronauts/Cosmonauts, the total number of Astronauts/Cosmonauts in the agency and the maximum capacity for this type of personnel. Clicking on the associated icon will take you to the Astronauts/Cosmonauts center.

The number of payload programs that are currently active and the maximum number of payload programs that can be potentially opened. Clicking on the associated icon will take you to the Headquarters.

The number of rocket programs that are currently active and the maximum number of rocket programs that can be potentially opened. Clicking on the associated icon will take you to the Vehicle Assembly Building.

MULTIPLAYER

SPM includes the option to play against another human player through Slitherine's unique online server system. From the Main Menu screen select the Multiplayer button. You will see a brief message informing you that you are being connected to the servers. Once you are connected the 'Multiplayer Login' screen will appear. If you already have a Slitherine account simply enter your user name and password and press the Login button. You can check the 'Remember Me' box to skip this step the next time you run SPM. If you do not have a Slitherine account you can create one at www.slitherine.com.



The Multiplayer Menu will appear once you are connected to the servers. There are four choices on the menu screen:

Create Game – Start a new multiplayer game
Join Game – Pick a game that has already been created to participate in
Games In Progress – Continue a game that has already started
Pending Games – Hosted games that haven't started yet

CREATE GAME

To create a new multiplayer game click on the 'Create Game' button. The 'Create Multiplayer Game' screen will appear. You may select one of two game modes: Cold War or Free Form. Cold War allows you to play as either NASA or the Soviet Space Agency in a race to see who can land a man on the moon and bring him safely home. Free Form is similar but allows you to choose from any of the three space agencies in any combination. Want to play as the Soviets and race against the Soviets at the same time? Free Form mode will let you do that! You may also choose to enter a password for the game is you wish to keep it private. You can even enter a comment about the game that will appear on the 'Join Game' screen for others to see. Once you have made your choices press the 'Start' button to create the game. You will receive an email from your opponent once your game is accepted.

JOIN GAME

To join a game that has already been created (by you or someone else), find the game in the list on the 'Join Multiplayer Game' list and selected it. You may need to enter a password if the host has created one. If so, the host must provide this password to you before you can play. Note that you can even accept your own game to play in hotseat mode!

GAMES IN PROGRESS

This screen will list all multiplayer games that you are currently participating in. You can resume a game by selecting one from the list. Games in progress can be sorted whose turn it is. Slitherine's online servers allow you to play at your own pace, even against opponents who are in different time zones. You'll get an e-mail notification that will inform you when to play your next move.

PENDING GAMES

A list of all games that have been created but not yet started are displayed on the 'Pending Games' screen. You can use this screen to delete them before someone else accepts them.

CREDITS

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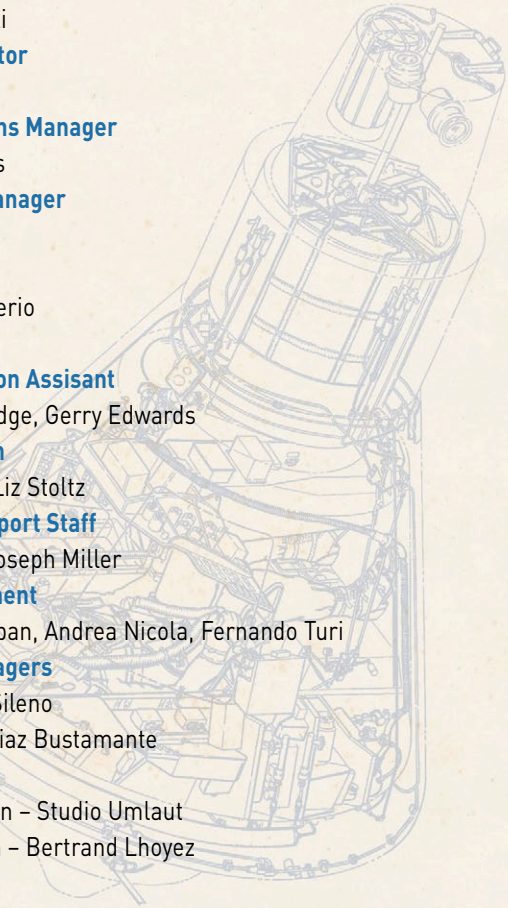


APPENDICES

APPENDIX A
Why the Soviet Union Lost the Race to the Moon

Article by Steve Lohr

Steven E. Lohr has had a life-long fascination with spaceflight and astronomy since watching the Apollo flights in the late 1960's. He has continued this fascination as a hobby, building and flying high power rockets. A graduate of the University of Iowa and the University of Florida law school, he served in the U.S. Navy as a surface warfare officer, retiring from the reserves with the rank of Commander. In civilian life he worked as an assistant state attorney specializing in criminal appeals. He lives in the mid-west with his wife and two daughters.

★★★★★

At the end of 1961, many observers believed the Soviet Union would win the race to the Moon. Beginning with Sputnik, the Soviets routinely established milestones that the United States struggled to reach. Notable Soviet achievements included launching the first orbital satellite, the first animal in orbit, the first manned orbital flight, the first day-long manned flight and the first probe to fly past the Moon. The Soviet R-7 booster, with over eight times the thrust of the American Juno I, gave the USSR an immense advantage in terms of lift capacity, far surpassing that of the United States. Meanwhile, the U.S. struggled with reliably launching small space probes, leading one newspaper describing a failed U.S. launch with the headline "Kaputnik!"

By 1969, the relative positions between the two countries had reversed. The United States had landed on the Moon twice and

had successfully sent probes to Mars. It possessed the Saturn V, the most powerful rocket ever built. In contrast, the Soviet manned program was a shambles, only recently resuming manned Earth orbital flights which were suspended after the 1967 death of Vladimir Komarov in Soyuz 1. What caused this reversal in fortune between these two competitors?

At first blush, this could simply be explained by the fact that America put more resources into its space program. During this period, the U.S. spent a total of $243.297 billion dollars on the program in constant 2007 dollars. The space program absorbed an average of 2.13% of the U.S. budget from 1958-1970, reaching a maximum of 4.41% of the federal budget in 1966.[1] Although estimates vary, at best the Soviet Union spent only half of what the U.S. spent during the same time frame. In fact, it may have spent as little as 10% of the U.S. amount.[2], [3] It is not enough to simply note that the U.S. spent more than the Soviet Union. Throughout the 1960s a majority of Americans did not believe Apollo was worth the cost, with 45-60% of Americans believing the U.S. was spending too much on space.[4] How was the U.S. able to muster and maintain the political will to spend more than the Soviet Union, given this tepid level of public support? And how was the U.S. able to successfully translate this spending into achieving its goal of landing on the Moon? NASA's success was because it had a clear goal, was able to more effectively build a coalition to support the program and was more efficient in managing its resources.

1 http://en.wikipedia.org/wiki/Budget_of_NASA

2 http://www.historyshots.com/space/backstory.cfm

3 Encyclopedia Astronautica. "Why did the Soviet Union lose the Moon Race?" Accessed September 22, 2014. http://www.astronautix.com/articles/whynrace.htm

4 Roger D. Launiu. (2003). Public opinion polls and perceptions of US human spaceflight. *Space Policy*, *19*, 163–175

LAYING THE FOUNDATION THE IMPORTANCE OF SETTING THE OBJECTIVE

Before a joint session of Congress in May 1961, President Kennedy fixed the American objective of "before this decade is out, of landing a man on the moon and returning him safely to the Earth." In this speech, Kennedy gave the U.S. space program a clearly defined and measurable objective that served as a focal point for all its subsequent efforts.

The Soviet program delayed setting an objective of reaching the Moon until August 1964. Even then, this goal was set primarily as a reaction to the American program. This delay gave the American space effort the incalculable advantage being officially assigned an objective by its leaders thirty-nine month ahead of the Soviets. NASA's clear and measureable goal was used as a focal point to generate support, create and fund programs and fly missions that built towards a lunar landing. In contrast, the Soviet space goal was largely reactive to American efforts, perhaps best be summed up as simply "beating the Americans." In effect, this reduced the Soviet program merely flying a series of short term missions that may have had propaganda value, but largely failed in advancing their space program.

BUILDING COALITIONS ENSURING POLITICAL AND PUBLIC SUPPORT FOR THE LONG HAUL

Coalition Building: The NASA experience

From the beginning, the NASA administration actively established coalitions with major political, economic and academic interests to ensure sufficient funding for the lunar program. Armed with a clear goal, NASA built robust relations with Presidents Kennedy and Johnson, as well as with Congress. With President Kennedy, this task was relatively easy. Kennedy was tied politically to the success of the space program. He had set the goal of going to the Moon in part to

overcome an image of weakness after the Bay of Pigs fiasco, and was bound politically to it. However, after his assassination, this level of support from his successor was no longer ensured. While President Johnson was a supporter of the lunar program, NASA had to protect its budget against the competing military demands and the increased spending required by President Johnson's Great Society programs. To maintain President Johnson's support, NASA linked the space program to the Great Society program, arguing that the lunar program helped the program through economic development, advances in education and technological spin offs.[5] NASA was also able to take advantage of Kennedy's death transmuting the space program into a type of memorial to him.[6]

NASA spent significant effort spent in cultivating Congress. Rather than an adversarial relationship, NASA made Congress part of the solution to the problem of reaching the Moon.[7] The agency was fortunate in having a natural supporter in Olin Teague, the chair of the House Subcommittee on Manned Space Flight.[8] Teague, arguably one of the most effective deal makers in the House of Representatives, stood as an effective supporter for the program. However, he needed assistance from NASA to overcome congressional objections to the substantial funding requirements of the lunar program. To help Teague muster this support, NASA cultivated relationships with lower ranking representatives, taking them on regular tours of NASA

5 W. Henry Lambright in Mack, Pamela Etter (eds). *From Engineering Science to Big Science: The NACA and NASA Collier Trophy Research Project Winners*. Washington, D.C.: National Aeronautics and Space Administration, NASA Office of Policy and Plans, NASA History Office, 1998, pg. 200.

6 Slotkin, Arthur L. *Doing the Impossible George E. Mueller and the Management of NASA's Human Spaceflight Program*. New York, NY: Springer, 2012. (Kindle Edition). Location 703.

7 Slotkin, Arthur L. *Doing the Impossible George E. Mueller and the Management of NASA's Human Spaceflight Program*. New York, NY: Springer, 2012. (Kindle Edition). Location 671

8 Slotkin, Arthur L. *Doing the Impossible George E. Mueller and the Management of NASA's Human Spaceflight Program*. New York, NY: Springer, 2012. (Kindle Edition). Location 328

facilities and briefing them openly and frequently on the program. This liaison was viewed as an opportunity to make Congress part of the space effort by educating it on the complexity of the space program, its problems and prospects and the reasons for the resources being requested.

To reach the Moon on schedule, it was vital that the program received consistent funding for its duration. Shortly after Kennedy set the goal of reaching the Moon, NASA Administrator James Webb told the administration that accomplishing this goal required political support for a decade.[9] Capitalizing on the brief bump in political support after Kennedy's speech, NASA signed many of the long-term contracts that were crucial to the Apollo program. These contracts hobbled critics from being able to effectively threaten the long term funding for key aspects of the program.[10]

NASA also diligently worked at gaining broad political support for the space program with both business groups and with the general public. NASA cultivated the business and banking communities, arguing that the economic impact of the space program, with its infrastructure construction, employment benefits, knowledge and technological spin-offs created a positive economic climate.[11] The fact that approximately 90% of NASA's Apollo budget was spent on contracts outside of government also ensured industry and business

9 W. Henry Lambright in Mack, Pamela Etter (eds). *From Engineering Science to Big Science: The NACA and NASA Collier Trophy Research Project Winners*. Washington, D.C.: National Aeronautics and Space Administration, NASA Office of Policy and Plans, NASA History Office, 1998, pg. 196.

10 W. Henry Lambright in Mack, Pamela Etter (eds). *From Engineering Science to Big Science: The NACA and NASA Collier Trophy Research Project Winners*. Washington, D.C.: National Aeronautics and Space Administration, NASA Office of Policy and Plans, NASA History Office, 1998, pg. 196.

11 Slotkin, Arthur L. *Doing the Impossible George E. Mueller and the Management of NASA's Human Spaceflight Program*. New York, NY: Springer, 2012. (Kindle Edition). Location 1035.

support for the program.[12] NASA also avoided a geographical concentration of political support by awarding contracts to a variety of contractors located throughout the country, helping to generate broad political support nation-wide. For example, NASA contracted with Boeing in Seattle to build the Saturn rocket's first stage from its facility in Louisiana. North American Aviation and Douglas Aircraft based in California built the second and third stages while MIT in Massachusetts built the rocket's guidance system. NASA also invested in construction contracts in the districts of influential congressmen, such as building the Manned Spacecraft Center in Houston, in the district of the House subcommittee chairman responsible for NASA's budget. This "spreading the wealth" helped to create and maintain a coalition of political support for NASA throughout the United States.[13]

Early on, NASA recognized that public affairs were crucial to the space program. As the Apollo 11 flight returned to Earth, von Braun addressed newsmen covering the flight saying "I would like to thank all of you for the fine support you have always given the program. Because without public relations and good presentations of these programs to the public, we would have been unable to do it."[14] To create and maintain public support for the space program, NASA developed a public relations campaign designed to both build broad support and to minimize active opposition. NASA gave reporters extensive access to briefing materials, crewmen and NASA officials, enabling the press to better explain the

12 W. Henry Lambright in Mack, Pamela Etter (eds). *From Engineering Science to Big Science: The NACA and NASA Collier Trophy Research Project Winners*. Washington, D.C.: National Aeronautics and Space Administration, NASA Office of Policy and Plans, NASA History Office, 1998, pg. 197.

13 W. Henry Lambright in Mack, Pamela Etter (eds). *From Engineering Science to Big Science: The NACA and NASA Collier Trophy Research Project Winners*. Washington, D.C.: National Aeronautics and Space Administration, NASA Office of Policy and Plans, NASA History Office, 1998, pg. 196.

14 Brain Pickings. "Marketing the Moon: How NASA Sold Space to Earth." Accessed October 3, 2014. http://www.brainpickings.org/2014/03/18/marketing-the-Moon/.

Figure 1. TANG advertisement

space program to the public. NASA also enlisted the help of businesses in supporting the program, allowing them to use their contracts with NASA in advertisements to promote civilian products. Perhaps the best known example of this being the ubiquitous "Tang" advertisements, which sold the space program to the public as it sold one of the most mundane of everyday commodities, a breakfast drink (Figure 1).

Beginning in 1965, the near-continual rate of American launches assisted NASA's public relations efforts. While the Gemini program served as a necessary technical link between Mercury and Apollo, its aggressive flight schedule had the additional benefit of keeping NASA in the public consciousness as a successful government program. The televised successful flights and recoveries of American manned spacecraft, followed by publicity tours of their crew cemented the space program in the public consciousness and minimized active public opposition to the spaceflight program.

NASA also worked on winning over members of the scientific community, many of whom thought the manned space program diverted resources away from other scientific endeavors. These critics believed that the space program was becoming "an engineering binge instead of a

scientific project."[15] This opposition was sufficiently strong to result in NASA's budget being reduced in 1964.[16], [17] In part to minimize scientific community opposition to manned spaceflight, NASA created the 'Sustaining University Program,' that provided long-term funding of Ph.D fellowships. It also funded general scientific research by universities in the space sciences, while minimizing NASA's oversight by leaving the specific research problem and schedule up to the recipient.[18], [19] NASA also created scientific advisory committees comprised of non-NASA scientists in part to improve relations with the scientific community.[20] While not eliminating the scientific community's opposition to NASA's lunar program, these efforts minimized much of that resistance.

NASA also worked to minimize Department of Defense (DoD) opposition to the program. The transfer of some DoD facilities to NASA during its creation, combined with the proposed increase in NASA's share of the space program created some resentment in DoD.[21] While conflict with the DoD was almost inevitable because of competing and

15 Where No Man Has Gone Before: A History of Apollo Lunar Exploration Missions." Chapter 1: Project Apollo: The Debate, Accessed October 5, 2014. http://www.hq.nasa.gov/pao/History/SP-4214/contents.html.

16 Newell, Homer Edward. *Beyond the Atmosphere: Early Years of Space Science*. Mineola, N.Y.: Dover Publications, 2010. pg. 208-09.

17 Slotkin, Arthur L. *Doing the Impossible George E. Mueller and the Management of NASA's Human Spaceflight Program*. New York, NY: Springer, 2012. (Kindle Edition). Location 415.

18 W. Henry Lambright in Mack, Pamela Etter (eds). *From Engineering Science to Big Science: The NACA and NASA Collier Trophy Research Project Winners*. Washington, D.C.: National Aeronautics and Space Administration, NASA Office of Policy and Plans, NASA History Office, 1998, pg. 196.

19 Newell, H. E. (2010). Beyond the atmosphere: Early years of space science. Mineola, NY: Dover Publications, pg. 224-7.

20 Newell, H. E. (2010). Beyond the atmosphere: Early years of space science. Mineola, NY: Dover Publications, pp. 214-15.

21 Boone, W. Fred. *NASA Office of Defense Affairs The First Five Years: December 1, 1962, to January 1, 1968*. Washington, D.C.: Historical Division, Office of Policy, National Aeronautics and Space Administration, 1970, Chap. 2. Available at http://history.nasa.gov/HHR-32/contents.htm

overlapping responsibilities, NASA was able to minimize the conflict by working with DoD. Kennedy's goal of landing a man on the Moon significantly reduced much of the rational for a DoD manned presence in space. To justify a DoD manned space program, proponents needed to articulate military requirements that a manned program could accomplish that an unmanned satellite could not while not duplicating NASA's manned program.[22] By flying DoD experiments on Gemini missions, NASA made it difficult for proponents of the DoD manned spaceflight program to avoid the duplication argument, and thereby neutralized a competing DoD program that could have led to conflict between the two organizations.[23]

NASA also sought out opportunities to work with DoD. NASA's manned spaceflight program gave it research facilities that DoD needed. NASA's research in engineering and basic science was as valuable for both the military and the civilian space program.[24] Conversely, NASA needed DoD facilities and equipment. NASA also needed DoD personnel not just for the astronaut corps, but for important posts such as the head of the Office of Manned Spaceflight.[25] Through sharing resources and creating working level groups and committees to coordinate on issues of joint concern, NASA and DoD were able to minimize conflict and effectively work together and avoid wasteful

22 Levine, A. S., & United States. (1982). *Managing NASA in the Apollo era*. Washington, DC: Scientific and Technical Information Branch, National Aeronautics and Space Administration, pg. 211.

23 Levine, A. S., & United States. (1982). *Managing NASA in the Apollo era*. Washington, DC: Scientific and Technical Information Branch, National Aeronautics and Space Administration, pg. 211.

24 Levine, A. S., & United States. (1982). *Managing NASA in the Apollo era*. Washington, DC: Scientific and Technical Information Branch, National Aeronautics and Space Administration, pg. 236-37.

25 W. Henry Lambright in Mack, Pamela Etter (eds). *From Engineering Science to Big Science: The NACA and NASA Collier Trophy Research Project Winners*. Washington, D.C.: National Aeronautics and Space Administration, NASA Office of Policy and Plans, NASA History Office, 1998, pg. 199-200.

duplication of efforts.[26], [27] Finally, both organizations tacitly agreed to avoid unnecessary turf battles by adopting the concept of "warranted duplication," allowing each other to have some duplicative space efforts, as long as the duplication was directed to agency needs or "represented different approaches to the same research problem."[28]

In summary, a potentially debilitating conflict between DoD and NASA was avoided by setting of a clear goal of landing on the Moon, eliminating much of the rational for competing programs. NASA and DoD, by consciously seeking to work together where possible and not hampering each other's agency-specific space programs, created a "win-win" situation for both agencies. Similarly, NASA sought to co-opt potential opponents of the space program by either making them part of the solution, or by demonstrating how the space program met their organizational needs.

Coalition Building: The Soviet Experience

In contrast to NASA's systematic coalition building, the Soviet program was much more ad hoc. Initially, the Soviet space program started at the intersection of common interests of four constituencies: 1) engineers, driven by the vision of exploring space; 2) the military, desiring new strategic rockets; 3) defense industrialists desiring to build the Soviet military industrial base and 4) the Communist Party, desiring to promote both it and the Soviet Union.[29] The energetic

26 Levine, A. S., & United States. (1982). *Managing NASA in the Apollo era*. Washington, DC: Scientific and Technical Information Branch, National Aeronautics and Space Administration, pg. 236-37

27 Newell, H. E. (2010). Beyond the atmosphere: Early years of space science (pp. 117). Mineola, NY: Dover Publications, pg. 117.

28 Levine, A. S., & United States. (1982). *Managing NASA in the Apollo era*. Washington, DC: Scientific and Technical Information Branch, National Aeronautics and Space Administration, pg. 236.

29 Siddiqi, Asif A. *Challenge to Apollo The Soviet Union and the Space Race, 1945-1974.* Washington, D.C.: National Aeronautics and Space Administration, NASA History Div., Office of Policy and Plans, 2000, pgs. 855

Sergei Korolev exploited this consensus to create the R-7 launch vehicle and launch the Sputnik and Vostok spacecraft. For example, to create the R-7 launch vehicle Korolev leveraged the need of the Communist Party and military for an ICBM with the engineers' need for a space launch vehicle to achieve their dream of space flight. The R-7 rocket met the goals of all the interested parties, so consensus to use it as a space launch vehicle easily achieved.

However, by the late 1950's, the difficulty in achieving the necessary consensus increased. For the Vostok spacecraft, the Soviet military wanted to produce Zenit, a military reconnaissance satellite, while the engineers wanted a manned spacecraft. After the government directed the building of the reconnaissance satellite, Korolev, using personal connections, arranged to have seven words added to the directive authorizing the reconnaissance satellite to also be designed for manned orbital flight.[30] While successful in authorizing the Vostok manned capsule, such stratagems would not work for more complex endeavor such as a lunar program. Such an effort required a consistent, long term national commitment. By the early – to mid-1960's, achieving the required consensus between these disparate groups for such a program was virtually impossible. The Soviet government had already decided that its military, in particular the ICBM program, would take priority over the space program.[31] As the smaller Soviet economy could simply not support a space program at U.S. levels unless it became a higher priority, the Soviet lunar program was doomed to being underfunded.

Even though the Soviets placed a lower priority on their space program, they could have achieved more if they had built a more robust

30 Gerovitch, Slava. "Stalin's Rocket Designers' Leap into Space: The Technical Intelligentsia Faces the Thaw." *Osiris* (2008): doi:10.1086/591874, pg. 202-03.

31 Encyclopedia Astronautica. "Why did the Soviet Union lose the Moon Race?" Accessed September 22, 2014. http://www.astronautix.com/articles/whynrace.htm.

coalition among these interest groups. For example, the dispute between Korolev and Valentin Glushko over the use of cryogenic fuels was a missed opportunity for coalition building. Korolev, designing a rocket to reach the Moon, wanted to use high energy, non-toxic cryogenic fuels for the N-1 lunar rocket. The Ministry of Defense (MoD), concerned with building combat-ready ICBMs wanted to use storable fuels. As the N-1 didn't use storable fuels, the MoD viewed it as a rocket with no valid military purpose, and refused to support the program. Had Korolev supported a modular booster design such as the UR-500 series and utilizing storable fuels, he may have been able to create sufficient political backing to proceed with a lunar version. By failing to seek a common purpose with the military, Korolev's lunar program was starved for resources, and it ultimately failed.

The absence of a common objective also meant that building a consensus for the space program necessitated dangerous inefficiencies. For example, two risky Voskhod missions were flown. The first of these, the Voskhod 1 flight, merely fit three men into the two man Voskhod capsule, saving weight by omitting both spacesuits and escape systems. This mission was either proposed either by Korolev to obtain more resources for the space program or was simply ordered by Khrushchev to upstage the American Gemini flights.[32] Similarly, the dangerous Voskhod 2 spacewalk was simply a risky attempt to upstage Gemini for political purposes. As space historian Asif Siddiqi observed, "for the Soviets, the 'space race' had degenerated into a little more than a circus act of one-upmanship."[33] While these missions were of dubious scientific and engineering

32 Siddiqi, Asif A. *Challenge to Apollo The Soviet Union and the Space Race, 1945-1974.* Washington, D.C.: National Aeronautics and Space Administration, NASA History Div., Office of Policy and Plans, 2000, pgs. 384-86.

33 Siddiqi, Asif A. *Challenge to Apollo The Soviet Union and the Space Race, 1945-1974.* Washington, D.C.: National Aeronautics and Space Administration, NASA History Div., Office of Policy and Plans, 2000, pgs. 385.

value, they were important for generating support for the space program.[34] The absence of a unifying goal that guided the Soviet program resulted in risky activities being taken to merely build the consensus necessary for funding the program.

NASA's successes in the mid-1960's also challenged the Soviet space program by minimizing any political value from merely duplicating previous American successes. What the Communist Party prized was the propaganda value of achieving spaceflight accomplishments ahead of the Americans. Until his ouster in 1964, this appears to have been Khrushchev's view of the program, seeing it primarily as a propaganda tool to enhance Soviet prestige.[35] His successor, Leonid Brezhnev was determined to build up a deterrent ICBM force and opposed taking resources away from this priority.[36] The Gemini missions, by breaking new ground in space exploration, minimized the propaganda value of similar Soviet flights. To the Soviet leadership, this significantly reduced the value of the space program, making them less likely to provide resources in the face of competing military priorities.

By the mid 1960's, NASA had constructed a coalition of support among influential government, industry, and academic leaders and institutions. This alliance ensured that NASA had adequate funding and could better survive temporary setbacks. In contrast, the Soviet program possessed a much smaller cadre of influential supporters, drawn mainly from the engineers who dreamed of spaceflight. After its early successes, this cadre had difficulty in establishing and

34 Siddiqi, Asif A. *Challenge to Apollo The Soviet Union and the Space Race, 1945-1974.* Washington, D.C.: National Aeronautics and Space Administration, NASA History Div., Office of Policy and Plans, 2000, pgs. 857

35 Siddiqi, Asif A. *Challenge to Apollo The Soviet Union and the Space Race, 1945-1974.* Washington, D.C.: National Aeronautics and Space Administration, NASA History Div., Office of Policy and Plans, 2000, pgs. 857

36 NASA. "United States-Soviet Space Cooperation during the Cold War." Accessed September 22, 2014. http://www.nasa.gov/50th/50th_magazine/coldWarCoOp.html.

maintaining a broad coalition in support of its goals. When their chief advocate Korolev prematurely died in 1966, they lost their most effective coalition builder. The tenuous relationships Korolev assembled were unable to effectively withstand the competition for scarce resources, dooming the Soviet efforts in the race to the Moon.

ORGANIZATIONAL STRUCTURE EFFICIENTLY USING EXISTING RESOURCES

Setting the goal of reaching the Moon and establishing a coalition for that purpose was only part of NASA's formula for success. To maintain support for the lunar program, NASA had to show that the program produced concrete results towards meeting its goal. NASA succeeded at this, transforming itself from a small research agency to leading the largest and most complex technological endeavor ever accomplished in human history.

Centralized v. Decentralized Organizations

Paradoxically, the Soviet space program was far less centrally planned and administered when compared to its American counterpart. The Soviet program was decentralized, with different design bureaus advocating their own proposals and competing with each other for work.[37] This decentralization was further exacerbated by the autonomy that the Soviet system gave chief designers, allowing them the right to refuse to be a part of a project.[38] As early as 1959, Korolev recognized this decentralization as a liability to Soviet space efforts, and argued for a major organizational concentration of the program. His proposal was

37 Science News, Articles, and Information – Scientific American. "The Moon Landing through Soviet Eyes: A Q&A with Sergei Khrushchev, son of former premier Nikita Khrushchev – Scientific American." Accessed September 21, 2014. http://www.scientificamerican.com/article/apollo-Moon-khrushchev/.

38 Federation of American Scientists – . "Why the Soviets Never Beat the U.S. to the Moon – INTERVIEW WITH CHARLES P. VICK." Accessed September 22, 2014. http://fas.org/spp/eprint/cp_vick_interview.htm.

ignored by Nikita Khrushchev. Consequentially, the Soviet program used many non-specialized design bureaus working for different ministries to construct space vehicles and facilities, with no single organization with total authority over a project.[39] For example, although 500 organizations in 28 departments produced equipment for the N-1 booster, the Military-Industrial Commission controlled only nine of them.[40] Even the relatively simple Vostok required a total of 123 organizations subordinated to 13 regional economic councils.[41] If any of these subcontractors missed a deadline, it conceivably sidetracked the entire project. Yet the contractors were not answerable to any central authority.[42]

The plethora of competing institutions lacking a single unifying agency produced organizational chaos.[43] Creating unified effort out of this cacophony was made more difficult because the Soviet program lacked a clear national goal to give guidance in negotiating and navigating though the Soviet system. Only relatively simple projects could be effectively steered through this bureaucratic labyrinth. Even these simple projects required program advocates using personal networks to overcome organizational and logistical bottlenecks.[44] Yet, personal connections alone were insufficient, as there were equally connected rivals in the Soviet system. For example, Korolev's rival Vladimir Chelomei hired Khrushchev's son Sergi. This gave Chelomei's rival

39 Federation of American Scientists – . "THE SOVIET MANNED LUNAR PROGRAM." Accessed September 23, 2014. http://fas.org/spp/eprint/lindroos_Moon1.htm

40 Encyclopedia Astronautica. "Why did the Soviet Union lose the Moon Race?" Accessed September 22, 2014. http://www.astronautix.com/articles/whynrace.htm.

41 Gerovitch, Slava. "Stalin's Rocket Designers' Leap into Space: The Technical Intelligentsia Faces the Thaw." *Osiris* (2008): doi:10.1086/591874, pg. 199

42 Gerovitch, Slava. "Stalin's Rocket Designers' Leap into Space: The Technical Intelligentsia Faces the Thaw." *Osiris* (2008): doi:10.1086/591874, pg. 194

43 Siddiqi, Asif A. *Challenge to Apollo The Soviet Union and the Space Race, 1945-1974.* Washington, D.C.: National Aeronautics and Space Administration, NASA History Div., Office of Policy and Plans, 2000, pgs. 857

44 Gerovitch, Slava. "Stalin's Rocket Designers' Leap into Space: The Technical Intelligentsia Faces the Thaw." *Osiris* (2008): doi:10.1086/591874, pg. 192.

UR-500/700 booster program an advantage over the Korolev's N-1 in obtaining necessary political and economic support. Similar political maneuvers were repeated at all levels throughout the Soviet space program, crippling it. As space historian Asif Siddiqi noted "The favor of not even Khrushchev, Brezhnev, or Ustinov, but of a totally forgotten Central Committee agent could determine the prospects for the development of the highly complex [space] sector for years."[45]

The lack of a centralized authority over the space program also resulted in decisions being made on the basis of expediency, rather than effectiveness. For example, the Soviet system made the Korolev/Chelomei controversy worse by arriving at a compromise that authorized both lunar programs, but funded them by simply dividing available resources between them, ensuring that neither proposal was adequately supported.[46] Because Korolev barely had sufficient funds to produce the N-1 booster, he then lacked sufficient resources to build test stands for it. Thus, all N-1 flights were made using a rocket which was never fully static tested, resulting in every N-1 flight failing.[47]

The lack of a centralized organization guided by a national objective also meant that personal rivalries could not be moderated by the larger organization. For example, personal disagreements and rivalries between Korolev and experienced engine designer Valentin Glushko resulted in Glushko's refusal to build engines for the N-1. This in turn forced Korolev to use engines from Nikolai Kuznetsov, an aircraft engine designer who lacked any experience in designing rocket engines. In

45 Siddiqi, Asif A. *Challenge to Apollo The Soviet Union and the Space Race, 1945-1974.* Washington, D.C.: National Aeronautics and Space Administration, NASA History Div., Office of Policy and Plans, 2000, pgs. 857

46 Gerovitch, Slava. "Stalin's Rocket Designers' Leap into Space: The Technical Intelligentsia Faces the Thaw." *Osiris* (2008): doi:10.1086/591874, pg. 195.

47 Gerovitch, Slava. "Stalin's Rocket Designers' Leap into Space: The Technical Intelligentsia Faces the Thaw." *Osiris* (2008): doi:10.1086/591874, pg. 194

essence, the lack of a centralized decision making organization resulted not merely in wasteful duplication of effort, but forced potentially dangerous design decisions driven by personal rivalries.

When compared to the chaos of the Soviet program, the NASA program was a model of organizational efficiency. However, even NASA needed to become more efficient to reach the Moon by 1970. A small agency in the mid-1950's, NASA had no experience in managing as large and complex a program as Apollo.[48] Although the U.S. space program was unified under NASA, within the agency there was significant waste and rivalries between sub-organizations. Created largely from the National Advisory Committee for Aeronautics (NACA), NASA was originally composed of three centers taken from its predecessor NACA: Langley Aeronautical, and the Lewis and Ames Research Centers. When created, NASA also took over the Army Ballistic Missile Agency (renamed the Marshall Space Flight Center). In its early years, a committee-based style relying on achieving consensus between colleagues dominated coordination between these centers. While suitable for smaller projects, this method was unsuitable for large undertakings such as Apollo.[49] The engineers who staffed NACA organization were also inexperienced in managing large projects like the space program. Significant cost overruns resulted. Some portions of the Mercury program cost overruns amounted to 639%, while in the Gemini program cost overruns ran as high as 155% of their budgets.[50] By 1964, these increasing costs attracted the attention of Congress, potentially risking support for the Apollo program.

48 Bilstein, Roger E. *Stages to Saturn: A Technological History of the Apollo/Saturn Launch Vehicles*. Washington: Scientific and Technical Information Branch, National Aeronautics and Space Administration, 1980., pg. 264

49 Johnson, Stephen B. *The Secret of Apollo Systems Management in American and European Space Programs*. Baltimore: Johns Hopkins University Press, 2002, pg. 122-23

50 Johnson, Stephen B. *The Secret of Apollo Systems Management in American and European Space Programs*. Baltimore: Johns Hopkins University Press, 2002, pg. 130.

Not only was NASA's organization fiscally weak, it also was failing to meet the timeline of a lunar landing by the end of the decade. When George Mueller took over as Head of the Office of Manned Spaceflight (OMSF) in 1963, he directed an analysis to determine whether the Apollo program could get to the Moon before the end of the decade and on budget.[51] The analysis concluded that the U.S. would be unable to meet this objective. Mueller realized that the program needed to be restructured to increase efficiency. His analysis indicated that the key to having the Apollo program meet schedule and costs was to increase communications not just between the program offices, but throughout the entire Apollo program. Using management concepts from the USAF, he created a program office structure that emphasized increasing communications organization-wide.[52] A key feature was implementing "GEM boxes" to provide both in depth and in parallel communications between the offices (Figure 1). [53], [54] Rather than individual departments reporting up their program hierarchy, and then to a related program office, the individual departments within a program would report daily to their counterparts in related programs (Figure 2).[55] This effectively created a daily organization-wide "round table," ensuring that issues were quickly aired, discussed and resolved by all involved offices.

To keep Apollo on schedule, Mueller compressed the testing and flight schedule. He terminated the Saturn I program at ten flights and

51 Slotkin, Arthur L. *Doing the Impossible George E. Mueller and the Management of NASA's Human Spaceflight Program*. New York, NY: Springer, 2012. (Kindle Edition). Location 444

52 Slotkin, Arthur L. *Doing the Impossible George E. Mueller and the Management of NASA's Human Spaceflight Program*. New York, NY: Springer, 2012. (Kindle Edition). Location 303

53 Johnson, Stephen B. *The Secret of Apollo Systems Management in American and European Space Programs*. Baltimore: Johns Hopkins University Press, 2002. pg. 134-35

54 Air & Space Magazine. "Interview: George Mueller | A&S Interview | Air & Space Magazine." Accessed October 5, 2014. http://www.airspacemag.com/as-interview/aamps-interview-george-mueller-710844/?no-ist

55 Slotkin, Arthur L. *Doing the Impossible George E. Mueller and the Management of NASA's Human Spaceflight Program*. New York, NY: Springer, 2012. (Kindle Edition). Location 341.

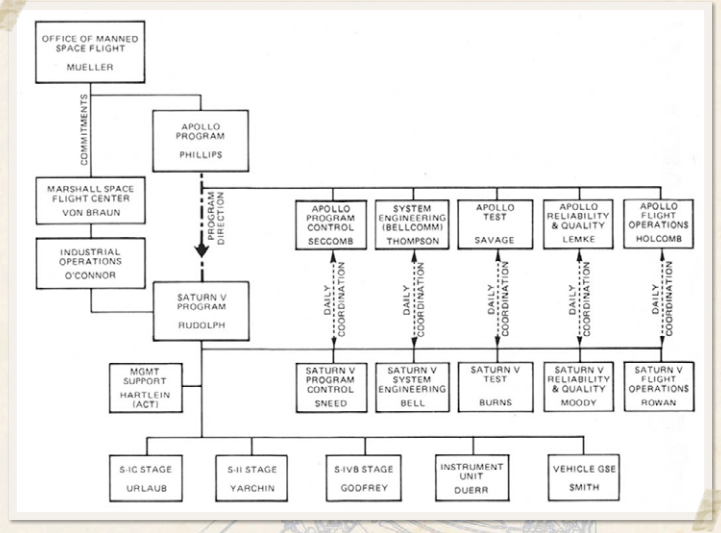


Figure 2. "GEM Boxes[56]

diverted the resources to the Saturn IB and Saturn V programs. More importantly, he instituted the concept "all up" flight testing. In contrast to the more methodical system of flight testing where each stage was tested separately, the "all up" concept flight tested all stages of the Saturn beginning with the initial flight. Unlike the Soviet N-1 program, system reliability was enhanced by using extensive ground testing of the entire booster as well as individual components. This "all up" testing saved significant time and expense by reducing the number of Saturn V/Apollo sets and flights from 20 to 15 and cutting years off the flight schedule. In turn, this progress helped to maintain Congressional and public support for the program throughout the 1960's, enabling the ultimate successful landing on the Moon.

56 Bilstein, Roger E. *Stages to Saturn: A Technological History of the Apollo/Saturn Launch Vehicles*. Washington: Scientific and Technical Information Branch, National Aeronautics and Space Administration, 1980., pg. 272.

Compared to the chaotic Soviet approach, the United States created a unified space program and quickly and aggressively introduced organizational efficiencies to accomplish the lunar landing goal on time and near budget.

CONCLUSION

The Soviet defeat and the American success in reaching the Moon were not due to any single factor. Rather, this result arose out of a combination of interrelated factors. The clearly established goal of landing on the Moon permitted the U.S. to build a coalition of support among organizations with competing interests. This in turn allowed the U.S. to focus its superior economic resources on achieving this objective. This measureable goal also helped NASA to make the internal organizational changes necessary to build the systems it needed on time and within budget.

The Soviet program was more organizationally fragile. Lacking a clear goal, it was both inefficient and relied heavily on individual personalities to drive the program through a bureaucratic labyrinth. A comparison of the American and Soviet system's response to the loss of their respective advocates illustrates the fragility of the Soviet program. In the United States, the assassination of President Kennedy caused minimal adverse effects on the U.S. space program. Built on a sold organizational and political base, the American space program flourished, despite tepid public support and the loss of its most powerful proponent.

The Soviet space program was not based on as firm an institutional and political foundation as the American. Consequentially, the premature death of Sergei Korolev in January 1966 dealt a crippling blow to it. The Soviet system emphasized personal networks in navigating within the system. Lacking a clear goal and deprived of

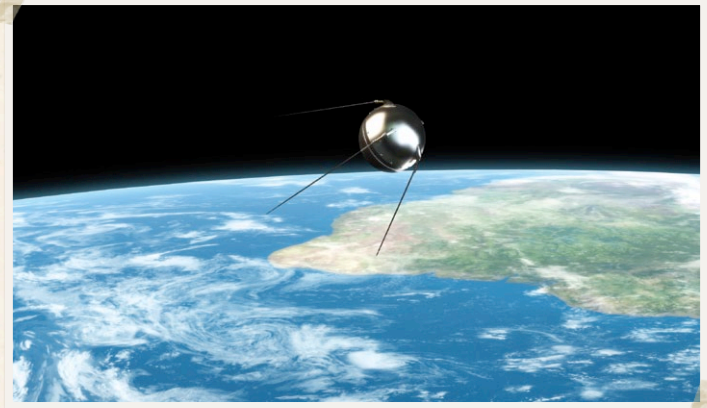
Korolev's inspired vision and drive, the Soviet space program took a serious blow that its weak institutions were unable to compensate for. Korolev had stood as a crucial lynchpin that held the Soviet lunar program together. Although it staggered along for the remainder of the 1960's, the death of Korolev eliminated any chance of the Soviet program rising to the American challenge.

APPENDIX B
Historical Information From The BuzzOpedia

The following section provides some extracts about the most iconic programs, mission configurations and components from the race to the Moon. For more information, please refer to the Buzz-opedia, the in-game feature that provides a wealth of information on all the elements available in SPM and how they relate to their real-life counterparts.

SPUTNIK 1 PROGRAM (FIRST ARTIFICIAL SATELLITE)

Launched in October 1957, Sputnik 1 was the first Earth-orbiting artificial satellite, its successful launch opening the "space age". The Soviet Union did not plan for the relatively unsophisticated Sputnik 1 to be the first Earth-orbiting satellite program. Rather, the much larger and more sophisticated "Object D" (later flown as Sputnik 3) was intended for this role. However, delays in developing "Object D" as well as the lower than expected specific impulse of the R-7 rocket threatened the overarching political goal of orbiting a satellite before the American VANGUARD. To beat the United States into orbit, the Soviet government, urged by Sergei Korolev, directed that his bureau design and fly the smaller and simpler "Basic Sputnik" (Russian: Prosteishy Sputnik)(PS-1) in only eleven months.



VOSTOK 1 MISSION (FIRST MAN IN SPACE)

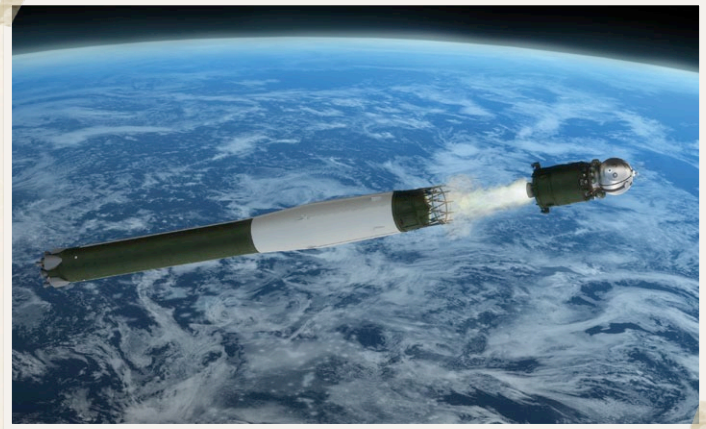
Launched on 12 April 1961, Vostok 1 was the first spacecraft to carry a human, Yuri A. Gagarin, into space. Launched into a 165 kilometers (periapsis) by 315 kilometers (apoapsis) orbit, Vostok 1 flew a single orbit in a 00d: 01h: 48m long flight. Because of concerns regarding the ability of a human to control a spacecraft during prolonged periods of weightlessness, the manual controls on the spacecraft were locked with a six-digit code. However, Gagarin was given the unlock code prior to launch.

The mission was relatively uneventful. The only technical problem was an initial failure of the orbital and equipment modules to fully separate prior to reentry, remaining attached by a bundle of wires. Gyrations during the atmospheric reentry ultimately severed the connection, and the remainder of the reentry was uneventful.

After ejecting safely from his capsule, Gagarin landed 280 kilometers from the planned landing site in Baikonur. Reportedly, the strange and unexpected sight of a man in a spacesuit and parachute landing frightened a nearby farmer and her daughter, leading Gagarin to tell them 'Don't be afraid, I am a Soviet citizen like you, who has

descended from space and I must find a telephone to call Moscow!' With these words, the space age was launched.

The subsequent Vostok 2 flight, launched in August 1961was a 17-orbit, 01d:01h:18m mission that demonstrated a human being could work in space. Based on this, future Vostok missions would begin evaluating the cosmonauts ability to control the capsule. The mission was marred by cosmonaut German Titov's prolonged bout of space sickness, an issue that required further Vostok flights to study.



PROJECT MERCURY (FIRST AMERICAN MANNED PROGRAM)

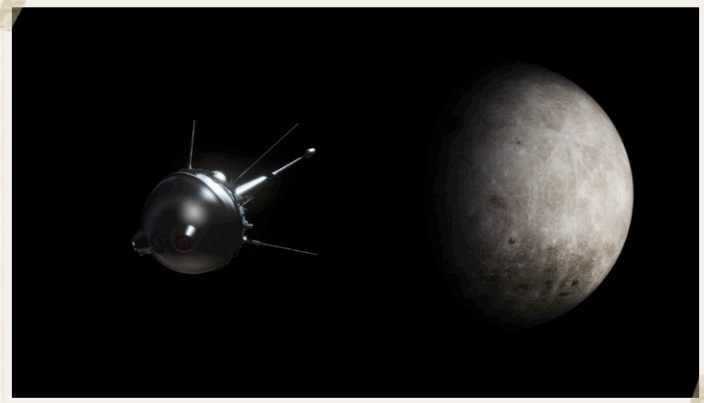
Running from August 1959 to May 1963, Project Mercury's goals were to 1) launch a manned spacecraft into Earth orbit; 2) assess man's performance capabilities and his ability to function in the space environment; and (3) recover the pilot and spacecraft safely. The program consisted of twenty test and evaluation flights and six manned flights, including four manned orbital missions. The experience and knowledge gained in Project Mercury directly impacted not only the

design of the Gemini and Apollo spacecraft, but also the ground control, systems engineering and even the management models used for these subsequent programs.

LUNA 2 MISSION (FIRST LUNAR IMPACTOR)

After launch on 12 September 1959, Luna 2 separated from its third stage, which traveled with it towards the Moon. Enroute, the third stage booster released a cloud of sodium gas for spacecraft tracking and to study the behavior of ionized gas in space. On 14 September 1959, thirty-three hours after launch, Luna 2 and the third stage impacted the moon 30 minutes apart. The Luna 2 mission confirmed that the Moon had no appreciable magnetic field or radiation belts. It also showed variations in the electron flux and energy spectrum in the Van Allen radiation belt.

The earlier Luna 1 mission missed the Moon. However, it discovered the solar wind and showed the Moon lacked a magnetic field.



VOSKHOD 2 MISSION (FIRST SPACEWALK)

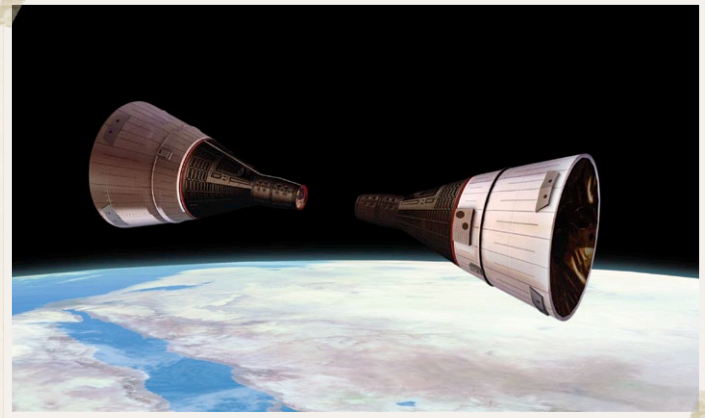
Launched on 18 March 1965 into a 167 kilometers (periapsis) by 475 kilometers (apoapsis) orbit, Voskhod 2 was a 16-orbit, 01d: 02 h: 02m: 17s flight crewed by Pavel Belyayev and Alexey Leonov. Initially, the flight proceeded smoothly. After an uneventful launch, the inflatable airlock deployable normally and Lenov conducted a 12 minute-long EVA, becoming the first man to walk in space. Thereafter, Voskhod 2 had a series of life-threatening malfunctions. Lenov had had difficulty reentering the airlock due to the stiffness of the Berkut spacesuit, and was able to do so only after risking decompression sickness by reducing the spacesuit's pressure to allow him to maneuver into the airlock. Upon reentry, they discovered the hatch would not fully seal. This lead to the environmental system flooding the capsule with pure oxygen, creating a fire hazard. Next, a failure of the automatic orientation system necessitated a manually controlled reentry. During reentry, the service module failed to completely separate from the reentry module, causing violent gyrations during the descent until the wires connecting the two modules burned through. Finally, the capsule landed 386 kilometers

from the intended landing site, forcing the crew to survive in – 30 degree Celsius temperatures for a day before rescue crews could cut through the forest and bring the crew out on skis.

GEMINI 6A AND GEMINI 7 MISSIONS (FIRST RENDEZVOUS IN SPACE)

Launched on 16 March 1966 into a 160 kilometers (periapsis) by 272 kilometers (apoapsis) orbit, Gemini 8 was the first planned docking and EVA mission between the Gemini capsule and the Gemini Agena Target Vehicle (GATV). Planned as a 71-hour mission crewed by Neil Armstrong and David Scott, the objectives of this flight were to perform multiple rendezvous and dockings with the GATV, conduct EVA operations and maneuver the GATV into a parking orbit for use by subsequent Gemini flights. The first docking with the GATV was successful, achieving the first docking of a manned spacecraft. However, an electrical short in the capsule Orbital Attitude and Maneuvering (OAMS) system left a thruster open, rolling the spacecraft and requiring Gemini 8 to undock. Without the Agena's mass, the still-open thruster rapidly increased Gemini's roll rate to a revolution per

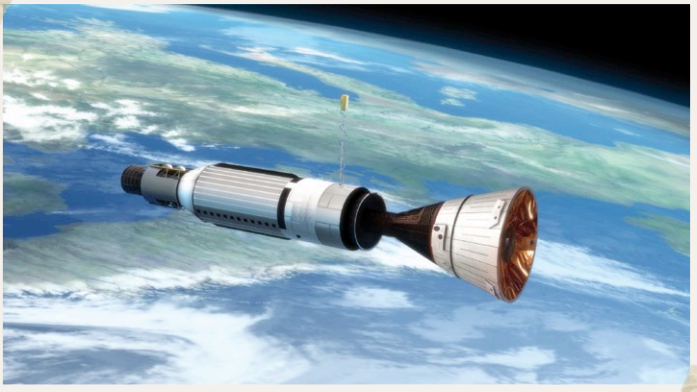
second, creating centrifugal forces that could potentially incapacitate the crew. Stability was restored only after Armstrong shut down the OAMS and used the reentry control system (RCS) to stabilize the capsule. Safety rules mandated that the use of the RCS required an early return, necessitating a landing to a secondary landing area in the Pacific after only seven orbits instead of the planned 45-orbit flight ending with an Atlantic splashdown. Despite the sudden change in flight plan, USAF pararescuers and the U.S.S. Leonard F. Mason (DD-852) rapidly deployed to the landing site and safely recovered the crew and capsule after a flight of 00d:10h:41m:26s. However, the shortened mission meant that neither the EVA nor any of the secondary objectives were achieved.



GEMINI 8 MISSION (FIRST DOCKING IN SPACE)

Launched on 16 March 1966 into a 160 kilometers (periapsis) by 272 kilometers (apoapsis) orbit, Gemini 8 was the first planned docking and EVA mission between the Gemini capsule and the Gemini Agena Target Vehicle (GATV). Planned as a 71-hour mission crewed by Neil Armstrong and David Scott, the objectives of this flight were to perform multiple

rendezvous and dockings with the GATV, conduct EVA operations and maneuver the GATV into a parking orbit for use by subsequent Gemini flights. The first docking with the GATV was successful, achieving the first docking of a manned spacecraft. However, an electrical short in the capsule Orbital Attitude and Maneuvering (OAMS) system left a thruster open, rolling the spacecraft and requiring Gemini 8 to undock. Without the Agena's mass, the still-open thruster rapidly increased Gemini's roll rate to a revolution per second, creating centrifugal forces that could potentially incapacitate the crew. Stability was restored only after Armstrong shut down the OAMS and used the reentry control system (RCS) to stabilize the capsule. Safety rules mandated that the use of the RCS required an early return, necessitating a landing to a secondary landing area in the Pacific after only seven orbits instead of the planned 45-orbit flight ending with an Atlantic splashdown. Despite the sudden change in flight plan, USAF pararescuers and the U.S.S. Leonard F. Mason (DD-852) rapidly deployed to the landing site and safely recovered the crew and capsule after a flight of 00d:10h:41m:26s. However, the shortened mission meant that neither the EVA nor any of the secondary objectives were achieved.



SATURN V BOOSTER (AMERICAN MOON ROCKET)

The Saturn V consisted of three stages. The S-IC first stage was powered by five F-1 engines arranged with one fixed F-1 engine mounted in the center, and surrounded by four gimbaled F-1 engines on the periphery (termed a "Quincunx" pattern). Each F-1 engine was fueled by RP-1 and liquid oxygen and generated 911.9 kN of thrust, for a total first stage thrust of 34,020 kN. For comparative purposes, this is a power output greater than 85 Hoover Dams.

The S-II second stage was powered by five J-2 engines arranged in a Quincunx pattern, with a fixed J-2 engine mounted in the center, surrounded four gimbaled J-2 engines on the periphery. Each J-2 engine was fueled by liquid hydrogen and oxygen and generated 1,001 kN of thrust, for a total second stage thrust of 4,400 kN.

The S-IVB-500 third stage was powered by a single gimbal-mounted J-2 engine fueled by liquid hydrogen and oxygen that generated 1,001 kN of thrust. Unlike the J-2 used in the Saturn IB, this J-2 could be restarted one time, allowing it to make a trans-lunar burn. Two Auxiliary Propulsion Systems (APS) modules mounted on the S-IV

provided roll control during the flight phase and three-axis control during coast phase. These also provided ullage services to give the J-2 engine a restart capability.

Between the third stage and the payload was a ring-like "Instrument Unit" section. This section contained guidance, monitoring, control, telemetry and communications systems used by the Saturn V launch vehicle before and during flight.

N1 ROCKET (SOVIET MOON ROCKET)

First launched in February 1969, the basic N1 booster was a conical-shaped, three stage, 105 meter long, 17 meter diameter missile with a launch weight of 2,750,000 kilograms, capable of lifting 95 tons to Low Earth Orbit. The unusual conical shape of the N1 was determined by the decision to use spherical fuel tanks in the stages. This decision gave the N1 greater structural strength.

The first stage of the N1 was powered by thirty NK-15 engines positioned in two rings, each NK-15 engine delivering 1,544 kN of thrust, for a total of 49,420 kN at liftoff. The second stage of the N1 used eight NK-15V engines each providing 1,648 kN of thrust. The NK-15V engine was a slightly modified NK-15 optimized for high altitude flight. The third stage, which was designed for the Trans-Lunar Insertion used four NK-21 engines. All of the N1 engines were fueled by RP-1 with Liquid Oxygen (LOX) as an oxidizer, and originally were intended to be cooled to maximize fuel capacity. Pitch and roll control was provided by throttling the engine thrust, although the inner ring of six NK-15s were gimbaled to provide yaw control. Four lattice fins also provide aerodynamic control. The complex fuel system needed to feed the thirty NK-15 engines ultimately proved to be its weak spot, and resulted in the loss of all the N1 missiles tested.

APOLLO 8 MISSION (FIRST LUNAR ORBITAL FLIGHT)

Launched on 21 December 1968 and crewed by Frank Borman, James Lovell, Jr., and William Anders, the objectives of the Apollo 8 mission was to demonstrate the Saturn V and Apollo command and service module performance in a cislunar and lunar space, to evaluate crew performance in a lunar-orbit mission, demonstrate communications and tracking at lunar distances, and to return high-resolution photography of proposed Apollo landing areas. Originally scheduled to test the Lunar Module (LM) in low Earth orbit, delays in the LM program, and the Zond 5 and 6 missions showing the Soviets were preparing for a lunar mission led to a potentially risky decision to switch the Apollo 8 mission to become the first manned spacecraft to orbit the Moon.

Initially inserted into a 191 kilometer (periapsis) by 183 kilometer (apoapsis) parking orbit, a third-stage burn injected the CSM into trans-lunar trajectory. An orbit insertion on 24 December put the spacecraft into an elliptical 311 km by 111 km lunar orbit, and a subsequent circularization burn put the CSM into 110 km by 112 km orbit. The Trans-Earth Injection (TEI) burn that took place on

25 December was so accurate that only one of the three planned midcourse corrections were needed. Apollo 8 conducted a successful reentry on 27 December 1968, after a mission of 6 days 3h:00m:43s.

The Apollo 8 mission was nearly flawless, demonstrating that mankind achieved the scientific and engineering capabilities to reach the Moon and boosting American morale after the tumultuous year of 1968. However, perhaps that biggest accomplishment of the mission was the way it both changed and affirmed mankind's perspective on his place in the universe. Orbiting the Moon on Christmas Eve, farther from Earth than any human in history, William Anders took the iconic "Earthrise" photograph, showing Earth, like a fragile blue marble with the desolate lunar surface in the foreground amid the blackness of space. He later commented "We came all this way to explore the Moon, and the most important thing is that we discovered the Earth". Later that day, a billion people watched a televised broadcast by the Apollo crew from lunar orbit, where the crew read the biblical creation account from Genesis. The Earthrise image, coupled with creation story combined to give humanity an image of the fragility and the uniqueness of the Earth in the cosmos that endures to this day.

APPENDIX C
An Interview With Buzz Aldrin

In this section, Buzz answers questions asked by members of the community and gives us some insight into his experiences as a NASA astronaut, the Apollo 11 mission and the future of spaceflight.

Leif

How confident were you when you participated to the Apollo 11 mission? Did you feel that everything was sure to come together or was it to some extent a huge gamble? Did you really feel ready to go to the Moon when you took place in the rocket?

BUZZ

Neil and I had both been on the backup crew for Apollo 8 and we'd worked together very smoothly and the selection of Mike Collins to round out the crew since he was essentially the communicator for Apollo 8 worked out well. The capability possessed by Neil Armstrong added great confidence as long as deviations were closely monitored by Mission Control and myself. We were in a simulator about a month before the mission and confidentially asked if we could use another month's training or stick to July 16. As a crew we talked about it and decided we were ready to go as scheduled. Afterward the reason of the question was asked was because of the very recent intelligence indicating an immense disastrous explosion of the Soviet N1 rocket.

Before the mission we informally reached a conclusion that successful landing was probably 60% doable but with aborts and other considerations we felt that 95% chance of return was acceptable and unquestionably worth the participation.

bardosy

Did you realize the distance from your love ones? And if did what did you feel about it? Was it shocking? Or the stress and the business press everything else?

BUZZ

This challenge was really unquestionably the best opportunity in my entire life. In combat the thoughts of being shot down and being POW for years was accepted without question and any risks in Apollo despite the loss of a crew, including my close friend Ed White. I felt my family quite equal to the task of accepting the risk and loss of life on top of my mother's taking her life the year before Apollo 11 and a loss of two of my cousins in airplane crashes was accepted as life's pitfalls. However I did bring pictures of my 3 kids along with me to the moon so in a way I had them with me.

Cody P AKA EMP

What do you think about video games being used not only as a tool to simulate space travel and life on space but also teach about space? Do you think it has a lot of potential? If so do you think it's met that potential thus far? Where do you see space travel/ life on space related video games going in the future?

BUZZ

Obviously the popularity of video games would be incomplete without attempts to project spaceflight experiences. Mostly these are done with unrealistic yet challenging hostilities, sensation producing and shoot em down type scenarios. It's a distant challenge to project the overwhelming reality of influences to be made in developing the reality of spaceflight preparations and executions. But the result is more than worth the attempts to separate fact from fiction. In fact

simulators were extremely useful in challenging the crew to deal with the reality, as well as prepared us for challenges of solving plausible failures. Rarely however did simulation ever cover the many actual incidents the crews later faced in flight.

jjknap

Had the Apollo program continued, would you have liked to fly on a second mission to the Moon, or did you decide ahead of time that Apollo 11 would be your one and only flight there? If NASA had gone on to Mars, would you have considered staying with NASA?

BUZZ

Realistically the only Apollo 11 crew member that stood to gain by remaining in crew selection was Mike Collins, who in retrospect could have probably have been the commander of the last flight, Apollo 17. I personally wanted to return to my military service in the air force hoping to ease my way back into recovering from 11 years of absence by the well staffed position of commandant of cadets at the Air Force Academy where I had served previously as aide to the dean of Faculty.

I think at that time I understood the complexities and extensive delays that would follow to schedule anything as ambitious as a human Mars mission. So I likely would have done the same thing and I feel my choice was appropriate despite bot being fulfilled since I was appointed as the commandant of the test pilot school rather than the air force academy.

3enrique

What advice(s) would you give to a 16 year old who wants to be an Aeronautical Engineer?

BUZZ

Try and find the most challenging impediments to expansion of aerospace capabilities and see if the depth of investigation deserves an encompassing commitment. Be ready to always change direction when common sense dictates otherwise.

Kase

What progress, in the field of space exploration, do you think we will make in the next 10 years?

BUZZ

I hope to strongly influence through continuous public reminders of US steps to leadership that would lead to a serious national and international commitment to an historic space achievement such as a 2 decade commitment to US lead international permanence on Mars.

VK7

What was your strongest feeling when you first landed on the Moon ? The joy of being on the Moon or the fear of never come back to Earth ?

BUZZ

The all encompassing jubilation of actually touching down and executing engine stop committed us to our next challenge of successful brief personally exploration of the lunar surface. We were committed to significant stay time on the moon. Returning to earth a relative simple execution of abort procedures so we were never afraid we weren't coming back. It never entered our minds.

action.girl
What do you think your life would have been like if you never walked on the moon?

BUZZ
A vast feeling of unfulfilment followed by a continual wondering how I could handle the complexity of what would come next.

shade_hancox
With the two super powers deeply in competition for the space race, how was the personal pressure placed on you and the need for success of this mission to land on the moon?

BUZZ
We were rather completely oblivious to any details of Soviet progress challenging our efforts. Clearly attention to the tasks outlined before us was all encompassing. We were focused on achieving success for a sufficient tall order.

Andrew P (Drewpan)
My question to you concerns the method of the Space Race. As someone who was there, what is your opinion of using Rocket technology to go to space, when at the time and during the race there were many other very promising technologies available at various stages of development. Did technologies like the X-15, linear and annular aerospikes, Ramjets and lifting bodies like Dynasoar actually have a chance if they were developed or was it just a case of "We have all of these German Rocket Scientists so lets use them." History says that NASA got a bum wrap with budgeting towards the end of the Race to the moon. Do you think that if these other technologies were developed sooner the race would have been different and if so, how?

BUZZ

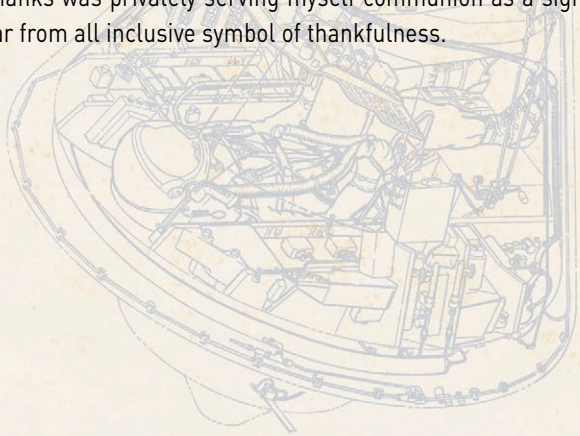
As a matter of fact the contributions of the German Rocketry experts was essential to success however, in retrospect, the decisions following my now role model, John Houbolt, to pursue lunar orbit rendezvous which enabled a single Saturn V to quite safely enable a successful landing attempt was the right decision.

Kalesin

I know that in some long missions you carried books to read, which book or books you read in your mission of Apollo 11.

BUZZ

Due to weight restrictions I couldn't carry any books or the whole bible but I had jotted down a psalm to be read as I asked the world to pause for a moment and give thanks in their own way for the recent successful moments in their own lives. My personal chosen symbol of thanks was privately serving myself communion as a significant but far from all inclusive symbol of thankfulness.



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