Bricks in Space

Volume I: The Race to Space

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Cover Image: The Redstone Mercury Rocket which took the US first astronaut John Glenn to space in 1961, pictured in the “rocket garden” of the John F. Kennedy Space Center’s Visitor Center, 2012.

Quote on p. 13: "It was like being Thor, playing with thunderbolts." by unknown Navy Commander in November 1942 after a successful test of Goddards throttleable JATO rocket engine on a sea plane. Quoted in: Goddard, Esther C., and G. Edward Pendray, eds. (1970). The Papers of Robert H. Goddard, 3 vols.,. New York: McGraw-Hill Book Co. p. 395.

Bricks in Space

Modelling Spaceflight with Lego

Volume I: The Race to Space

Edited by Wolfram Broszies

Second Edition, February 2019

To my children

Contents

Acknowledgements

In the summer of 2017, browsing while inspired by the news about successful launches and landings of Space X' Falcon 9, I discovered the most beautiful Lego model I had seen since the classic space cruiser: A Saturn V rocket, realistically scaled at 1:110, and its production had just been approved after a kickstarter-like campaign on lego-ideas.com. For the first time in my life, I bought a Lego model for myself, not as a present. My kids and I spent some happy hours assembling it, and even more time telling and re-telling the story of mankinds flight to the moon, and the adventures of Apollo 13, and all of NASAs often so glorious history.

I wanted more of that, and to my delight I discovered building instructions for a Skylab space station at the same scale as the Saturn V. Soon Excel sheets were created, Lego boxes plundered and weird pieces ordered from exotic places. Skylab was soon joined by an exotic pantheon of classical-named rockets: Juno and Jupiter and Mercury. The monstrous Nasa Crawler is not yet finished, but for future reference and for my kids, I decided to collect the treasures available in one place.

Most of the models presented in this and the following volumes were designed and built not by me, but by users on lego-ideas.com and other platforms. Creating instructions from builds is a laborious task, so for the most of this book I relied on instructions kindly provided by others. Having these instructions did not only prove useful in building the models, it also helped immensely in learning a lot of new construction techniques, things I hadn't thought about in thirty years, and coming up with unique solutions for problems I would haven't even dared tackling on my own.

Thanks first and foremost to Grant Passmore aka eiffleman for his designs of the rocket garden, launch complex 5 and many other models depicted in this book. His designs and construction methods have been inspiring to me, and his encouraging and helpful comments are one of the reasons the whole idea of modelling NASA's space race with Legos took off.

A big deal of gratitude is also deserved for Benjamin Unis who modelled some of the earliest US rockets, the Vanguard and Scout X-1, as well as to Mark Balderrama who created the model of the V2.

This book rests heavily on countless editors of Wikipedia, whose articles on the individual rockets and spaceships provided the base of most of the model descriptions and the historical background. I hope I did not violate the spirit of Wikipedia by copying parts of their texts into this book. Whatever is well written and concise in these chapters is theirs – the complicated and convoluted sentences are mine.

I will be forever grateful to Mark Wades astronatix.com which provided an inexhaustible source of information on even the most exotic rocket model variants. Any error contained in this work are clearly mine, probably based on a wrong reading on Mark's excellent encyclopedia.

Last but not least I my deepest respect and gratitude to the women and men of NASA for their work, as well for their extensive documentation .Nearly all of the images and graphics in this book were made by NASA, and it would have been a dull undertaking without the rich and beautiful pictures taken. If this book can convey only a fraction of the inspiration their work has been to me, I would be honored.

Finally, this book would not have happened without the love, support and help of my family. My kids curiosity and questions as well their help in assembling models were a driving force to get this book done. Without the patience and writing skills of my wife, who did the proofreading and shaped this collection of various historical reminiscences into a coherent narration, it would be a much lesser work.

Berlin, November 2018

Preface

"It was like being Thor, playing with thunderbolts."

Unknown Navy Commander in November 1942 after a successful test of Goddards throttleable JATO rocket engine on a sea plane. Quoted in: Goddard, Esther C., and G. Edward Pendray, eds. Papers of Robert H. Goddard, New York, 1970

Rockets were invented over a thousand years ago by stuffing bamboo sticks with gunpowder and throwing them into fire at festivities. Quickly, however, they became weapons, by strapping the bamboo sticks to arrows. The first documented use of rockets in war was in 1232, when the Chinese Army used “fire arrows” to frighten the horses of an invading Mongol Army at the battle of Kai-Keng. While successfully disabling the Mongol’s most potent arm, the cavalry, rockets were not enough to stop the Mongol invasion. The new rulers of China were masters at adapting weapons and institutions to their own use, and incorporated rockets in their armies. The Mongol conquests, overrunning Asia and half of Europe in the 1240s, spread the knowledge of

A Chinese soldier launches a „Fire Arrow“

rockets and gunpowder to Europe, India and Arabia.

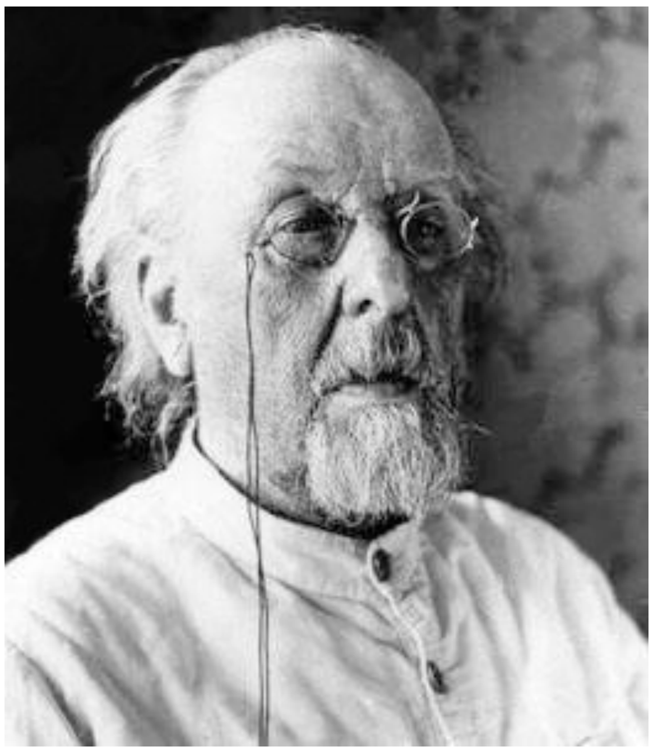
Guns and artillery provided a simpler and more effective way of fighting, so rockets stayed mostly at the fringes of war, being used for signaling.

During the end of the 18th century and early into the 19th, rockets experienced a brief revival. The success of Indian rocket barrages against the British in 1792 and again in 1799 caught the interest of an artillery expert, Colonel William Congreve. Congreve set out to design rockets for use by the British military. The Congreve rockets were highly successful in battle. Used by British ships to pound Fort McHenry in the War of 1812, they inspired Francis Scott Key to write "the rockets' red glare," words in his poem that later became The Star-Spangled Banner.

The introduction of breech-loading artillery and explosive shells in the 1850ies relegated rockets back to the status of auxiliary – or as an entertainment for crowds who loved fireworks at celebrations.

As the 19th century progressed, the fruits of reforms and industrial revolution enabled young brilliant people to pursue their ideas of a better future. Konstantin Tsiolkovsky was one of them: Inspired by the novels of Jules Verne, he devoted his life to the study of space physics. Amongst his 400 publications roughly a quarter are devoted to space travel and related subjects. Among his works are designs for rockets with steering thrusters, multistage boosters, space stations, airlocks for exiting a spaceship into the vacuum of space, and closed-cycle biological systems to provide food and oxygen for space colonies, and they lastingly inspired generations of space engineers.

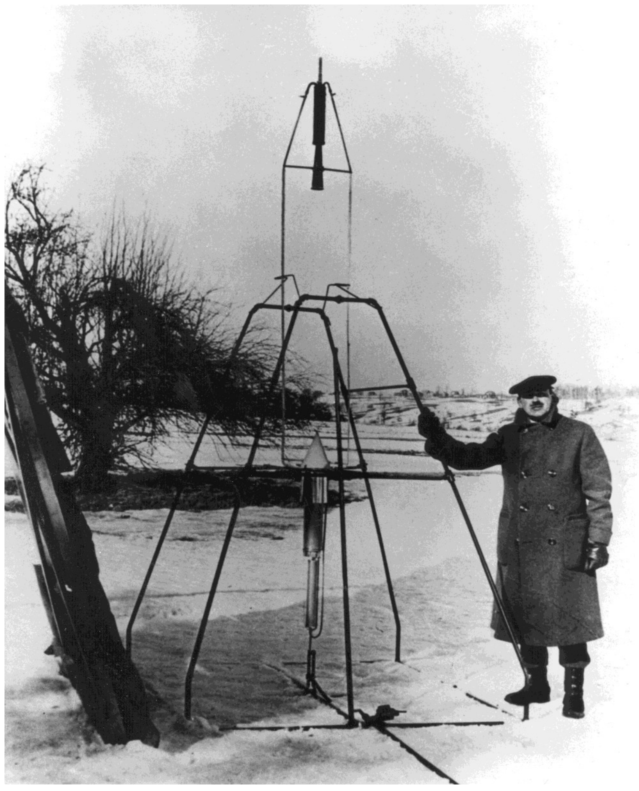
Tsiolkovsky never even launched a firecracker, for all we know. Other, more practical minds started to test his ideas for practical application. For decades, however, rockets remained an esoteric field, belittled by the public and disdained by the scientific community.



Konstantin Tsiolkovsky , the father of modern spaceflight

In the US, Robert H. Goddard conducted practical experiments in rocketry. He had become interested in a way of achieving higher altitudes than were possible for lighter-than-air balloons. Goddard published a pamphlet in 1919 entitled A Method of Reaching Extreme Altitudes. It was a mathematical analysis of what is today called the meteorological sounding rocket. Goddards work was met in the papers with such ridicule that he refused to share any of his research with outsiders except for a chosen few, experimenting in solitude instead.

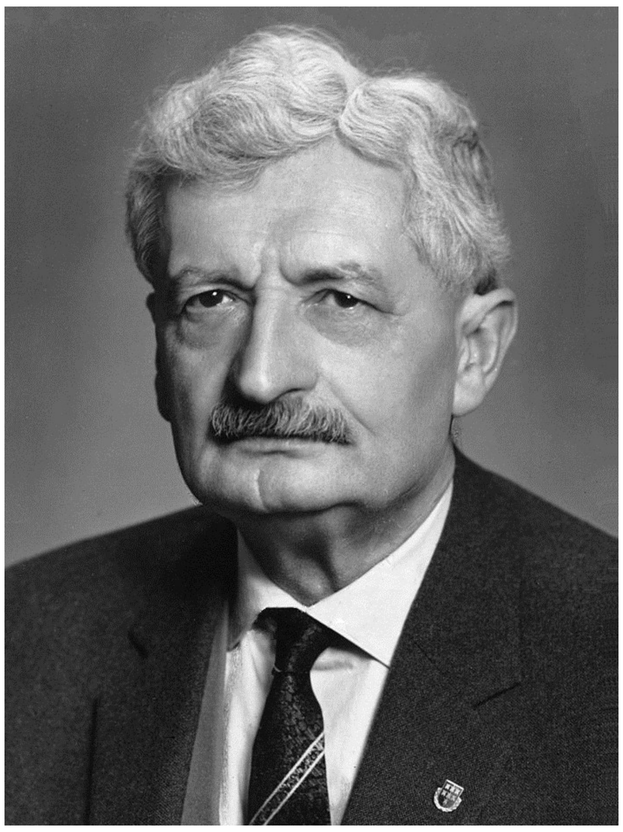
While working on solid-propellant rockets, Goddard became convinced that a rocket could be propelled better by liquid fuel. No one had ever built a successful liquid-



Dr. Robert H. Goddard and a liquid oxygen-gasoline rocket at Auburn, Massachusetts. On 8 March 1926.
Credit: NASA

propellant rocket before. It was a much more difficult task than building solid- propellant rockets. Fuel and oxygen tanks, turbines, and combustion chambers would be needed. In spite of the difficulties, Goddard achieved the first successful flight with a liquid- propellant rocket on March 16, 1926. Fueled by liquid oxygen and gasoline, the rocket flew for only two and a half seconds, climbed 12.5 meters, and landed 56 meters away in a cabbage patch. By today's standards, the flight was unimpressive, but like the first powered airplane flight by the Wright brothers in 1903, Goddard's gasoline rocket was the forerunner of a whole new era in rocket flight.

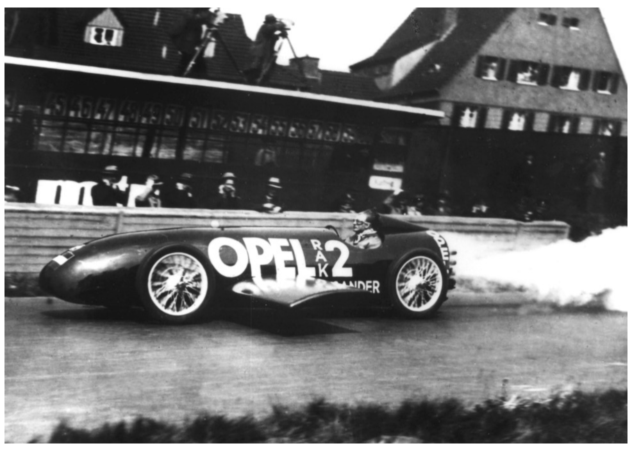
In Germany, Hermann Oberths dissertation about practical challenges of building rockets was rejected However, his



Herman Oberth (25 June 1894 – 28 December 1989)

book “Die Rakete zu den Planetenräumen” ("The Rocket into Planetary Space") .published in 1923 became an inspiration to various groups and researchers around the world, who continued scientific experiments despite the public skepticism. The experiments of the “Verein für Raumschiffahrt” were seen as little more than public stunts for its youthful face, industrial heir Fritz von Opel, yet they resulted in significant technological advances.

The Verein ultimatedly dissolved in 1934 in a row about the question if to take funds from the German Army. Most members declined, but one of Oberth’s students, a promising engineer named Wernher von Braun, accepted. Once more, rockets were to be employed in war. This time, the result would carry humanity to space.



Fritz von Opel in RAK 2 on the AVUS track in Berlin, May 23, 1928.
Credit: OPEL

The German Army developed the A4, the worlds first guided ballistic missile, spending a significant part of Nazi Germanys war research budget in the process. The A4 came late to the war and failed to change its outcome, but it represented a leap in technology that was immediately interesting to the Allied victors. Both the US and USSR immediately started to create their own rocket programs. Other nations followed suit.

This volume covers the US space program from its beginnings in 1945 to the first astronaut launches. NASA remains the best funded, most successful and most ambitious human effort to explore the solar system and expand our knowledge of the universe. In the past seventy years, it has significantly contributed to many fields of science. From Mathematics to Information Sciences to Engineering, Geology, Earth Sciences and, of course Astronomy and Cosmology, numerous faculties and an uncountable number of scientists have all profited, and contributed in turn, to the space program. Data gathered by satellites and probes provided us with us a much better understanding not only of other planets, but first and foremost of Earth, its history and its future. Precise weather forecasts, discovery of ore deposits and other natural resources, environmental and pollution monitoring profited significantly from space. Material sciences have found new ways to manufacture everyday products better, cheaper and friendlier to the environment.

The space programs of both USA and USSR are rooted in a terrible war. They were and remain intertwined with geopolitical questions of influence and prestige. Most rockets were first developed as weapons, designed to carry nuclear bombs deep into enemy territory and threaten his civilian population with nuclear fire and destruction. This does not take away anything from the scientific knowledge gained for the benefit of all. For in its sum, the US space program was always more than a military effort, reflecting a dedication to science and exploration, and as such marks, too, a milestone of human civilization.

Since space exploration always was conducted for political gain, the public always took exceptional interest in the exploits of astronauts and kosmonauts alike. Men like Yuri Gagarin and Buzz Aldrin became famous and were celebrated like rock stars. Space became an inspiration for design, architecture and fashion. Rocket models decorated most kids rooms. In fact, this book owes its very existence due to the continuous fascination of children and men all over the world with space.

Restored A4 rocket in the Smithsdonian Museum, 18 February 2004.
Credit: Wikipedia/Falkue

In the earliest days of space exploration, most calculations for early space missions were done by “human computers,” and most of these computers were women. These women's calculations helped the U.S. launch its first satellite, Explorer 1. This image from 1953, five years before the launch of Explorer 1, shows some of those women on the campus of the Jet Propulsion Laboratory (JPL).
Credit: NASA

The space programs of both nations were created in a time when traditional gender roles were being reaffirmed after two wars that had given women the vote in nearly all democracies and increased their economic and political power. While women worked in engineering and computing, the lead positions were universally occupied by men. The USSR was the first one to field female *kosmonauts* under the flag of equality. However, when Valentina Tereshkova launched atop of *Vostok* 6 on June 16th, 1963 to become the worlds first women in space, it was as more of a political stunt than a reflection of equal standing. It took another 19 years for the USSR to send another female *kosmonaut* to space. On the other side of the wall, Nasa

Jeanette Scissum joined NASA’s Marshall Space Flight Center in 1964 after earning bachelor's and master's degrees in mathematics from Alabama A&M University. Scissum published a NASA report in 1967, “Survey of Solar Cycle Prediction Models,” which put forward techniques for improved forecasting of the sunspot cycle.

Credit: NASA/MSFC

was carefully making sure women were excluded from all important roles. Under the—privately funded—FLAT program conducted by Dr. Randy Lovelace twenty-five women trained in the fifties to become female astronauts, only to be stymied by “political pressure and internal opposition” (in the words of today’s NASA). The USA in the Cold War era reverted to socially conservative positions, and men reasserted their dominance in all prestigious positions. The liberation movements of the Sixties bypassed NASA, which simply wasn’t seen as a target worthy of engagement, but criticized in general as an instrument of technology and war. However, the changing attitudes did not leave NASA untouched, even if only at a snail’s pace. On June 18th, 1983 Sally Ride boarded STS-7 to finally become the first female NASA astronaut.

Margaret Hamilton stands next to a stack of Apollo Guidance Computer source code., 1969

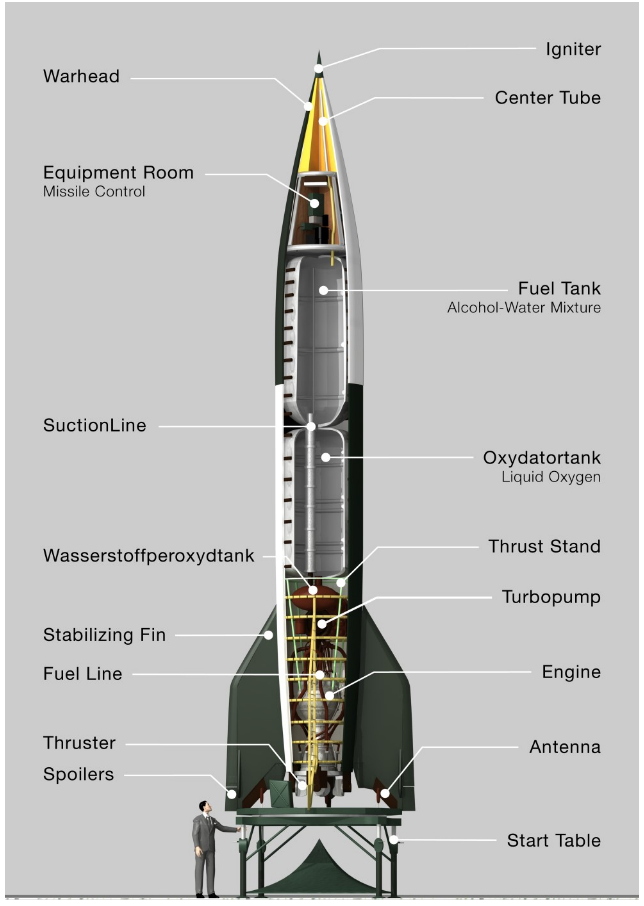
Credits: Courtesy MIT Museum

As the middle class retreats across the world and society returns to more ancient ways, rockets have become a toy – or a business opportunity – for the rich. The only technology enabling us to leave our cradle increasingly is in the hands of individuals unbound by concerns about the fate of their fellow men. The hope for benevolence replaces control by a society that deems any restrictions to the individual as a limitation of freedom itself. This book is also written in the hope that we will remember that the biggest challenges – in technology, in war, and in building LEGO - were always overcome by the many, not the few.

A4

The *Aggregat* 4, short A4, was the world's first long-range guided ballistic missile. Developed as a delivery vehicle for roughly a ton of explosives after the Luftwaffe had lost control of the skies to the Allied air forces, the A4 embodies a significant technological advance. Its development cost at least $ 2 billion in 1944 dollars and represented a significant part of the German research effort during the war. Unlike the Atomic bomb, it never turned out to be a war-changing weapon, but instead turned out to be an enormous waste of resources—and the ancestor of all modern rockets.

In 1932 a veteran named Walter Dornberger returned to the German army after finishing an engineer degree. The German Army, anxious to free itself from the restrictive Versailles Treaty, tasked him with the research and development into solid rockets as a replacement for the prohibited heavy artillery. Dornberger approached the Verein für Raumschiffahrt ("Club for Space Travel"), and successfully recruited Wernher von Braun. With funds now available, von Braun was able to increase the thrust of the nascent rocket engines fivefold: His A2, launched in December 1934 to a height of 2 km, had 300kg of thrust. However, many obstacles lay ahead in the attempts to scale the rockets to a size where they could carry significant payload.



Schematic of the A4 rocket

One of them was –despite the achievements - the required thrust, which had to be increased by magnitudes to reach the 25 tons necessary to lift the A4 off the pad. While a workable rocket engine of 1,5 tons thrust was developed by 1938, all attempts of scaling this further up failed. Von Brauns solution was to cluster 18 of the engines around a common "combustion chamber", a complicated construction that, despite only being intended for tests, had to be rolled out into production later.

Similar problems were encountered in getting the A4 ready to fly, since there was no theory and no models for supersonic flights available. Substituting trial and error for knowledge, the shape of the A4 developed through a long series of grueling tests in windtunnels, air drops and test launches, which lead to hundreds of changes, even while production was already ramping up. The delays were not for the lack of resources. Dornberger had successfully lobbied the head of the German Army, Werner von Fritsch.

Detail of the A4's rocket engine showing the multitude of injection chambers and double wall construction.
Credit: Wikimedia Commons/Skipweasel, 2018

Already in 1936 the Army acquired third of the island of Usedom, and from 1937 to 1942 nearly half a billion Reichsmark went into the construction of testbeds, factories, storage halls and barracks of the new "Heeresversuchsanstalt Peenemünde".

After four years of work, on October 3rd 1942, the A4 successfully launched to a height of 84km. Further tests in 1944 crossed into space and reached 174km. Space, however, was not the target. Giant Factory halls and barracks quickly sprung up around the testing grounds, and more factories raised in the Reich. von Braun enlisted slave workers from Germany's concentration camps to produce the first operational ballistic missile under horrific circumstances of hunger and violence. More than 12.000 of them perished before the wars end.

The A4, termed "Vergeltungswaffe 2", short V2 by Nazi propaganda, was fired from concrete emplacements and, later, mobile launch platforms. Targets included London, the ports of southern England and the Netherlands. Of the nearly 7.200 built, roughly half was actually launched against the Western Allies. Since targeting and guidance were infant technologies, rockets were usually aimed at large cities, which in turn meant most victims of the rocket bombardment were civilians. In total, an estimated 8.000 civilians and soldiers died from A4-bombardments.

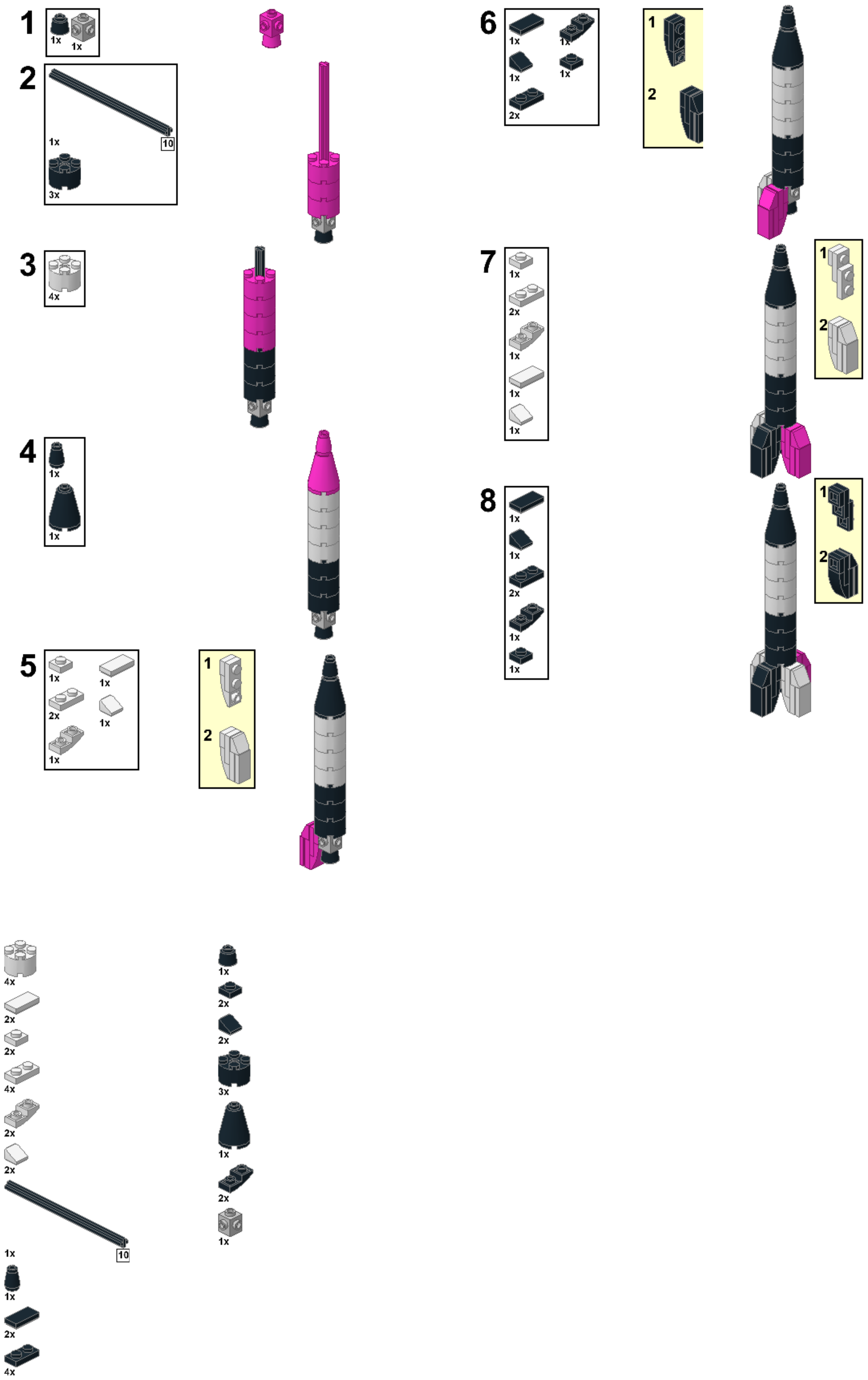
Destroyed houses after an A4 hit Amsterdam, March 1945.
Credit: S.C. van Vleuten. Collection: R. van Vleuten

Overleaf: Replica of an A4 rocket in Peenemünde, Germany,
Credit: Wikimedia Commmons/AElfwine

Datasheet A4

General	
Name	Aggregat 4
Function	Ballistic Missle
Manufacturer	Mittelwerk GmbH
Country of origin	Germany
Cost per Launch	100,000 RM January 1944, 50,000 RM March 194
Family	
Size	
Height	14m (45ft 11 in)
Diameter	1,65m (5ft 5 in)
Width	3,56m (11ft 8in)
Mass	12,805 kg (28,230 lb)
Stages	1
Capacity	
Payload suborbital	1000 kg with 320km range
Payload to LEO	.
Payload to GEO	.
Payload to TLI	.
Payload to escape	-
Launch history	
Status	Retired
Launch sites	Mobile launcher
Total launches	~ 3.200
Successes	~ 2700
Failures	~200
Partial failures	~1300
First flight	March 13th, 1942
Last flight	Sept 19th, 1952
Notable payloads	

First stage	
Engines	A4 engine
Thrust	264.90 kN (59,552 lbf)
Specific impulse	239 s
Burn time	68 seconds
Fuel	3,810 kg (8,400 lb) 75% etha-nol, 25% water 4,910 kg (10,820 lb) liquid oxygen
Gross mass	12,805 kg (28,230 lb)
Empty mass	4,008 kg (8,836 lb)
Length	14m (45ft 11 in)
Diameter	1,65m (5ft 5 in)
Model	
Year Created	2018
Author	Mark Balderrama
Parts count	36
Diameter	3,4 cm
Height	12,1 cm
Weigth	19,2 g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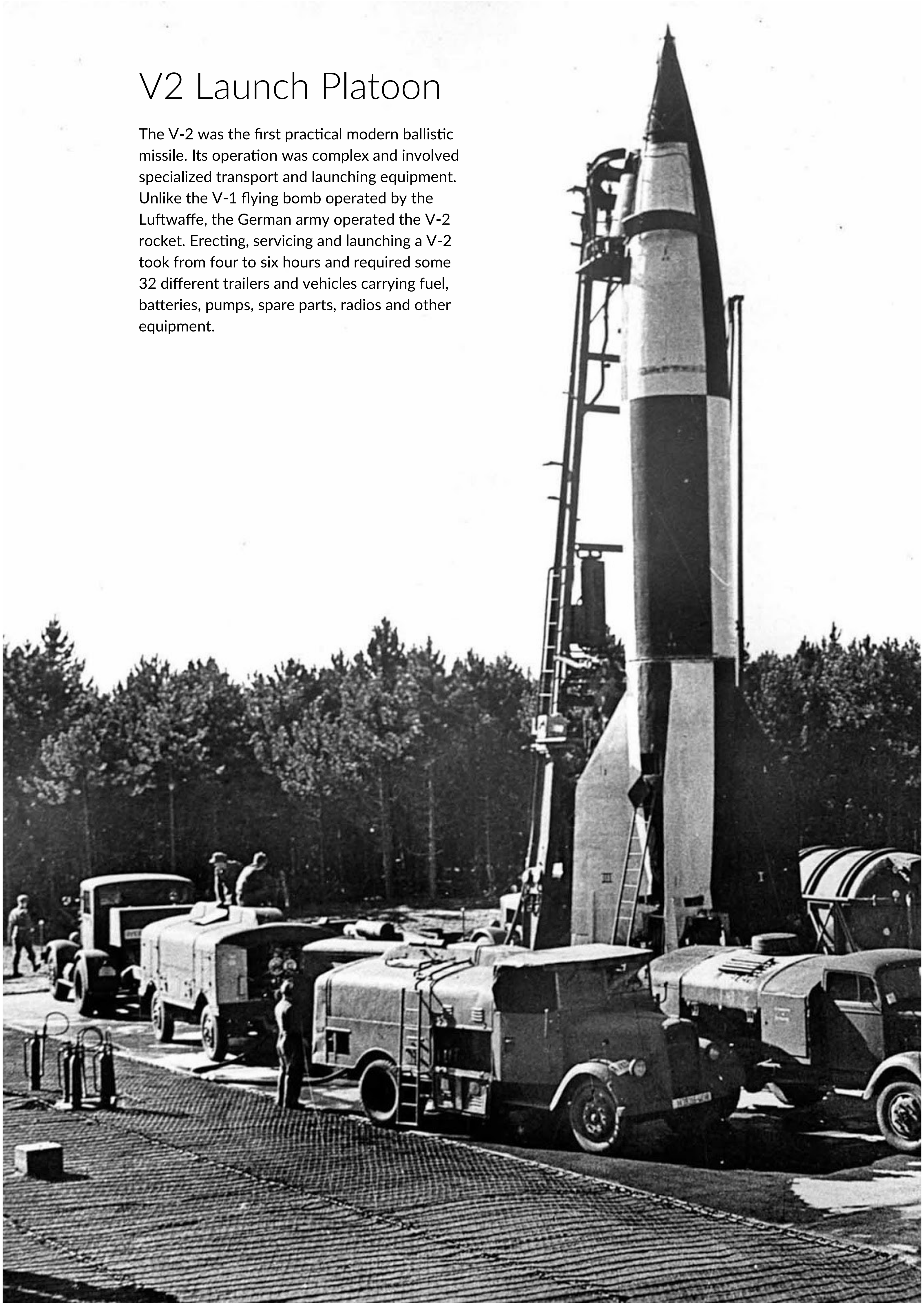
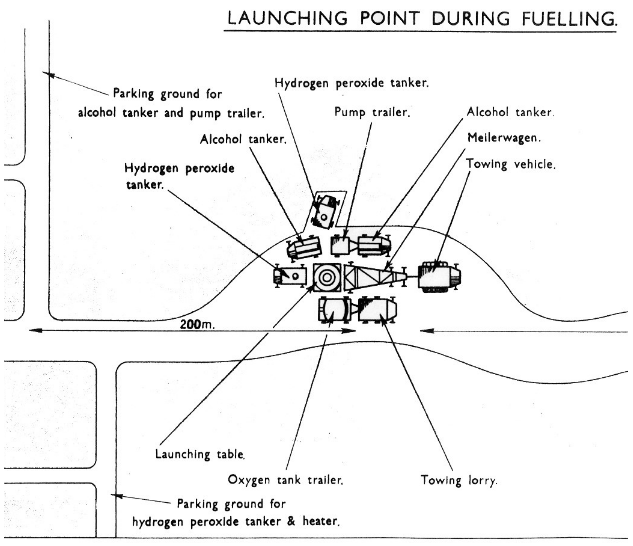
V2 Launch Platoon

The V-2 was the first practical modern ballistic missile. Its operation was complex and involved specialized transport and launching equipment. Unlike the V-1 flying bomb operated by the Luftwaffe, the German army operated the V-2 rocket. Erecting, servicing and launching a V-2 took from four to six hours and required some 32 different trailers and vehicles carrying fuel, batteries, pumps, spare parts, radios and other equipment.





Plan of a V2 launch platoon preparing a V2 for liftoff. (c) nV2book.com

Overleaf: A V-2 rocket ready for launching at Cuxhaven in Lower Saxony. 1945. © rarehistoricalphotos.com

The first units to operate the V2 were raised in the Summer of 1943 in Blinza (Poland), where a second test center was being erected. By the spring of '45, four different regiment-sized units were tasked with conducting the launches, each consisting out of several batteries, with more than 10.000 men and 3.000 vehicles overall.

Because of Allied air superiority, V2s were launched from easily concealed areas - such as the wooded areas of Den Haag (The Hague). The concentration of troops preparing a V2 for launch would be a great temptation to any Allied fighter looking for ground targets.

A Typical V2 Batterie consisted of five platoons. All platoons also carried the usual weapons of a combat unit and the normal equipment associated with their duties.

Headquarters Group
Launching Group
Radio Group
Technical Group
Fueling Platoon

The launching platoon was divided into three units of 39 men each. Each 39 man firing crew were assigned one of the following duties: (1) The fire control crew with the Feuerleitpanzer fire-control vehicle; (2) The surveying and adjustment crew; (3) The engine crew; (4) The electrical crew; (5) The vehicle crew with the Meillerwagen and firing table.

A V2 launches from near Cuxhaven, 1945. Credit: NASA

The firing crews would proceed to the launch site and place the towed launching table into position. Once the legs of the launch table were extended, the table was raised enough for the towing dolly to be removed. The 3600 lb. launching table (Abschussplattform) was made from welded steel and was, in itself, very ingenious. The launching crew next would back the Meillerwagen up to the launching table and raise the rocket into position on the table.

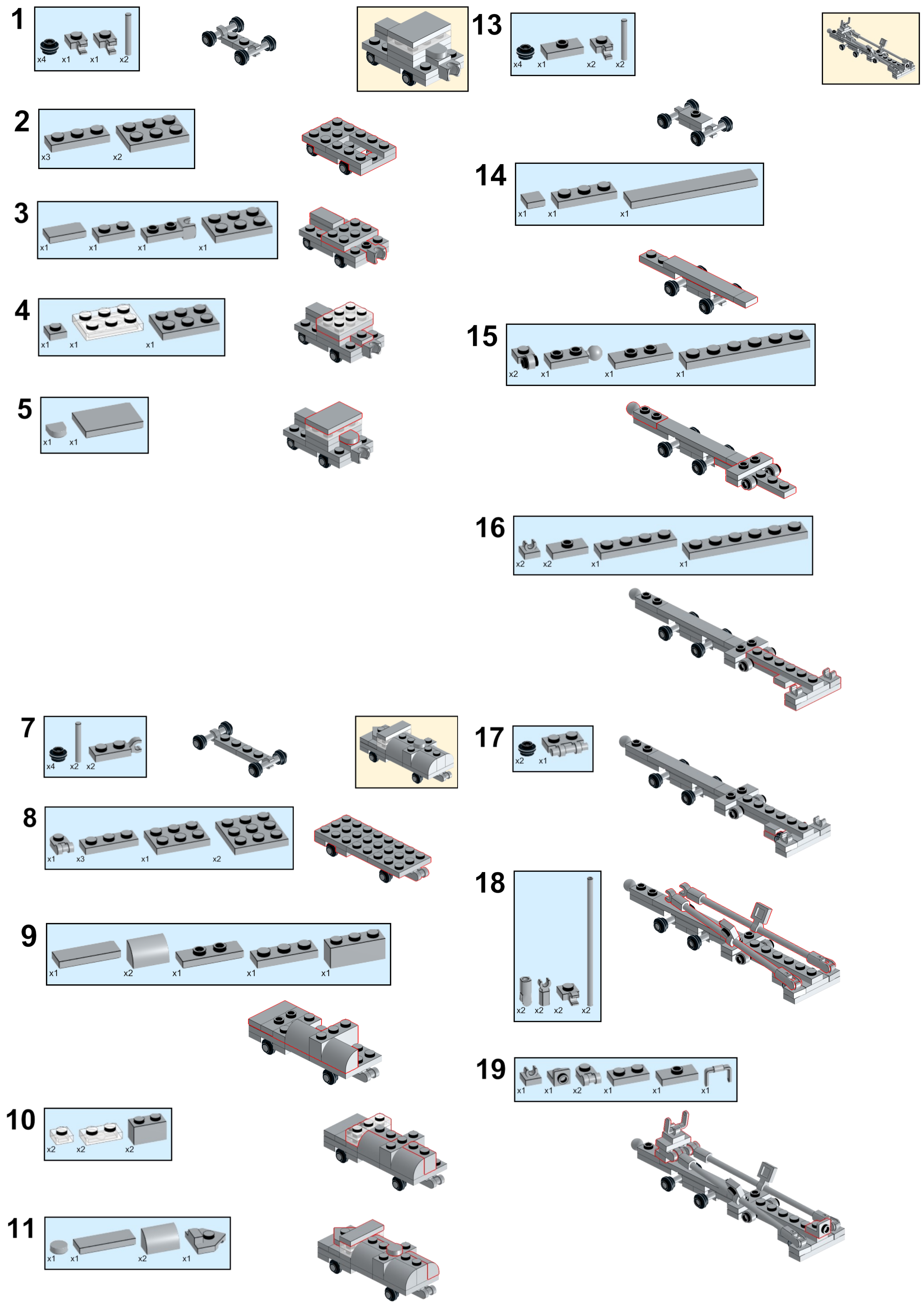
The rocket had to be fueled in the vertical position because the fuel tanks inside of the V2 were designed to withstand the weight of the fuel in the upright position only. The fueling trucks and trailers consisted of two alcohol supply vehicles, one pump, and a towed liquid oxygen vehicle. The launching crews first filled the V2 with alcohol, then liquid oxygen. The frost from the liquid oxygen can be seen in most launch photos from the period as a band of white appearing around the body of the rocket, just above the fins. Electrical power for the V-2 was provided by ground sources when it rested on the launching platform and by batteries while in flight. When possible, the troops would use local municipal electrical power sources.

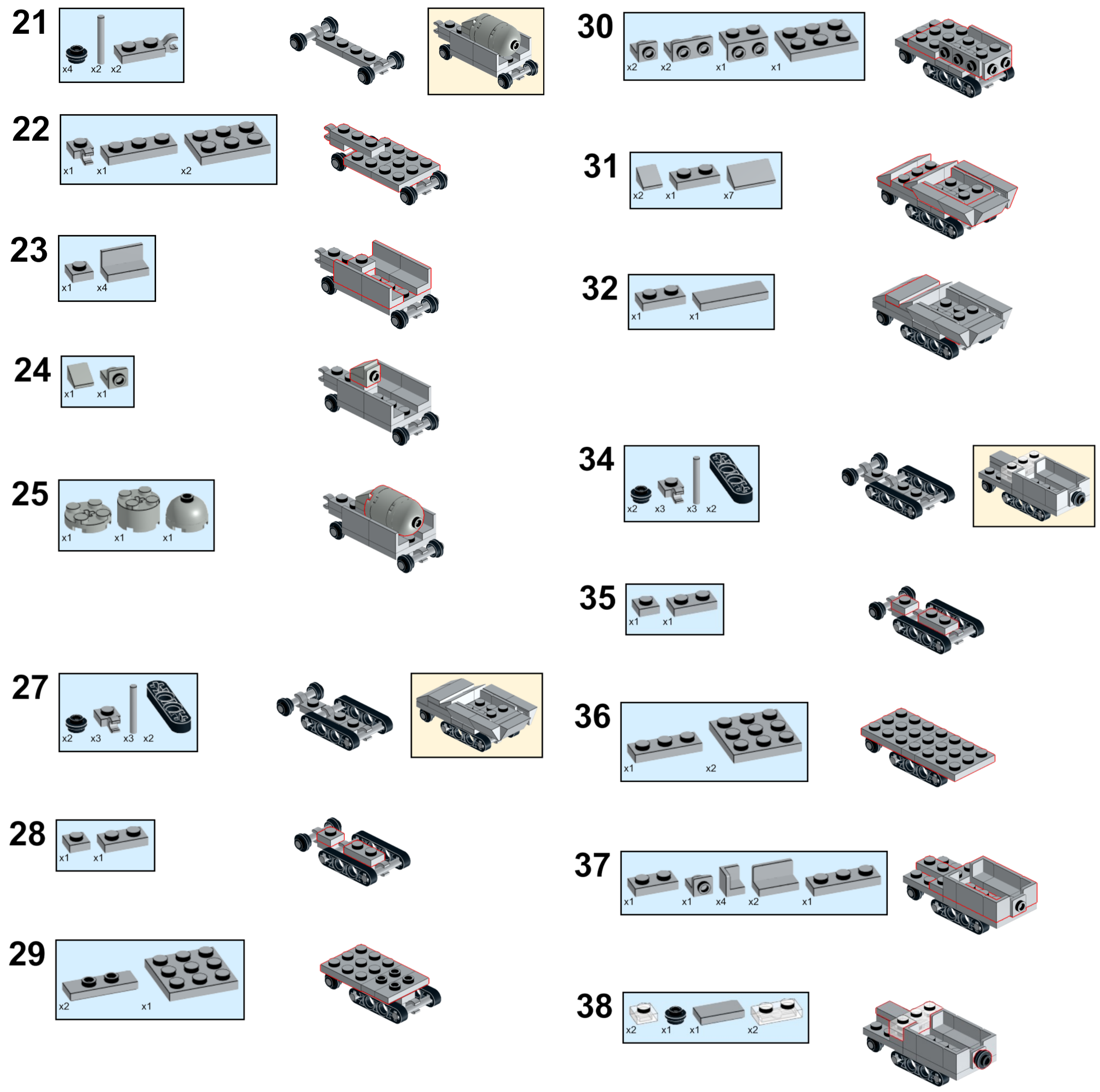
A V-2 rocket being errected for firing from ist trailer, the „Meillerwagen", near Cuxhaven in Lower Saxony. 1945.. Credit: NASA

The arm of the Meillerwagen was lowered after the fueling was completed. The V2 was then oriented to its exact firing position by using a dial-sight incorporated into the launching table. The firing troops then would install the electrical igniter into the combustion chamber. After all personnel and vehicles were cleared from the launching site, the troop commander would enter the firing control vehicle. It was from this armored vehicle that the final remote tests of the steering controls were completed. The troop commander then would give the order to launch the V2.

This set amounts to 180 pieces and is meant to accompany the previous model of the A4.. The construction of the Mailerwagen is tricky and results in a rather fragile contrsuction if older stones are used for construction, but it works fine as a display.

V2 Launch Platooon

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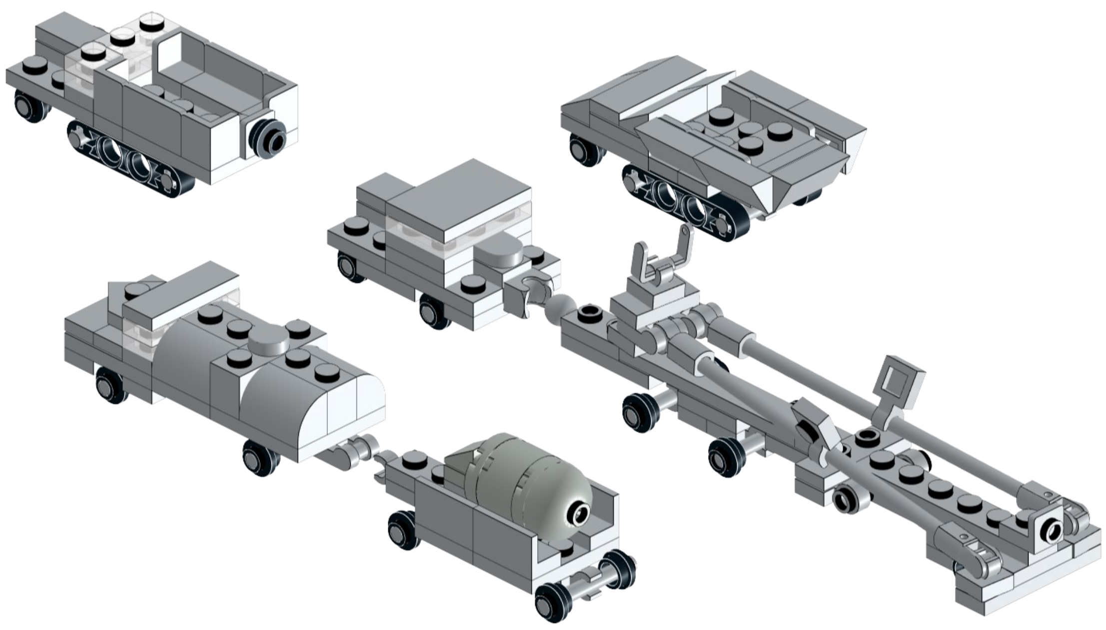


Redstone

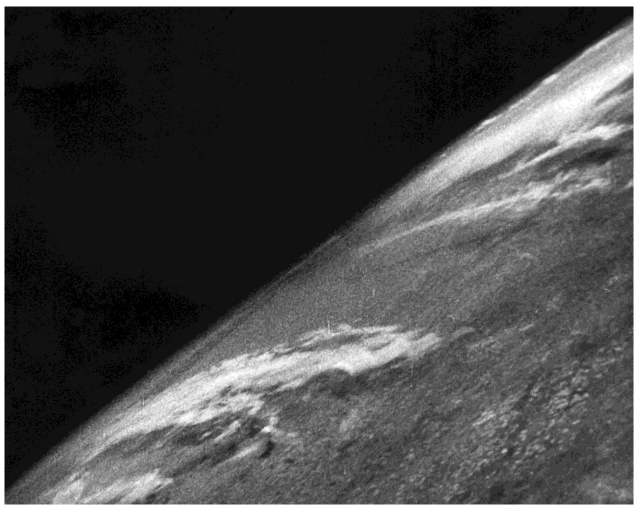
The PGM-11 Redstone was both a direct descendant from the A4 as well as the first large American ballistic missile, capable of carrying a nuclear warhead over a range of 270km. Its designers were german engineers, housed in New Mexico.

At the end of the war, a race began between the United States and the USSR to retrieve as many V-2 rockets and staff as possible. At the close of the Second World War, The US Army conducted “Operation Paperclip”, and over 300 rail cars filled with V-2 engines, fuselages, propellant tanks, gyroscopes, and associated equipment were brought to the railyards in Las Cruces, New Mexico, so they could be placed on trucks and driven to the White Sands Proving Grounds. 126 of the principal designers, including Werner von Braun and Walter Dornberger, were in American hands.

In addition to V-2 hardware, the U.S. Government delivered German mechanization equations for the V-2 guidance, navigation, and control systems, as well as for advanced development concept vehicles, to U.S. defense contractors for analysis. In the 1950s some of these documents were useful to U.S. contractors in developing early U.S. programs such as the Atlas and Minuteman guidance systems.

Group of 104 German rocket scientists in 1946, including Wernher von Braun, Ludwig Roth and Arthur Rudolph, at Fort Bliss, Texas, 1946.
Credits: NASA

In their camp in New Mexico, the German engineers initially did little practical work, since the US Army mostly sought to extract their theoretical knowledge. Engineering work was done –amongst others – at *Project Hermes*, which sought to replicate German rocket technology advances. However, with outbreak of the Korean War the Army developed an urgent need to field a ballistic missile, and the fledgling Hermes project was shifted from luckless General Electrics to von Braun's German team in 1950. Equally loathed and admired, the Germans worked in isolation until their successes were – in the view of the US public – big enough to justify the taint the US space program acquired with such association. von Braun's group was first named Ordnance Guided Missile Center, then Guided Missile Development Division (GMDD), changed in 1956 to Army Ballistic Missile Agency (ABMA), before finally being transferred in 1959 to the civilian control of the National American Space Agency (NASA).



The first photo from space was taken from a V-2 launched by US scientists on 24 October 1946.
Credit: NASA

Overleaf: Redstone research and development missile number CC-56 launch at Atlantic Missile Range (AMR), Cape Canaveral, Florida, 17 September 1958. Credit: US Army

Tasked with quickly delivering a medium ranged ballistic missile for the US Army, von Braun's team completed design of the first 400 km (250 mile) range missile in 1952. The Redstone rocket, named after the barracks that housed the engineers, combined proven V-2 technology (aerodynamic fins, exhaust diverters for pitch control, liquid oxygen/alcohol propellant) with some new concepts (inertial navigation, separable warhead). The rocket was powered by a version of the Rocketdyne XLR43-NA-1 engine, an evolution of the V-2's powerplant for the USAF Navaho program. As was von Braun's practice, his team built the prototype rockets, with production being handled by an outside contractor. The first test launch occurred in August 1953, the first Chrysler production missile flew in July 1956, and Redstone became operational with US Army units in Germany in June 1958.

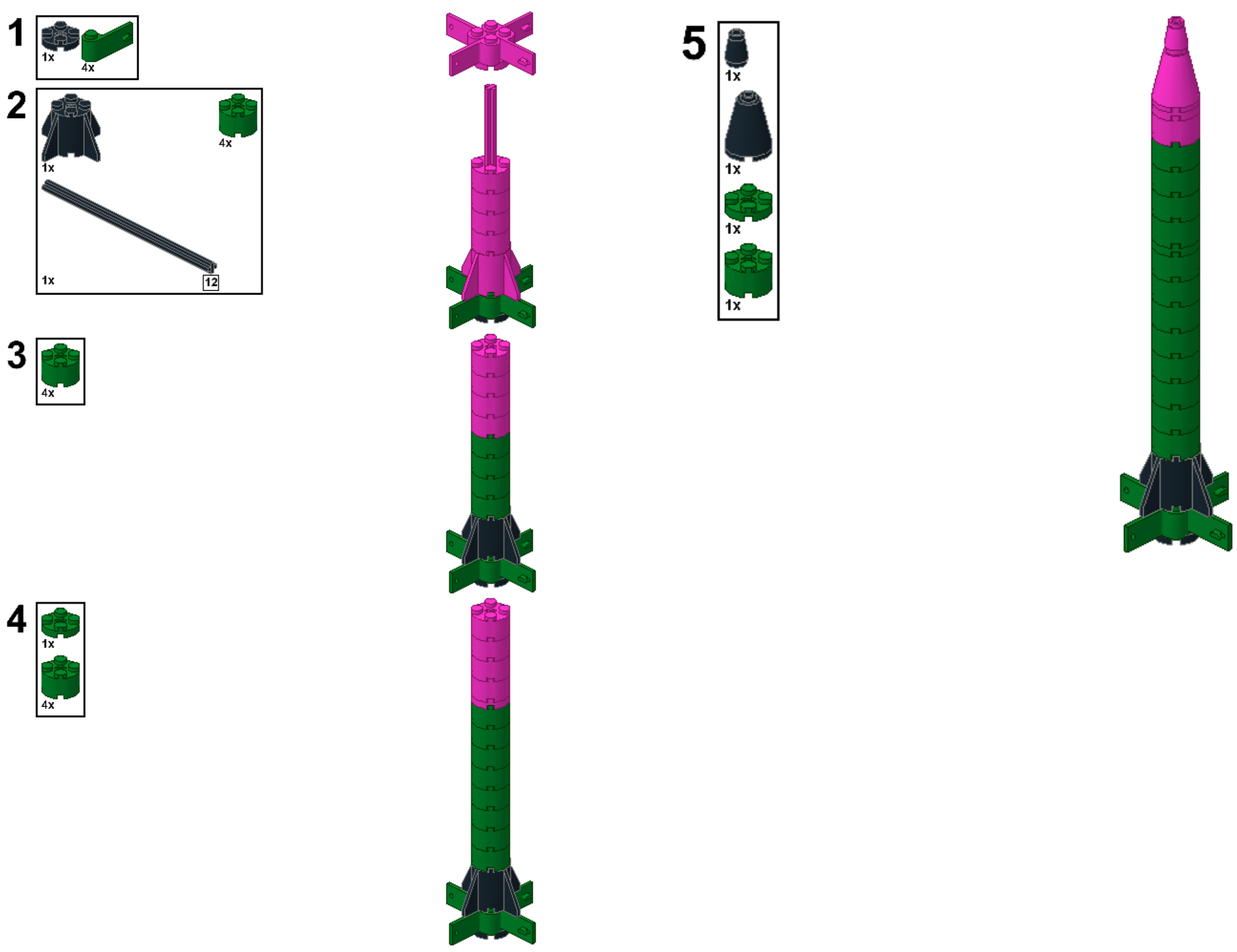
With the arrival of newer solid-fueled missiles that could be stored and not require fueling before launch, Redstone was rendered obsolete and production ended in 1961. The 40th Artillery Group was deactivated in February 1964 and 46th Artillery Group was deactivated in June 1964, as Redstone missiles were replaced by the Pershing missile in the U.S. Army arsenal.

The Redstone was an excellent design which proved its merits through its descendants, which carried the first US satellite to space (The Juno I), the first US astronaut to space (Redstone-Mercury), and played a significant part in the Moon program (Saturn I and Ib).

Datasheet Redstone

General	
Name	SSM-A-14/M8/PGM-11 Reds-tone
Function	Tactical ballistic missile Short-range ballistic missile
Manufacturer	Chrysler Corporation
Country of origin	United States
Cost per Launch	1.994 million in 1956 dollars
Family	Redstone
Size	
Height	69.3 feet (21.1 m)
Diameter	5.83 feet (1.8 m)
Width	
Mass	61,207 pounds (27,763 kg)
Stages	
Capacity	
Payload suborbital	6,305 pounds (2,860 kg)
Payload to LEO	
Payload to GEO	
Payload to TLI	
Payload to escape	
Launch history	
Status	retired
Launch sites	guided missile platform laun-cher M74
Total launches	55
Successes	
Failures	
Partial failures	
First flight	August 20, 1953
Last flight	Dec 1st, 1965
Notable payloads	

First stage	
Engines	A-6
Thrust	414.340 kN (93,147 lbf)
Specific impulse	265 sec
Burn time	155 sec
Fuel	Lox/Alcohol
Gross mass	28,440 kg (62,690 lb)
Empty mass	3,125 kg (6,889 lb)
Length	
Diameter	
Model	
Year Created	2018
Author	Wolfram Broszies
Parts count	24
Diameter	4,8 cm
Height	19,4 cm
Weigth	24,9 g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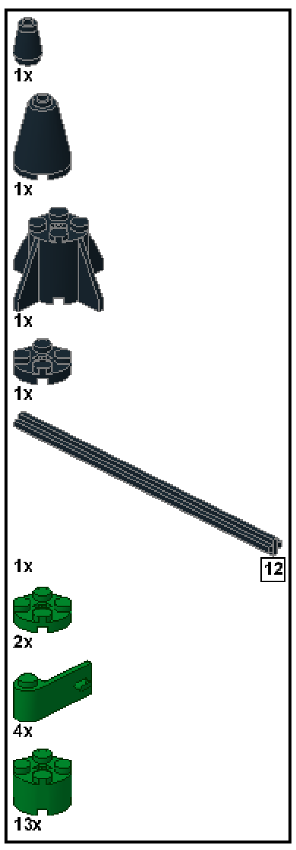
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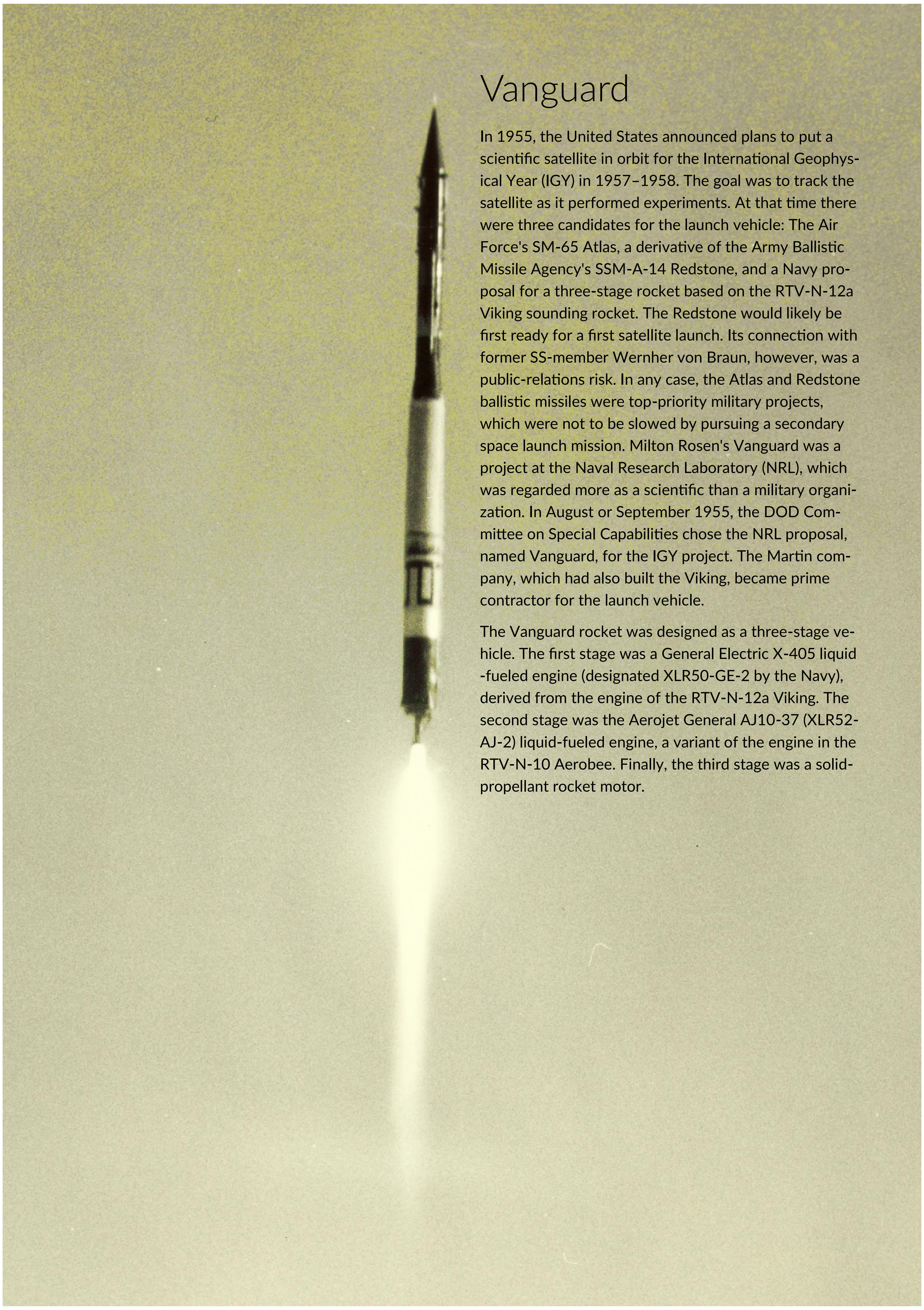


Vanguard

In 1955, the United States announced plans to put a scientific satellite in orbit for the International Geophysical Year (IGY) in 1957–1958. The goal was to track the satellite as it performed experiments. At that time there were three candidates for the launch vehicle: The Air Force's SM-65 Atlas, a derivative of the Army Ballistic Missile Agency's SSM-A-14 Redstone, and a Navy proposal for a three-stage rocket based on the RTV-N-12a Viking sounding rocket. The Redstone would likely be first ready for a first satellite launch. Its connection with former SS-member Wernher von Braun, however, was a public-relations risk. In any case, the Atlas and Redstone ballistic missiles were top-priority military projects, which were not to be slowed by pursuing a secondary space launch mission. Milton Rosen's Vanguard was a project at the Naval Research Laboratory (NRL), which was regarded more as a scientific than a military organization. In August or September 1955, the DOD Committee on Special Capabilities chose the NRL proposal, named Vanguard, for the IGY project. The Martin company, which had also built the Viking, became prime contractor for the launch vehicle.

The Vanguard rocket was designed as a three-stage vehicle. The first stage was a General Electric X-405 liquid-fueled engine (designated XLR50-GE-2 by the Navy), derived from the engine of the RTV-N-12a Viking. The second stage was the Aerojet General AJ10-37 (XLR52-AJ-2) liquid-fueled engine, a variant of the engine in the RTV-N-10 Aerobee. Finally, the third stage was a solid-propellant rocket motor.

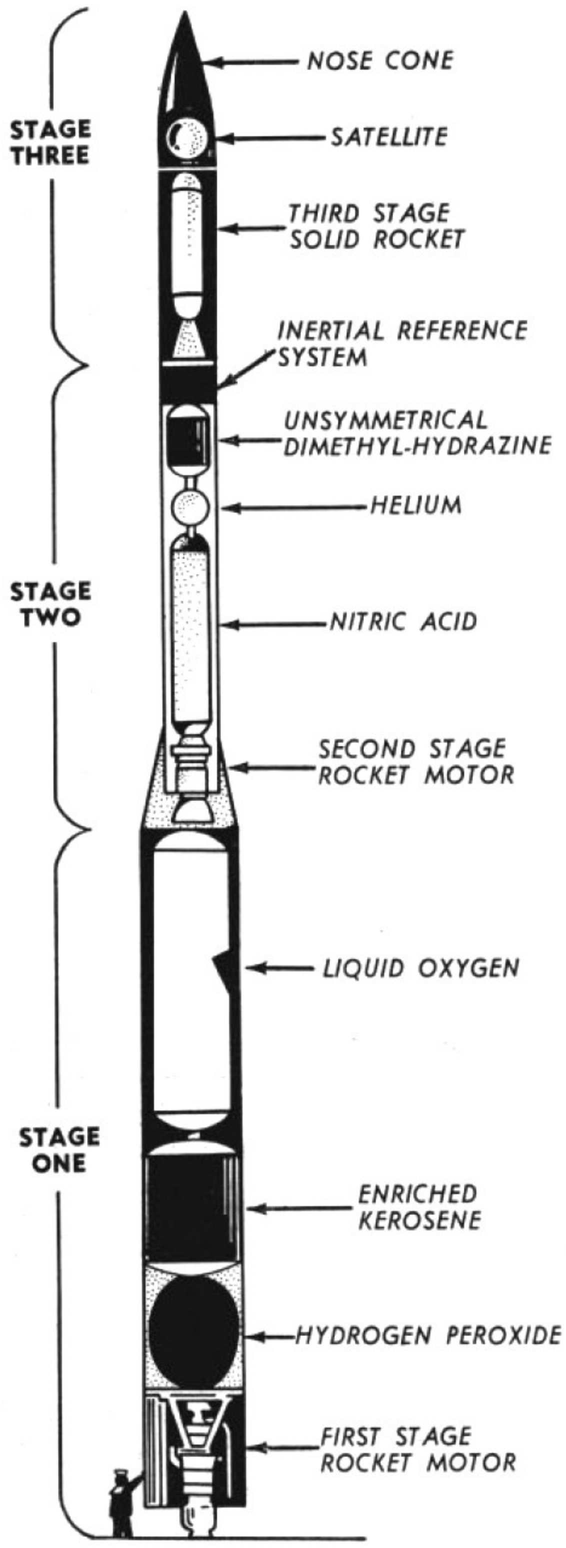
All three-stage Vanguard flights except the last one used a motor built by the Grand Central Rocket Company. Vanguard had no fins, and the first and second stages were steered by gimbaled engines. The second stage also housed the vehicle's telemetry system, the inertial guidance system and the autopilot. The third stage was spin-stabilized, the spin being imparted by a turntable on the second stage before separation.

Despite being one of the earliest rockets, the Vanguard's legacy endures up to the present: Its second stage served for decades as the Able and Delta second stage for satellite launch vehicles. The AJ10 engine which made up those stages was adapted into the AJ10-137, which was used as the Apollo Service Module engine. The AJ10-190, adapted from the Apollo spacecraft was used on the Space Shuttle for orbital maneuvers, and will be repurchased for use on NASA's upcoming Orion spacecraft.

Vanguard, however, took too long, held up in development for a variety of reasons. Vanguard TV-2, launched on October 23, 1957 after several abortive attempts, was the first real Vanguard rocket. By that time, the Soviet Union had already placed the Sputnik 1 satellite into orbit, and therefore project Vanguard was more or less forced to launch its own satellite as soon as possible. Although the NRL and Martin tried to emphasize that the TV-3 mission was a pure test flight (and one with several "firsts"), everyone else saw it as the first satellite launch of the Western world, billed as "America's answer to Sputnik".

Foreground, Vanguard second-stage Aerojet LR52-AJ-1 (AJ10-118); rear, Vanguard first-stage General Electric XLR50-GE-2 (X-405). Credit: NASA

Overleaf: Vanguard Missle Launch. Credit: San Diego Air & Space Museum



On 6 December 1957 the US Navy launched Vanguard TV-3 rocket, carrying a 1.3 kg (2.9 lbs) satellite, from Cape Canaveral. It only reached an altitude of 1.2 meters (4 ft), fell, and exploded. The American press was livid, Vanguard was mocked as *Kaputnik*.

On March 17th, 1958, TV-4 finally succeeded in orbiting the Vanguard 1 satellite. By that time, however, the Army's Juno (Jupiter-C) had already launched the United States' first satellite, Explorer 1. The TV-4 rocket had put the satellite Vanguard 1, to a relatively high orbit of (3966 km (2465 miles) x 653 km (406 mi)). Vanguard 1 and its third stage remain in orbit as the oldest man-made artifacts in space.

Datasheet Vanguard

General	
Name	Vanguard
Function	Expendable launch system
Manufacturer	Martin
Country of origin	United States
Cost per Launch	1985$: 5,660 million
Family	
Size	
Height	23.00 m (75 feet)
Diameter	1.14 m (3.74 feet)
Width	
Mass	10,050 kg (22,150 lb)
Stages	3
Capacity	
Payload suborbital	
Payload to LEO	9 kg
Payload to GEO	
Payload to TLI	
Payload to escape	
Launch history	
Status	Retired
Launch sites	LC-18A, Cape Canaveral
Total launches	11
Successes	3
Failures	8
Partial failures	0
First flight	October 23, 1957
Last flight	September 18, 1959
Notable payloads	Explorer 1
First stage	**Vanguard**
Engines	1 X-405
Thrust	30,303 lbf (134.79 kN)
Isp	248 seconds
Burn time	2 min 25 s
Fuel	LOX/Kerosene
Gross mass	10,050 kg (22,150 lb)
Empty mass	811 kg (1,787 lb)
Length	12.20 m (40.00 ft)
Diameter	1.14 m (3.74 ft)

Second stage	Delta
Engines	1 AJ10-37
Thrust	7,599 lbf (33.80 kN)
Isp	261 seconds
Burn time	1 min 55 s
Fuel	Nitric acid/UDMH
Gross mass	2,164 kg (4,770 lb)
Empty mass	694 kg (1,530 lb)
Length	5.36 m (17.58 ft)
Diameter	0.84 m (2.75 ft)
Third stage	**Grand Central**
Engines	1 Solid
Thrust	2,599 lbf (11.56 kN)
Isp	230 seconds
Burn time	31 s
Fuel	Solid
Gross mass	210 kg (460 lb)
Empty mass	31 kg (68 lb)
Length	2.00 m (6.50 ft)
Diameter	0.50 m (1.64 ft)
Model	
Year Created	2018
Author	Benjamin Unis
Parts count	21
Diameter	1,6 cm
Height	19 cm
Weigth	14,8 g

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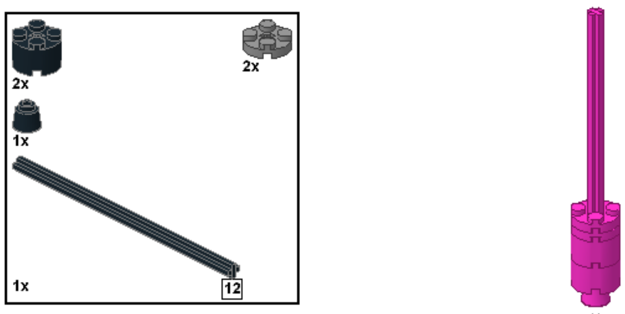
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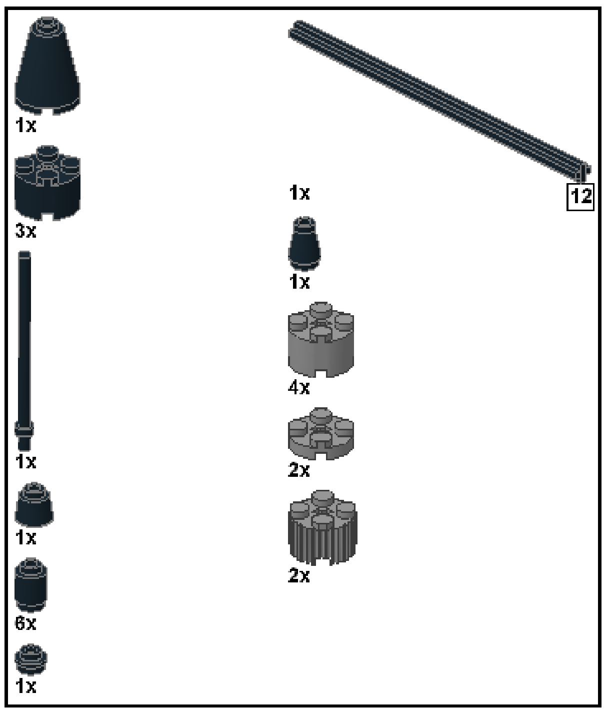
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Scout X-1

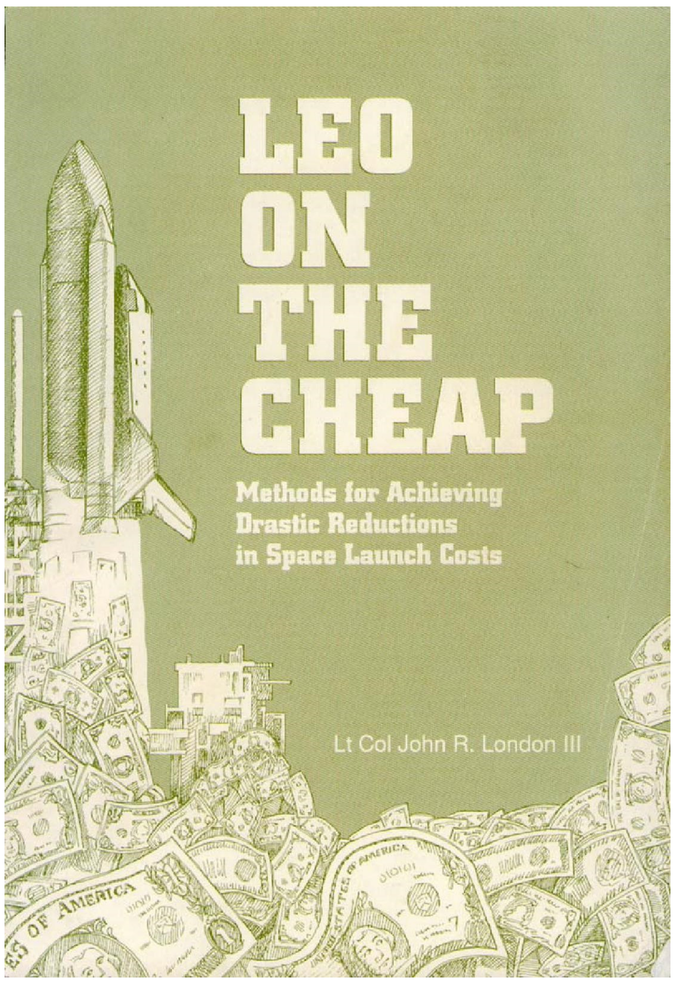
Nothing demonstrates the pitfalls of rushing into space more dramatically than the early history of the Scout rocket program. This relatively small, four-stage solid-fuel rocket was conceived in 1956 by NACA engineers in Langley's Pilotless Aircraft Research Division (PARD) as a simple but effective way of boosting light payloads into orbit. Scout eventually proved to be one of the most economical, dependable, and versatile launch vehicles ever flown not just by NASA but by anyone, anywhere.

The program did not begin, however, with an impressive performance; it began with four years of confidence crushing failures. To make Scout a success, researchers had to climb a long and torturous learning curve, which resembled, at least to those involved, the infernal hill up which Sisyphus eternally pushed his uncooperative rock

The PARD group's idea was to employ solid propulsion and use as many existing solid-fuel rockets for the various stages of the proposed launch vehicle as possible. The basic NASA Scout configuration, from which all variants were derived, was known as Scout-X1. It was a four-stage rocket, which used the following motors:

- 1st stage: Aerojet General Algol
- 2nd stage: Thiokol XM33 Castor
- 3rd stage: Allegany Ballistics Laboratory X-254 Antares
- 4th stage: Allegany Ballistics Laboratory X-248 Altair

Scout's first-stage motor was based on an earlier version of the Navy's Polaris missile motor; the second-stage motor was developed from the Army's Sergeant surface-to-surface missile; and the third- and fourth-stage motors were adapted by NASA's Langley Research Center; Hampton, VA, from the Navy's Vanguard missile.[6] Unlike the Thor or Atlas-Agena the Scout was non-military and could be sold to foreign customers.

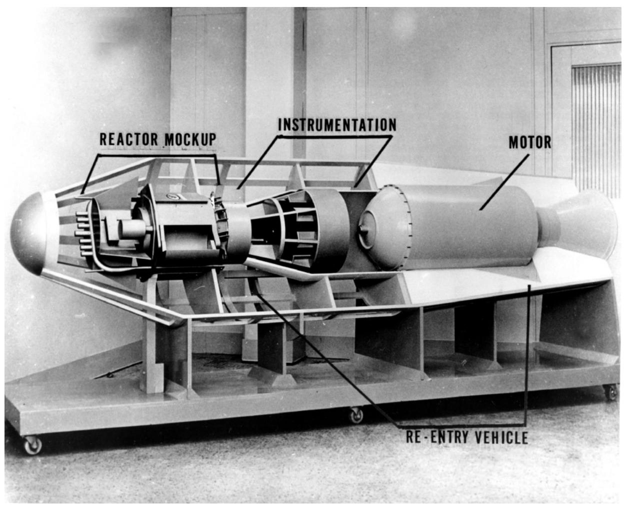


The cover of John R. London's „LEO On The Cheap: Methods for Achieving Drastic Reductions in Launch Costs“, fiked as U.S. Air Force Research Report No. AU-ARI-93-8, which significantly influenced the Scout development.
Credit: US Air Force

The Scout X-1, the first production variant of the Scout family, was flown seven times between August 1960 and October 1961. Four orbital and three suborbital launches were made, with four of the launches resulting in failures. All seven launches occurred from Launch Area 3 at the Wallops Flight Facility. The maiden flight was a suborbital test of the rocket's systems, and was conducted successfully on 2 July 1960, with the rocket launching at 00:04 GMT. Following this, a suborbital radiation experiment was successfully launched on 4 October. The first orbital launch attempt, with the S-56 satellite, was made on 4 December, and ended in failure after the second stage malfunctioned.

On 16 February 1961, a Scout X-1 successfully placed Explorer 9, a reflight of the failed S-56, into Earth orbit, in the first successful orbital launch to be conducted by a Scout rocket. Up to the present, there have been 118 Scout launches with an overall 96 percent success rate of 96%, and the rocket remains one of the most used, cheapest, most reliable – and most ignored – orbital launch systems.

Several derivatives of the Scout X-1 were also flown. The United States Navy developed the Blue Scout, which was a three-stage sounding rocket, and the Blue Scout II which was almost identical to the Scout X-1. The Scout X-1A, a five-stage variant of the Scout X-1, was used for a single suborbital launch in March 1962. It featured an improved first stage, and a NOTS-17 upper stage.



Mockup of the fourth stage of the Scout launch vehicle which launched the re-entry vehicle, including a reactor mockup, for AEC's Re-entry Flight Demonstration-1 (RFD-1) from Wallops Island, Virginia. 1963
Credit: Dep. Of Energy, USA

Overleaf: First launch of a „Scout B“ on Oct 8th, 1965. Credit: NASA

Datasheet Scout X-1

General	
Name	Scout X-1
Function	Satellite launch vehicle
Manufacturer	
Country of origin	United States
Cost per Launch	1985$: 8.910 million.
Family	
Size	
Height	25.00 m (82.00 ft)
Diameter	1.01 m (3.31 ft)
Width	
Mass	16,240 kg (35,800 lb)
Stages	4
Capacity	
Payload suborbital	
Payload to LEO	59 kg (130 lb)
Payload to GEO	
Payload to TLI	
Payload to escape	
Launch history	
Status	Retired
Launch sites	Wallops LA-3
Total launches	7
Successes	3
Failures	4
Partial failures	
First flight	July 2nd, 1960
Last flight	October 19th, 1961
Notable payloads	
First Stage	**Algol**
Engines	1 x Algol 1
Thrust	470.934 kN (105,870 lbf)
Isp	236 sec
Burn time	40 sec
Fuel	Solid
Gross mass	10,705 kg (23,600 lb)
Empty mass	1,900 kg (4,100 lb)
Length	9.12 m (29.92 ft)
Diameter	1.01 m (3.31 ft)

Second Stage	Castorant
Engines	1 x M33-20-4
Thrust	286.001 kN (64,296 lbf)
Specific impulse	247 sec
Burn time	27 sec
Fuel	Solid
Gross mass	3,852 kg (8,492 lb)
Empty mass	535 kg (1,179 lb)
Length	5.92 m (19.42 ft)
Diameter	0.79 m (2.59 ft)
Third Stage	**Antares 1A**
Engines	1 x X-254
Thrust	60.497 kN (13,600 lbf)
Specific impulse	256 sec
Burn time	39 sec
Fuel	Solid
Gross mass	1,225 kg (2,700 lb)
Empty mass	294 kg (648 lb)
Length	3.38 m (11.08 ft)
Diameter	0.78 m (2.55 ft)
Forth Stage	**Altair 1A**
Engines	1 x X-248A
Thrust	13.788 kN (3,100 lbf)
Specific impulse	255 sec
Burn time	40 sec
Fuel	Solid
Gross mass	390 kg (850 lb)
Empty mass	181 kg (399 lb)
Length	2.50 m (8.20 ft)
Diameter	0.46 m (1.50 ft)
Model	
Year Created	2018
Author	Benjamin Unis
Parts count	25
Diameter	1,6 cm
Height	20,3 cm
Weigth	6,5 g

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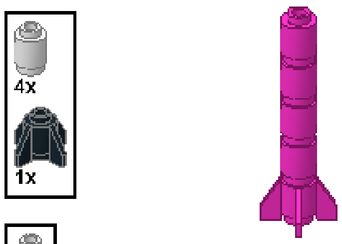

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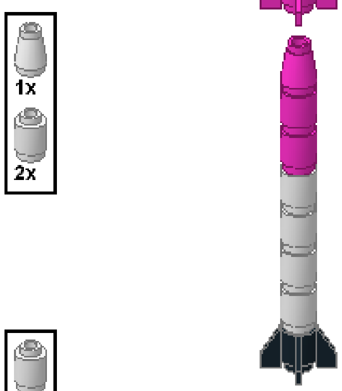

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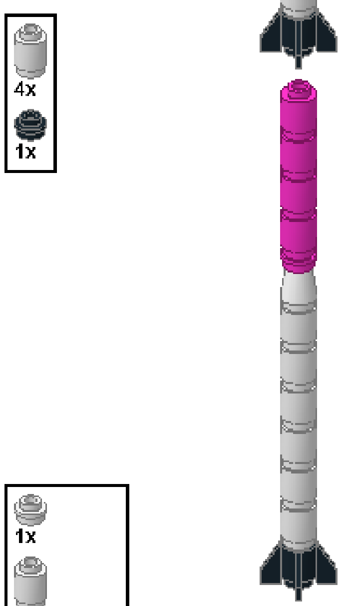

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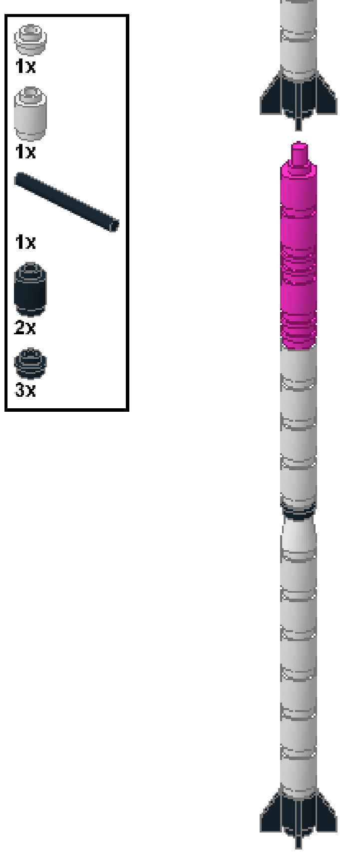

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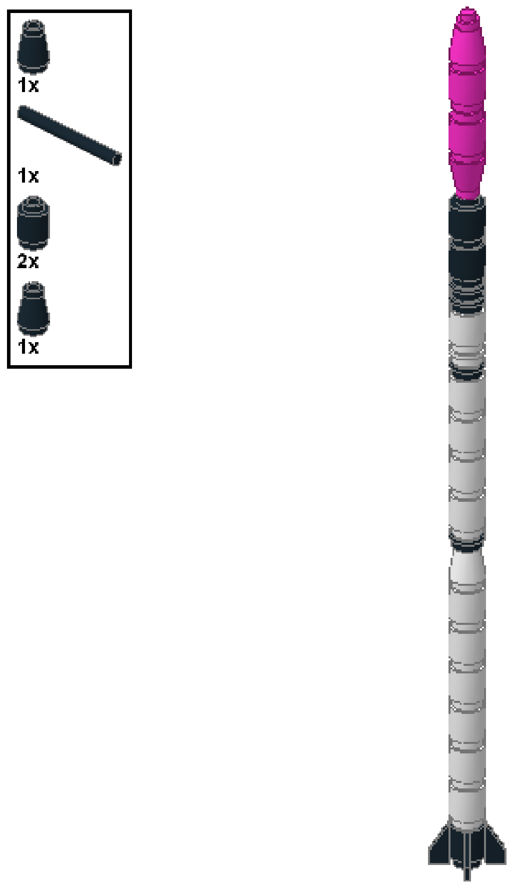
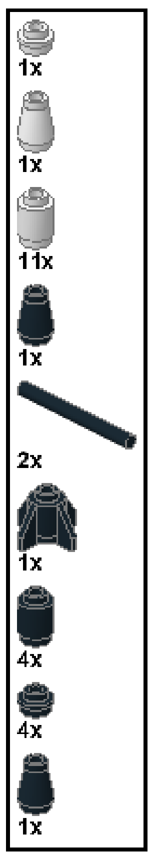


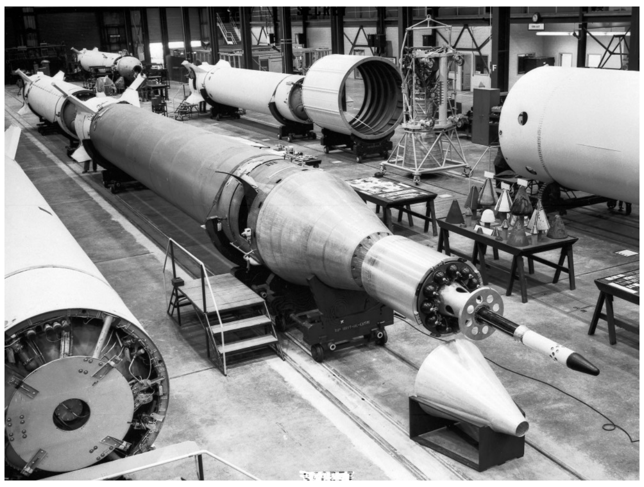


Juno I

The Juno I was a four-stage American booster rocket which launched America's first satellite, Explorer 1, in 1958. Juno I was based on the Jupiter C, developed as a sounding rocket and testbed by the ABMA engineers. Jupiter C was launched successfully three times in 1956 and 1957.

On October 4, 1957, the Soviet Union unexpectedly launched Sputnik I. Although there had been some idea that the Soviets were working towards this goal, even in public, no one considered it to be very serious. When asked about the possibility in a November 1954 press conference, Defense Secretary Wilson replied "I wouldn't care if they did." The public did not see it the same way, however, and the event was a major public relations disaster for the US. Vanguard was planned to launch shortly after Sputnik, but a series of delays pushed this into December, when the rocket exploded in spectacular fashion. The press was harsh, referring to the project as "Kaputnik" or "Project Rearguard".

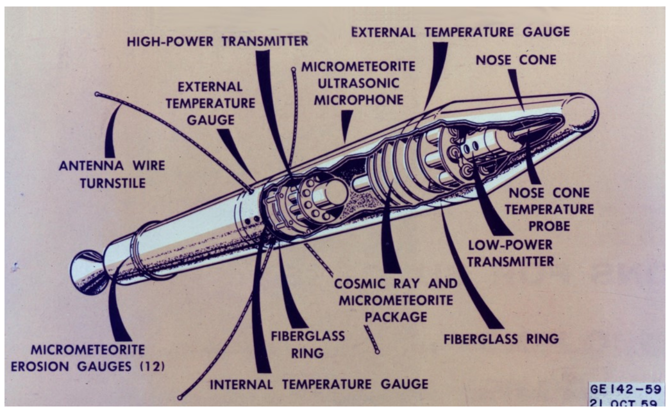
von Braun responded to Sputnik I's launch by claiming he could have a satellite in orbit within 90 days of being given a go-ahead. There was no immediate response while everyone waited for Vanguard to launch, but the continued delays in Vanguard and the November launch of Sputnik II resulted in the go-ahead being given that month. von Braun kept his promise with the successful launch of Explorer I on top of a Juno I on January 31, 1958. Vanguard was finally successful on March 17, 1958, but by then von Brauns reputation eclipsed the other development efforts.



Jupiter-C Missile No. 27 assembly at the Army Ballistic Missile Agency (ABMA), Redstone Arsenal, in Huntsville, Alabama.
Credits: NASA

Overleaf: Launch of Jupiter-C/Explorer 1 at Cape Canaveral, Florida on January 31, 1958.
Credits: NASA

To reach orbit, some modifications to Jupiter C were necessary, resulting in the Juno I. Each rocket consisted of a modified Redstone ballistic missile with two solid-propellant upper stages. The tanks of the Redstone were lengthened by 8 ft (2.4 m) to provide additional propellant. The instrument compartment was also smaller and lighter than the Redstone's. The second and third stages clustered in a "tub" atop the vehicle. The second stage was an outer ring of eleven scaled-down Sergeant rocket engines; the third stage was a cluster of three scaled-down Sergeant rockets grouped within. A fourth stage was mounted on top of the "tub" of the third stage, and fired after third-stage burnout to boost the payload and fourth stage to an orbital velocity of 8 kilometres per second (29,000 km/h; 18,000 mph). The tub along with the fourth stage were set spinning while the rocket was on the launch pad to provide gyroscopic force in

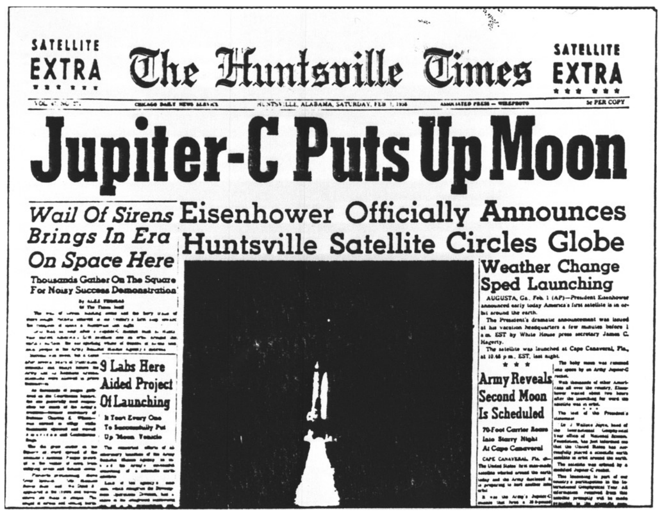


Schematics for „Explorer 1“, the first satellite successfully launched by the USA.
Credit: NASA

lieu of a guidance system that would have required vanes, gimbals, or vernier motors.

Explorer 1, the first US satellite, was a short, blunt-nosed arrow with a mass of 13kg. The team around William H. Pickering from the JPL managed to pack an impressive load of experiments and transmitters into the small satellite, a first foreshadowing of the US technological advantage – Sputnik had only contained a radio transmitter and some batteries. After an successful launch, Explorer 1 stopped transmission of data on May 23, 1958 when its batteries died, but remained in orbit for more than 12 years. It reentered the atmosphere over the Pacific Ocean on March 31, 1970 after more than 58,000 orbits.

Although Juno I's launch of the Explorer 1 satellite was a huge success for the U.S. space program, only two of its remaining five flights were successful; launching Explorer 3 and 4. The American public was happy and relieved that America had finally managed to launch a satellite after the launch failures in the Vanguard and Viking series. With the relative success of the Juno I program, von Braun developed the Juno II, using a PGM-19 Jupiter first stage instead of a Redstone.



SATELLITE EXTRA The Huntsville Times SATELLITE EXTRA

Jupiter-C Puts Up Moon

Wail Of Sirens Brings In Era On Space Here

Thousands Gather On The Square For Noisy Success Demonstration

Eisenhower Officially Announces Huntsville Satellite Circles Globe

Weather Change Sped Launching

9 Labs Here Aided Project Of Launching

Army Reveals Second Moon Is Scheduled

Title page of the Huntsville Times on February 1st, 1958 about the launch of Explorer 1

Datasheet Juno I

General	
Name	Juno 1
Function	Orbital launch vehicle
Manufacturer	Chrysler for the ABMA
Country of origin	United States
Cost per Launch	
Family	
Size	
Height	21.2 m (70 ft)
Diameter	1.78 m (5 ft 10 in)
Width	
Mass	29,060 kg (64,070 lb)
Stages	4
Capacity	
Payload suborbital	
Payload to LEO	11 kg (24 lb)
Payload to GEO	
Payload to TLI	
Payload to escape	
Launch history	
Status	Retired
Launch sites	LC-5 and 26A, Cape Canaveral Missile Annex, Florida
Total launches	6
Successes	3
Failures	3
Partial failures	
First flight	January 31, 1958
Last flight	October 23, 1959
Notable payloads	
First stage	**Redstone (stretched)**
Engines	1x Rocketdyne A-7
Thrust	42,439 kgf (416.18 kN; 93,560 lbf)
Isp	235 sec
Burn time	155 seconds
Fuel	Hydyne/LOX
Gross mass	
Empty mass	
Length	
Diameter	

Second stage	Baby Sergeant cluster
Engines	11 Solid
Thrust	7,480 kgf (73.4 kN; 16,500 lbf)
Specific impulse	214 sec
Burn time	6 seconds
Fuel	Solid - polysulfide-aluminum and ammonium perchlorate
Gross mass	462 kg
Empty mass	231 kg
Length	1.0 m
Diameter	1.0 m
Third stage	**Baby Sergeant cluster**
Engines	3 Solid
Thrust	2,040 kgf (20.0 kN; 4,500 lbf)
Specific impulse	214 sec
Burn time	6 seconds
Fuel	Solid
Gross mass	126 kg
Empty mass	63 kg
Length	1.0 m
Diameter	0.50 m
Forth stage	**Baby Sergeant**
Engines	1 Solid
Thrust	680 kgf (6.7 kN; 1,500 lbf)
Specific impulse	214 sec
Burn time	6 seconds
Fuel	Solid
Gross mass	42 kg
Empty mass	21 kg
Length	1.0 m
Diameter	0.30 m
Model	
Year Created	2017
Author	Grand Passmore
Parts count	25
Diameter	4,8 cm
Height	19,6 cm
Weigth	22 g
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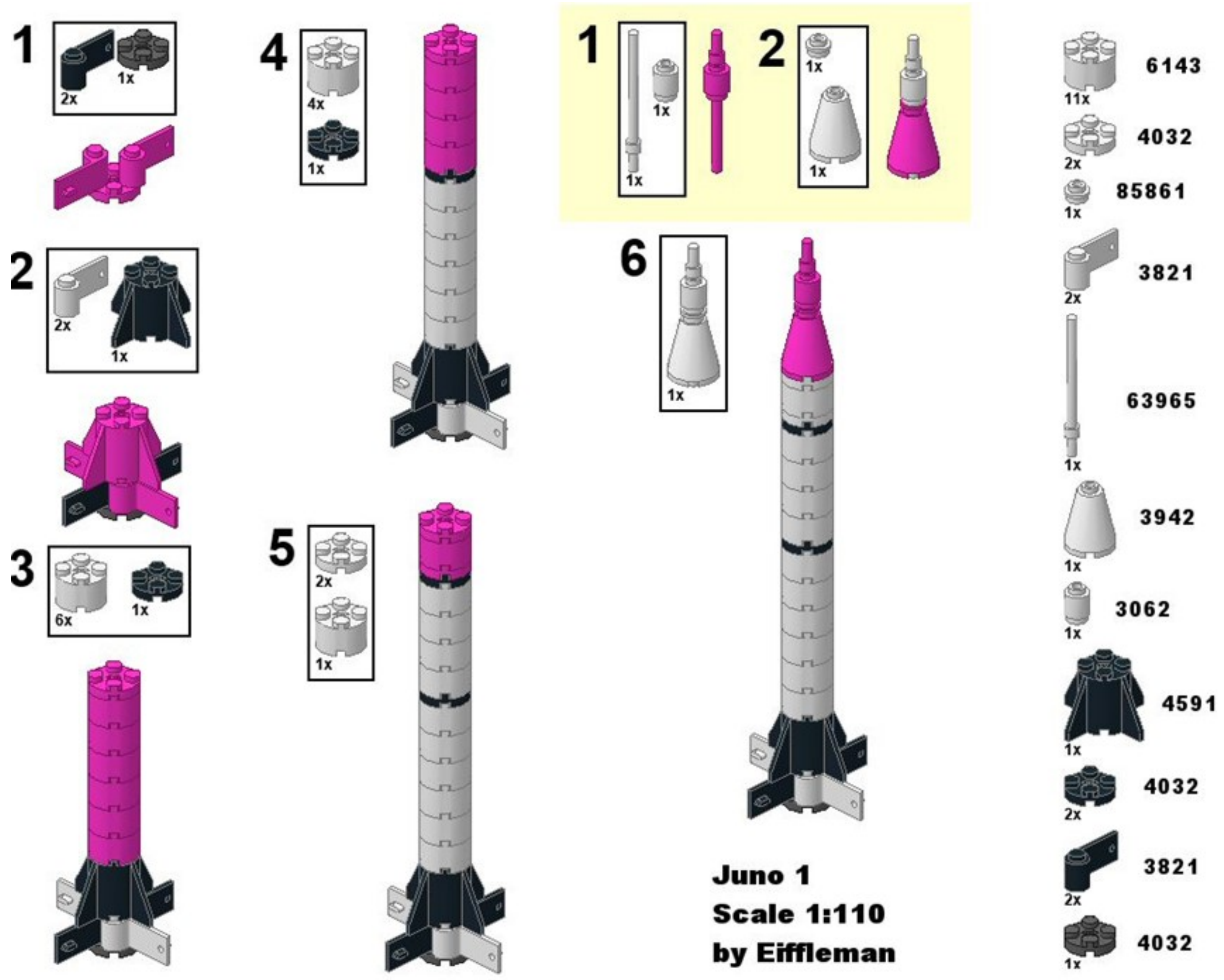
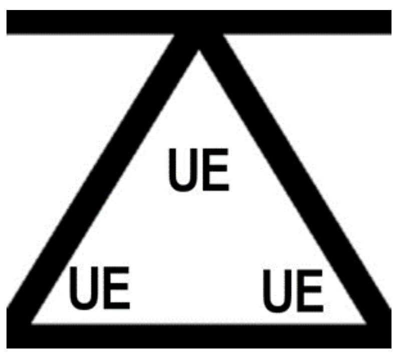




Copy the graphic and wrap it around your model. Print as a sticker or use a smallpiece of tape to fixate it in order to give yourrocket the markings of the Juno I.

Juno II

Juno II was another member of the Redstone family and the second derivative of the PGM-19 Jupiter. Developed rapidly and used for ten satellite launches it Juno II suffered six failed launches and was retired soon afterwards. It launched Pioneer 3, Pioneer 4, Explorer 7, Explorer 8, and Explorer 11 Mercury.

The success of the Redstone rocket provided von Brauns engineers with more resources and an influx of demands by the military, which the group scrambled to meet. Several modifications of the Redstone design were designed and launched in quick succession.

The first Redstone derivate was the PGM-19 Jupiter A. The Army was looking for a highly accurate missile designed to strike high-value targets like bridges, railway yards, troop concentrations and the like. The Navy also expressed an interest in the design as an SLBM, but left the collaboration to work on their own Polaris. Jupiter retained the short, squat shape intended to fit in naval submarines.

The U.S. Army set accuracy goals so high that some expressed skepticism they could be met, but the Redstone team successfully designed a system with a circular error probable (CEP) of 0.5 miles (0.80 km), substantially more accurate than similar designs like the US Air Force's Thor. Production went ahead and the nuclear tipped missiles were deployed in both Italy and Turkey in 1961 due to NATO's Cold War deterrence against the Soviet Union. All were then removed just three years later by the United States as part of a secret agreement (The Secret Deal) with the Soviet Union during the Cuban Missile Crisis.

As with Jupiter C, solid rocket motors derived from the MGM-29 Sergeant were used as upper stages —eleven for the second stage, three for the third stage, and one for the fourth stage. On some launches to low Earth orbit the fourth stage was not flown, allowing the rocket to carry an additional nine kilograms of payload. Development of the Juno II was extremely fast due to being completely built from existing hardware. The project began in early 1958 and the first vehicle flew at the end of the year. Chrysler were responsible for the overall contract, while Rocketdyne handled the first stage propulsion and Jet Propulsion Laboratory handled the upper stage propulsion. The first three were converted Jupiter missiles, however all remaining boosters were built as Juno IIs from the beginning.

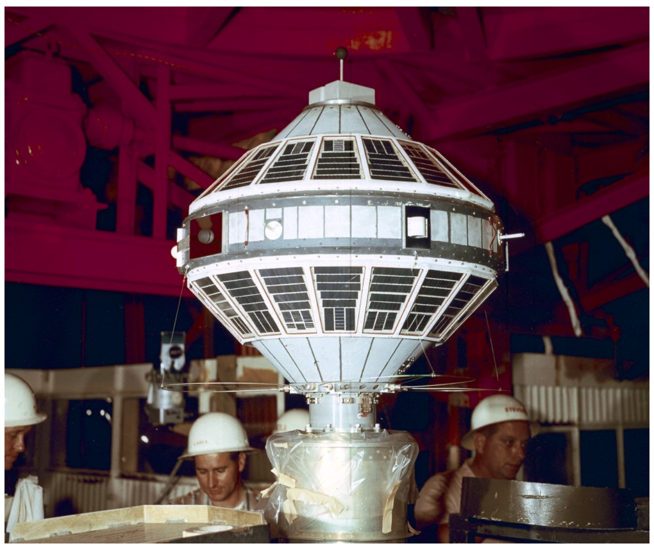
The attempted launch of an Explorer satellite on July 16 failed dramatically when the Juno II lost control almost immediately at liftoff. Credits: NASA

The main differences between the Juno II and Jupiter were stretched propellant tanks for increased burn time (the first stage burn time was approximately 20 seconds longer than on the Jupiter), a reinforced structure to support the added weight of upper stages, and the inertial guidance system replaced with a radio ground guidance package, which was moved to the upper stages.

The first launch of a Juno II, Pioneer 3 on December 12, 1958, suffered a premature first stage cutoff, preventing the upper stages from achieving sufficient velocity. Pioneer 3 could not escape Earth orbit, but transmitted data for some 40 hours before reentering the atmosphere. Pioneer 4 launched successfully on March 3, 1959, making for the only first generation US lunar probe to accomplish all of its mission goals, as well as the sole successful US lunar probe until 1964.

After Pioneer 4, NASA shifted their lunar efforts to the bigger Atlas-Able booster and decided instead to utilize the Juno II for Earth orbital launches.

Overleaf: The ignition of Juno II (AM-19). The launch successfully placed a physics and astronomy satellite, Explorer VII, in orbit on October 13, 1959
Credits: NASA



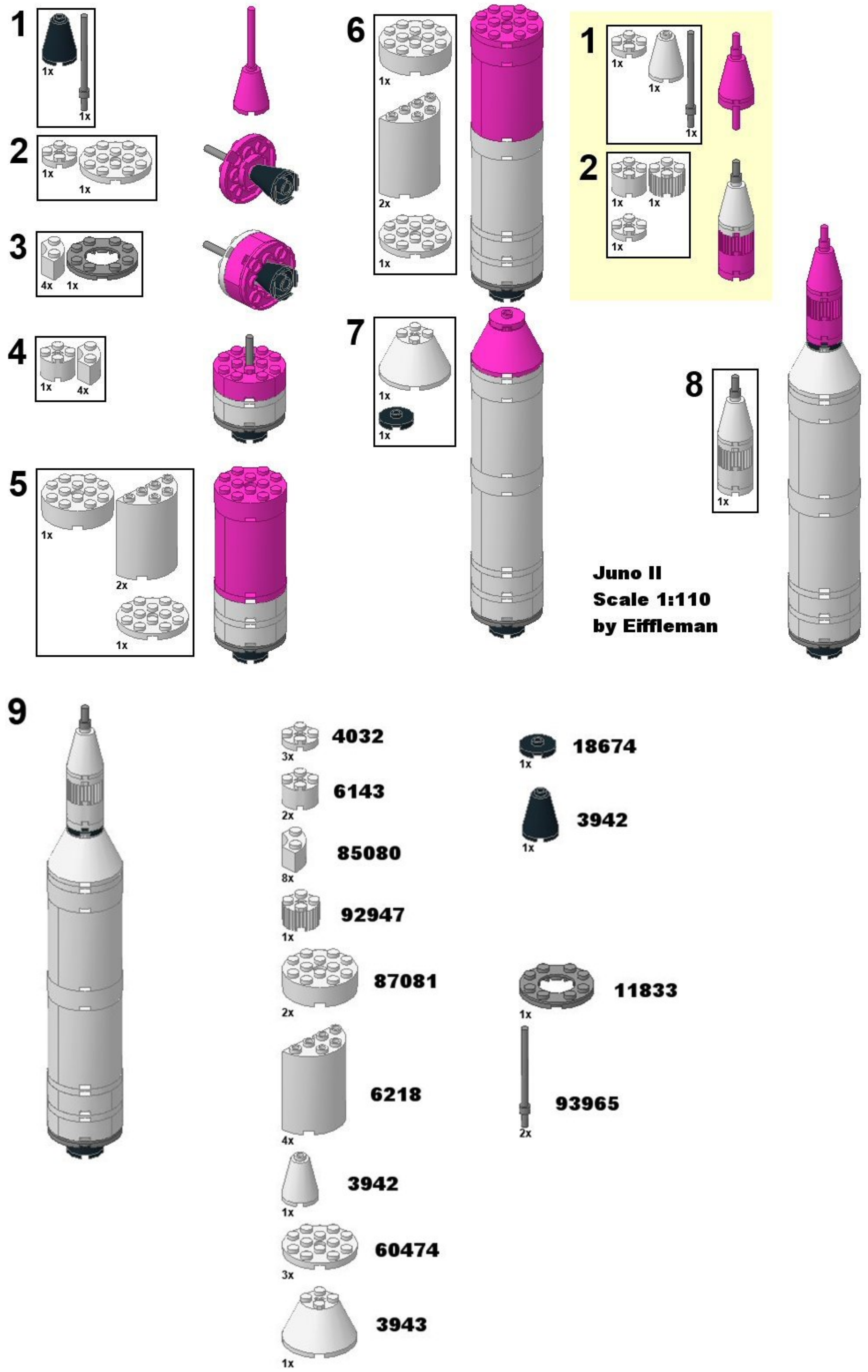
Juno II was a part of America's effort to increase its capability to lift heavier satellites into orbit. One payload was Explorer VII. This photograph depicts workers installing the Explorer VII satellite on Juno II (AM-19A) booster. The Explorer VII investigated energetic particles and obtained data on radiation and magnetic storms.
Credits: NASA

Upper stages stack of the Juno-I (Jupiter-C) and Juno-II rocket inspected before montage, 1958.
Credits: NASA

Datasheet Juno II

General	
Name	Juno II
Function	Expendable launch system
Manufacturer	Chrysler for the ABMA
Country of origin	United States
Cost per Launch	US$10.83m (1985)
Family	
Size	
Height	24.0m (78.7ft)
Diameter	2.67m (8.76ft)
Width	
Mass	55,110kg (121,500lb)
Stages	3 - 4
Capacity	
Payload suborbital	
Payload to LEO	41kg (90lb)
Payload to GEO	
Payload to TLI	6kg (13lb)
Payload to escape	
Launch history	
Status	Retired
Launch sites	LC-5 & LC-26B, CCAFS
Total launches	10
Successes	4
Failures	5
Partial failures	1
First flight	06.12.1958
Last flight	24.05.1961
Notable payloads	
First stage	**Jupiter (Stretched)**
Engines	Rocketdyne S-3D
Thrust	667 kN
Isp	248 s (2.43 kN·s/kg)
Burn time	182 s
Fuel	LOX/RP-1
Gross mass	54,431 kg
Empty mass	5,443 kg
Length	18.28 m
Diameter	2.67 m

Second stage	Baby Sergeant cluster
Engines	11 Solid
Thrust	7,480 kgf (73.4 kN; 16,500 lbf)
Specific impulse	214 sec
Burn time	6 seconds
Fuel	Solid - polysulfide-aluminum and ammonium perchlorate
Gross mass	462 kg
Empty mass	231 kg
Length	1.0 m
Diameter	1.0 m
Third stage	**Baby Sergeant cluster**
Engines	3 Solid
Thrust	2,040 kgf (20.0 kN; 4,500 lbf)
Specific impulse	214 sec
Burn time	6 seconds
Fuel	Solid
Gross mass	126 kg
Empty mass	63 kg
Length	1.0 m
Diameter	0.50 m
Forth stage	**Baby Sergeant**
Engines	1 Solid
Thrust	680 kgf (6.7 kN; 1,500 lbf)
Specific impulse	214 sec
Burn time	6 seconds
Fuel	Solid
Gross mass	42 kg
Empty mass	21 kg
Length	1.0 m
Diameter	0.30 m
Model	
Year Created	2017
Author	Grant Passmore
Parts count	30
Diameter	3,2 cm
Height	21,7 cm
Weigth	46,4 g
Link	https://ideas.lego.com/projects/c3efd970-24c4-443c-8b26-1d6d7f2efa2b/updates


Juno II
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by Eiffleman
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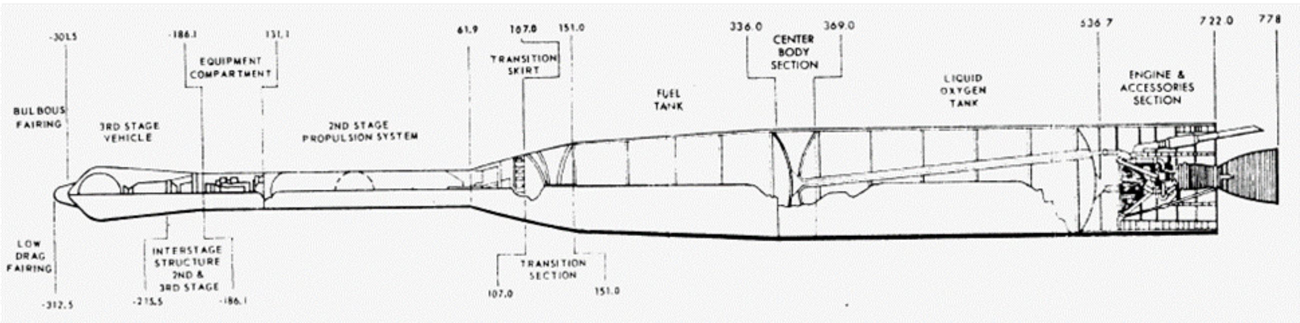
4
5
6
7
8
9
4032 3x
6143 2x
85080 8x
92947 1x
87081 2x
6218 4x
3942 1x
60474 3x
3943 1x
18674 1x
3942 1x
11833 1x
93965 2x

Thor-Delta

Second World War had established the US Air Force as an independent for all practical purposes, but it took until September 1947 to formally separate Army and Air Force into two completely independent branches. The Air Force became responsible not only for fighters and bombers, but also for rockets with a rage over 1.500 miles. However, the Army was loathe to let go of its rocket program, so the Air Force, under pressure to come up with solutions for medium and intercontinental ballistic missiles, set up its own programs, which proved to be successful beyond expectations. Designed to serve as the first operational ICBMs, the Atlas, Thor, and Titan rockets, even though rapidly being replaced with more modern models, formed the backbone of the US unmanned space program while contributing heavily to the success of the manned Apollo program.

The Thor rocket was the first US operational ballistic missile developed under the auspices of the US Air Force. It could deliver a nuclear warhead over a distance of 1,850 to 3,700 km with a CEP of 3.2 km. This range made it possible to hit Moscow from a launch site in the UK.

The panic that struck the US after the Soviet launches of Sputnik in late 1957 caused Secretary of Defense Charles Wilson, in his final act before leaving office, to announce instead that both Thor and Jupiter would go into service.

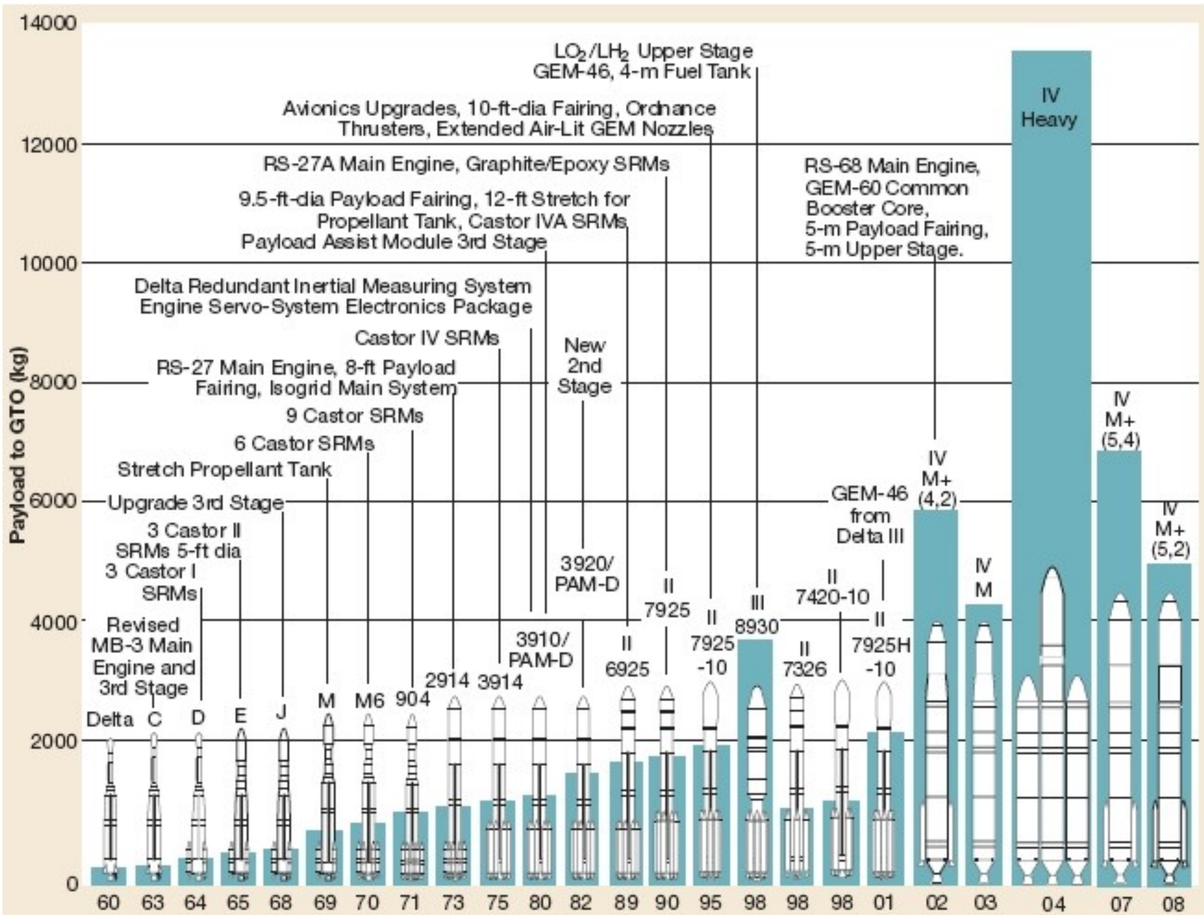


Thor was being developed and tested parallel to the Jupiter rocket. With two IRBMs of nearly identical capabilities, the Army and Air Force were at loggerheads with each other as it seemed obvious that only one of the two would ultimately achieve operational status. Jupiter's testing program, which began two months after Thor's, proceeded more smoothly and avoided accidents such as the explosion of Thor 103 due in large part to the employment of the experienced rocket team of Wernher von Braun. Thanks to the thorough testing done at Huntsville, Jupiter missiles mostly all arrived at CCAS in flight-ready condition while Thors typically required extensive repairs or modification before launch.

Thor was deployed to the UK starting in August 1958, operated by 20 squadrons of RAF Bomber Command under US-UK dual key control. The first active unit was No. 77 Squadron RAF at RAF Feltwell in 1958, with the remaining units becoming active in 1959. As its breathren, the Thor was rapidly aging, and all units were deactivated by September 1963.

Thor-Delta was one of the orbit-capable versions of the Thor. The first stage was a Thor missile in the DM-19 configuration. The second stage was the Delta upper stage, which had been derived from the earlier Able stage. An Altair solid rocket motor was used as a third stage. The Thor-Delta was used for 12 orbital launches in the early 1960s..

The Thor-Delta launched a number of significant payloads, including the first communications satellite, Echo 1A; the first British satellite, Ariel 1; and the first active direct-relay communications satellite, Telstar 1. All 12 launches occurred from Cape Canaveral Air Force Station Launch Complex 17. The real winner, however, proved to be the Delta upper stage. Despite its unassuming launch record the Thor Delta was the first in a long history of Delta-tipped rockets. The design proved so successful that a derivative, the Delta II, remains in service in the present day.

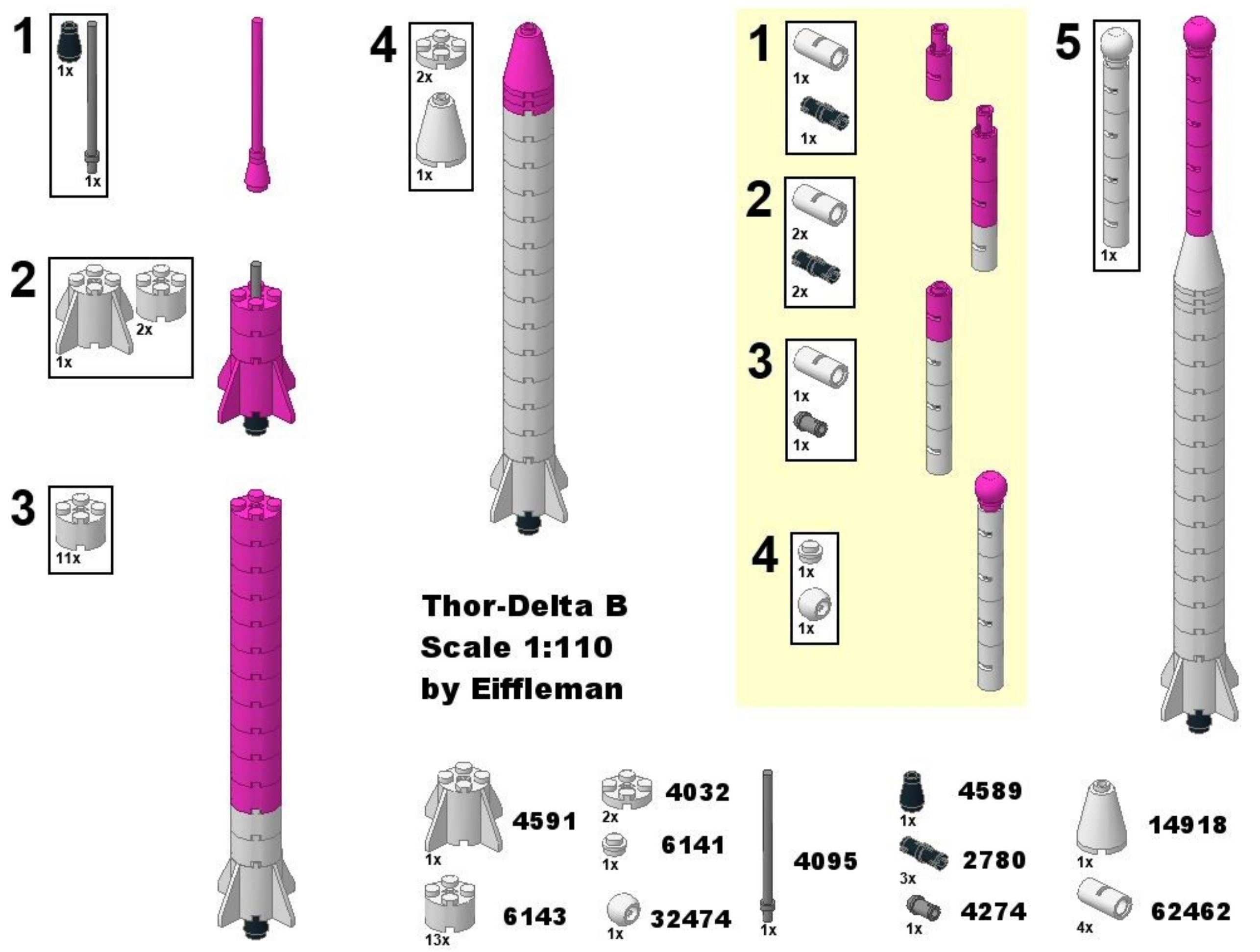


Overleaf: LV Thor Delta B ready to launch with TIROS 8 satellite (Dec. 21 1963)
Credit: USAF

Datasheet Thor—Delta

General	
Name	Thor-Delta
Function	Expendable launch system
Manufacturer	Douglas
Country of origin	United States
Cost per Launch	1985$: 7.270 million.
Family	Thor
Size	
Height	31.00 m (101.00 ft).
Diameter	2.44 m (8.00 ft)
Width	
Mass	54,050 kg (119,150 lb)
Stages	2-3
Capacity	
Payload suborbital	
Payload to LEO	226 kg (498 lb)
Payload to GEO	45 kg (99 lb)
Payload to TLI	
Payload to escape	
Launch history	
Status	Retired
Launch sites	Cape Canaveral LC-17
Total launches	12
Successes	11
Failures	1
Partial failures	
First flight	13.05.1960
Last flight	18.09.1962
Notable payloads	TIROS, Echo, P-14, EPE, OSO,
First stage	**Thor**
Engines	1 MB-3-1
Thrust	760.643 kN (170,999 lbf
Isp	285 sec
Burn time	164 sec
Fuel	RP-1/LOX
Gross mass	48,354 kg (106,602 lb)
Empty mass	2,948 kg (6,499 lb)
Length	18.41 m (60.40 ft)
Diameter	2.44 m (8.00 ft)

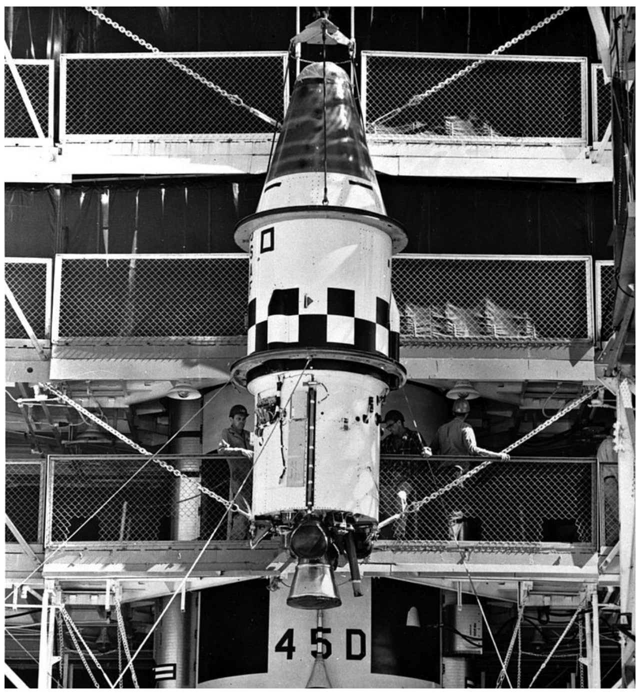
Second stage	Delta
Engines	1 x AJ10-118D
Thrust	33.695 kN (7,575 lbf)
Specific impulse	278 sec
Burn time	170 sec
Fuel	Nitric acid/UDMH
Gross mass	2,693 kg (5,937 lb)
Empty mass	545 kg (1,201 lb)
Length	5.58 m (18.30 ft)
Diameter	0.84 m (2.75 ft)
Third stage	**Altair 1**
Engines	1 x X-248
Thrust	12.450 kN (2,799 lbf)
Specific impulse	256 sec
Burn time	38 sec
Fuel	Solid
Gross mass	238 kg (524 lb)
Empty mass	30 kg (66 lb)
Length	1.83 m (6.00 ft)
Diameter	0.46 m (1.50 ft)
Model	
Year Created	2017
Author	Grant Passamore
Parts count	29
Diameter	3,2 cm
Height	25,2 cm
Weigth	23,7 g
Link	https://ideas.lego.com/projects/c3efd970-24c4-443c-8b26-1d6d7f2efa2b/updates


Thor-Delta B
Scale 1:110
by Eiffleman
4591
4032
6141
6143
32474
4095
4589
2780
4274
14918
62462

Atlas Agena

For research and development the US Air Force could not rely on expertise of captured experts and technology, and thus had to rely on the ingenuity its own engineers. With the reputation of winning the biggest war the world had seen, it had no problem attracting talent from the most prestigious universities. Amongst them were such prodigies as John von Neumann, who headed the ICBM committee, as well as Karell Bossart, who would be named right next to Werner von Braun if most of his work hadn't been classified for decades. The first results of the Air Force engineers was the Atlas, which established a lasting legacy.

The initial impulse for the U.S. Air Force to develop ballistic missiles was the Korean War, after which the Air Force received funding for research and development. By September 1951 the engineers determined that a ballistic rocket design was preferable to a winged vehicle concept. A contract was awarded to Convair (which became the Convair division of General Dynamics Corporation in 1953) for the development of a ballistic missile system, dubbed by Convair as "Project Atlas." In January 1955, even before the first successful flight, the Air Force ordered the Atlas into production.

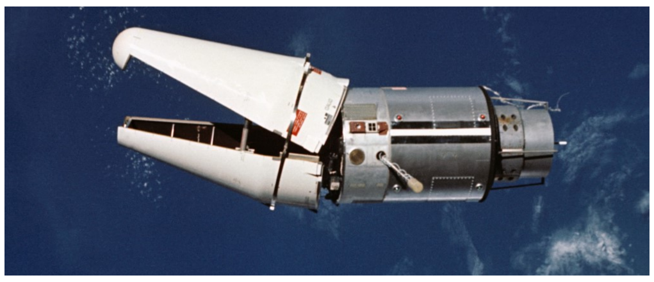


Agena A upper stage with Bell Model 8048 rocket positioned on top of an Atlas rocket at Cape Canaveral, ahead of the May 1960 launch of MIDAS-2
Credits: US Air Force

Overleaf: Atlas Agena D launching Lunar Orbiter 4 on May 4, 1967.
Credit: NASA

Atlas was informally classified as a "stage-and-a-half" rocket; Both the central sustainer engine and the set of two booster engines were started at launch, each drawing from a single set of propellant tanks. At staging, the booster engines would be shut off the booster section would then be released by a series of hydraulic clamps and slide off the missile. From there on, the sustainer and verniers would operate by themselves. Booster staging took place at roughly two minutes into launch, although the exact timing could vary considerably depending on the model of Atlas as well as the particular mission being flown.

The stage-and-a-half design mainly came about because of the Atlas design being finalized in the mid-1950s, at a time when engineers had not yet figured out how to air-start a rocket engine, so having all engines running at liftoff would avoid this problem. Interestingly, he contemporary Soviet R-7 missile used a similar design for the same reason. However, technology advanced quickly and not long after design work on Atlas was completed, Convair rival Martin proposed a solution to the air-starting problem, and their Titan



The "Angry Alligator": A modified Agena upper stage, named Gemini Agena Target Vehicle (GATV) was intended for docking exercises during Gemini 9 mission. However, one half of the protective shroud failed to open, limiting Gemini 9 to rendezvouz exercises. June 3, 1966.
Credit: NASA

I missile, developed as an Atlas backup, had a conventional two stage design.

The Atlas's complicated, unconventional design proved difficult to debug compared with rocket families such as Thor and Titan which used conventional aircraft-style structures and two stage setups and there were dozens of failed launches during the early years. The numerous failures led to Atlas being dubbed an "Inter County Ballistic Missile" by missile technicians, but by 1965 most of the problems had been worked out and it was a reliable launch vehicle.

Atlas shared the fate of Jupiter A and the Titan I insofar it was never fully effective as an ICBM. As a launch vehicle it has formed the basis of the most successful and reliable expendable rockets in service, the Delta rocket family. One of the first derivatives, the Atlas-Agena, was used to launch the first five Mariner unmanned probes to the planets Venus and Mars, and the Ranger and Lunar Orbiter unmanned probes to the Moon. The upper stage was also used as an unmanned orbital target vehicle for the Gemini manned spacecraft to practice rendezvous and docking.

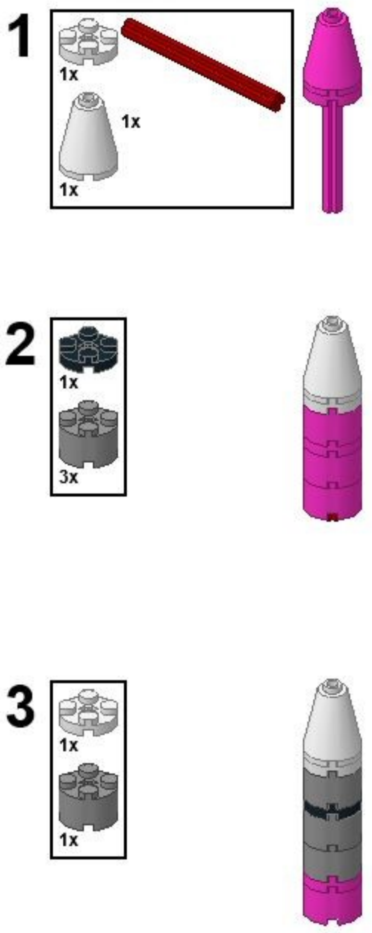
Late in 1960, Lockheed introduced the uprated Agena B stage which was restartable and had longer propellant tanks for more burn time. It first flew on the Redstone-derived Thor and did not make its maiden voyage on an Atlas for months, when Midas 3 launched on July 12, 1961.

Researchers at the National Aeronautics and Space Administration (NASA) Lewis Research Center conducted a series of shroud jettison tests for the second Orbiting Astronomical Observatory (OAO-2) in the Space Power Chambers during April 1968.
Credit: NASA

Datasheet Atlas SLV-3 Agena D

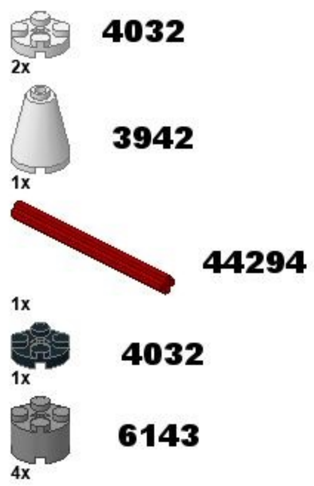
General	
Name	Atlas-Agena
Function	Expendable launch system
Manufacturer	Convair, General Dynamics
Country of origin	United States
Cost per Launch	
Family	Atlas
Size	
Height	32.10 m (105.30 ft)
Diameter	10.0 feet (3.0 m)
Width	3.05 m (10.00 ft)
Mass	140,000 kg (300,000 lb)
Stages	2½-4½
Capacity	
Payload suborbital	
Payload to LEO	2,200 pounds (1,000 kg)
Payload to GEO	1,540 pounds (700 kg)
Payload to TLI	850 pounds (390 kg)
Payload to escape	575 pounds (261 kg)
Launch history	**(all Atlas Agena)**
Status	Retired
Launch sites	LC-12, 13 & 14, CCAFS, SLC-3 & 4, Vandenberg
Total launches	109
Successes	93
Failures	13
Partial failures	3
First flight	26 February 1960
Last flight	27 June 1978
Notable payloads	
Boosters	**Atlas MA-5**
Engines	2 x LR-89-7
Thrust	1,896.010 kN (426,240 lbf)
Isp	294 s
Burn time	174 s
Fuel	LOX/RP-1
Gross mass	3,646 kg (8,038 lb)
Empty mass	3,646 kg (8,038 lb)
Length	5,20 m (17.00 ft)
Diameter	4.90 m (16.00 ft)

First stage	Atlas Agena SLV-3A
Engines	1 x LR-105-7
Thrust	386.300 kN (86,844 lbf)
Specific impulse	316
Burn time	175 seconds
Fuel	LOX/Kerosene
Gross mass	142,000 kg (313,000 lb)
Empty mass	3,700 kg (8,100 lb)
Length	20.67 m (67.81 ft)
Diameter	4.90 m (16.00 ft)
Third stage	**Agena D**
Engines	1 x Bell 8096
Thrust	71.166 kN (15,999 lbf)
Specific impulse	300 s
Burn time	265 s
Fuel	Nitric acid/UDMH
Gross mass	6,821 kg (15,037 lb)
Empty mass	673 kg (1,483 lb)
Length	7.09 m (23.26 ft)
Diameter	1.52 m (4.98 ft)
Forth stage	**Burner 2**
Engines	1 x Star 37
Thrust	43.551 kN (9,791 lbf)
Specific impulse	285 s
Burn time	42 s
Fuel	Solid
Gross mass	774 kg (1,706 lb)
Empty mass	116 kg (255 lb)
Length	0.84 m (2.75 ft)
Diameter	0.66 m (2.16 ft).
Model	
Year Created	2018
Author	Grant Passmore
Parts count	85
Diameter	6,8 cm
Height	25 cm
Weigth	74,7 g
Link	https://ideas.lego.com/projects/c3efd970-24c4-443c-8b26-1d6d7f2efa2b/updates



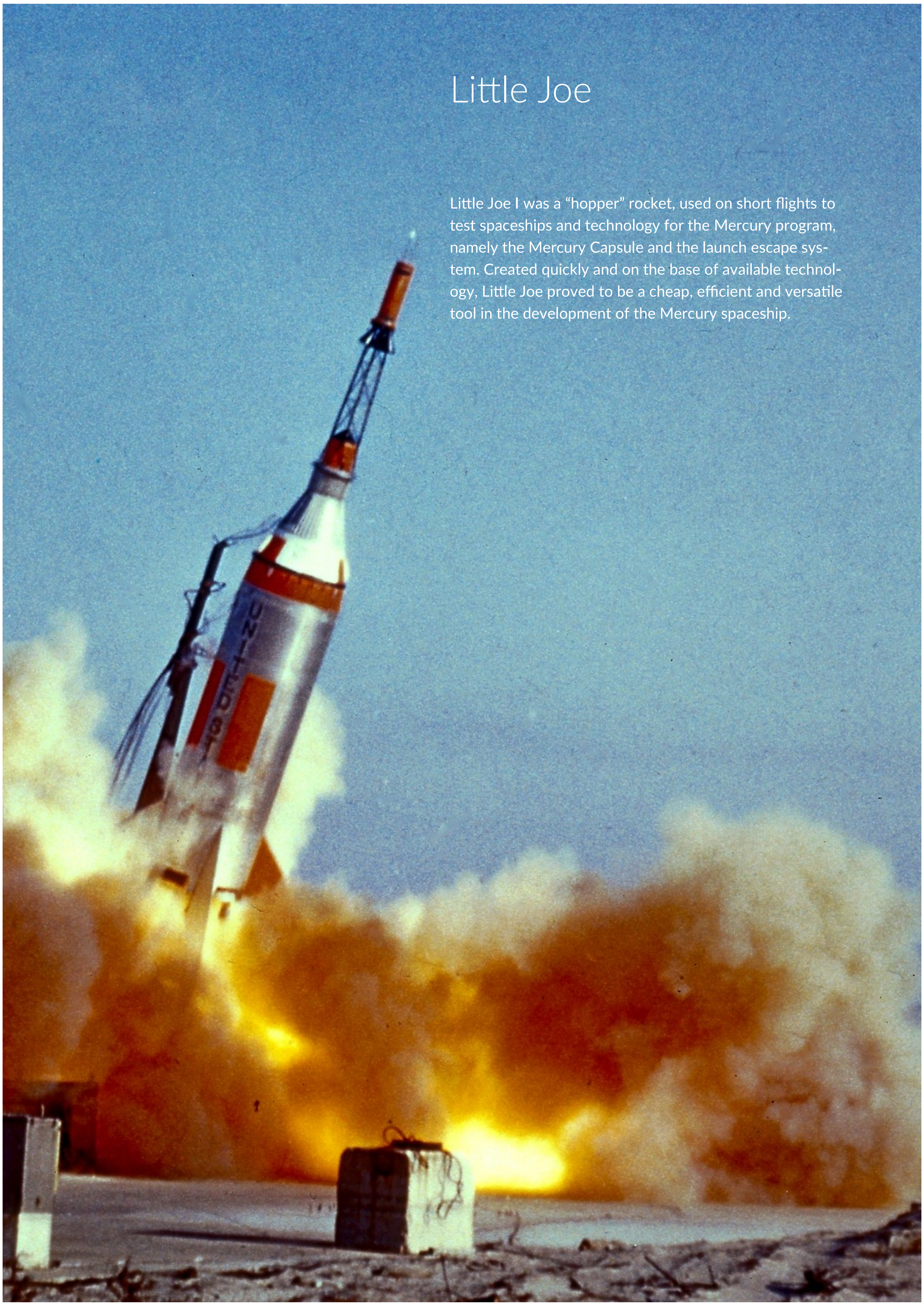
Agena D payload
for Atlas Rocket
(replaces Mercury Capsuel)
Scale 1:110

Agena D Parts list



Little Joe

Little Joe I was a “hopper” rocket, used on short flights to test spaceships and technology for the Mercury program, namely the Mercury Capsule and the launch escape system. Created quickly and on the base of available technology, Little Joe proved to be a cheap, efficient and versatile tool in the development of the Mercury spaceship.

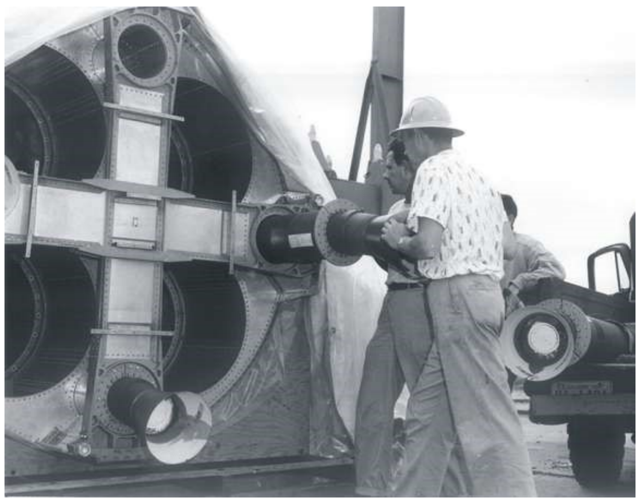


After Sputnik, the US government decided to concentrate all space efforts in a civilian agency. On October 1, 1958, NASA was officially founded and absorbed a host of various missile agencies from Army, Navy and Air Force, laboratories and test facilities. Its first project, named Project Mercury, was to get a human to space as quickly as possible.

The Atlas rockets who were supposed to carry astronauts into orbit would cost approximately $2.5 million each, and even the Redstone would cost about $1 million per launch. The managers of the Mercury program recognized that the numerous early test flights would have to be accomplished by a far less expensive booster system. As it turned out, the Little Joe rocket NASA designed for these tests cost about $200,000 each.

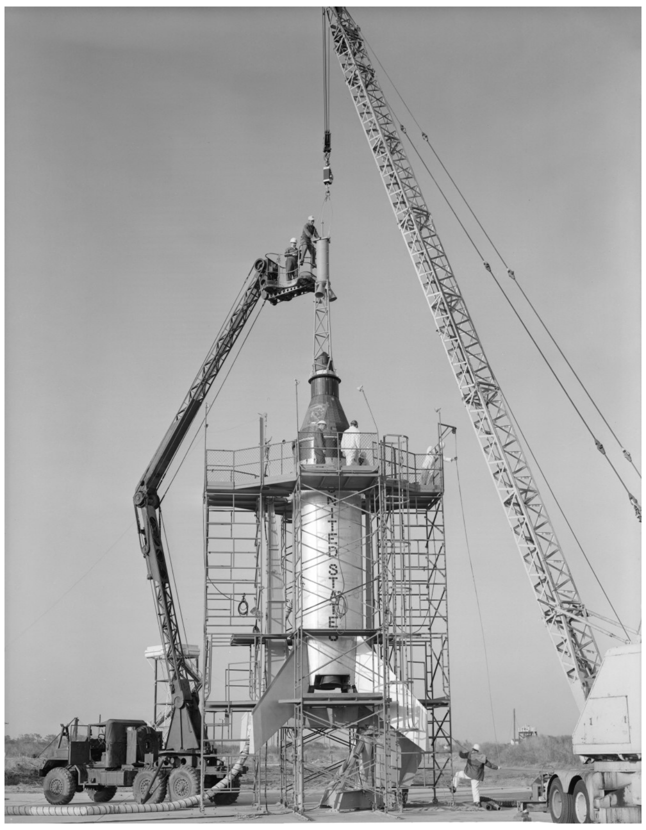
By being relatively cheap, Little Joe allowed numerous test flights to qualify various solutions to the myriad problems associated with the development of manned space flight, especially the problem of escaping from an explosion at or during launch. Capsule aerodynamics under actual reentry conditions was another primary concern. To gain this kind of experience as soon as possible, its designers had to keep the clustered booster simple in concept; it should use solid fuel and existing proven equipment whenever possible, and should be free of any electronic guidance and control systems.

The designers made the Little Joe booster assembly to approximate the same performance that the Army's Redstone booster would have with the capsule payload. But in addition to being flexible enough to perform a variety of missions, Little Joe could be made for about one-fifth the basic cost of the Redstone, would have much lower operating costs, and could be developed and delivered with much less time and effort. And, unlike the larger launch vehicles, Little Joe could be shot from the existing facilities at Wallops Island.



Castor boostrers are loaded into a Little Joe rocket.
Credit: NASA

Overleaf: The launch of the Little Joe booster for the LJ1B mission on the launch pad from the Wallops Flight Facility, Wallops Island, Virginia, on January 21, 1960.
Credit NASA



View of the mating of Little Joe-5B launch vehicle with Mercury capsule #14 on 23 April 1961.
Credit NASA

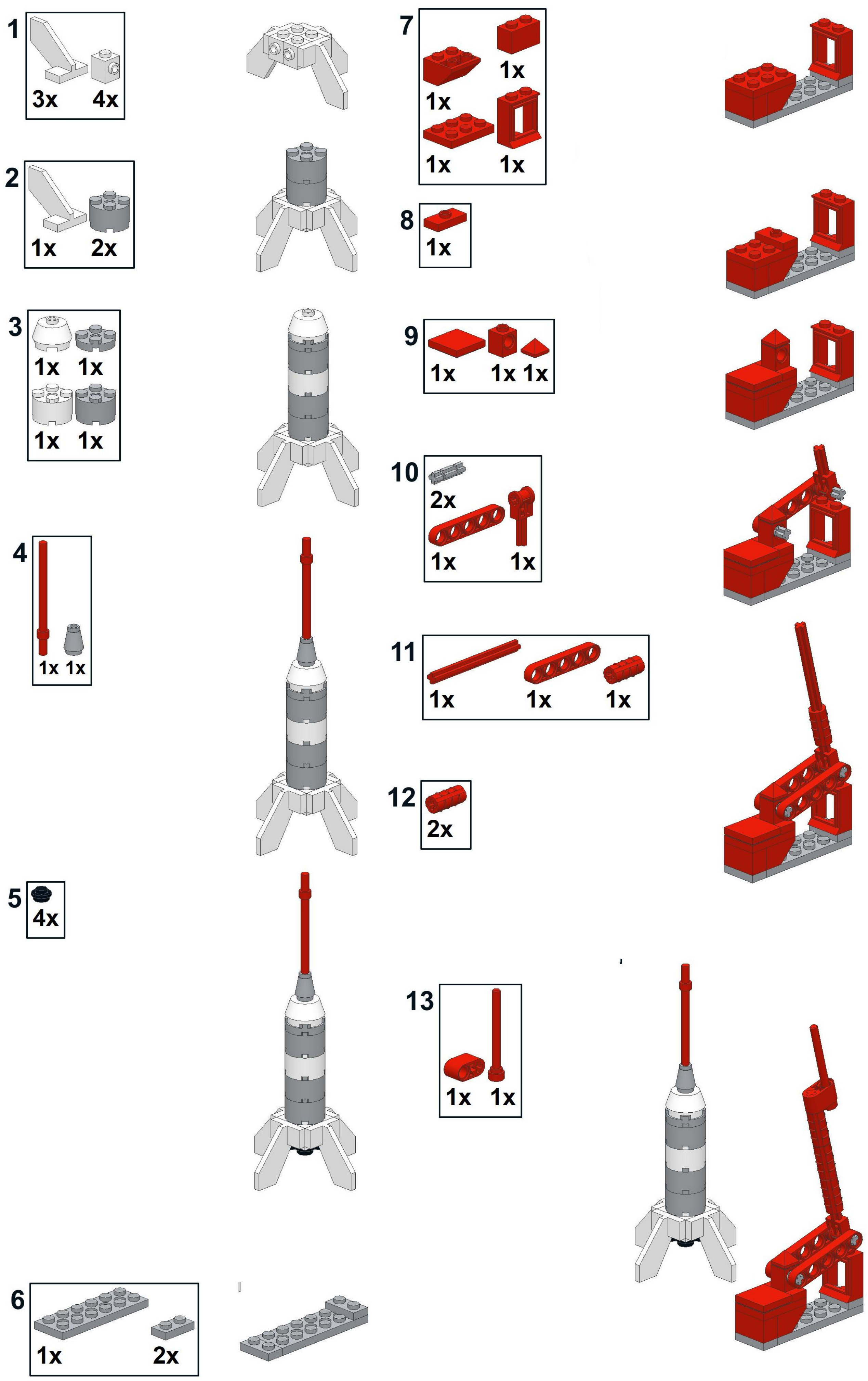
The first of only two booster systems designed specifically and solely for manned capsule qualifications, Little Joe was also one of the pioneer operational launch vehicles using the rocket cluster principle. Since the four modified Sergeants (called either Castor or Pollux rockets, depending upon modification) and four supplemental Recruit rockets were arranged to fire in various sequences, the takeoff thrust varied greatly, but maximum design thrust was almost 230,000 pounds (1,020 kilonewtons). Theoretically enough to lift a spacecraft of about 4,000 pounds (1,800 kg) on a ballistic path over 100 miles (160 km) high, the push of these clustered main engines should simulate the takeoff profile in the environment that the manned Atlas would experience. Furthermore, the additional powerful explosive pull of the tractor-rocket escape system could be demonstrated under the most severe takeoff conditions imaginable. The engineers who mothered Little Joe to maturity knew it was not much to look at, but they hoped that their ungainly rocket would prove the legitimacy of most of the ballistic capsule design concepts, thereby earning its own honor.

The Little Joe name has been attributed to Maxime Faget at NASA's Langley Research Center in Hampton, Virginia. He based the name on four large fins which reminded him of a slang term for a roll of four in craps.

Datasheet Little Joe

General	
Name	Little Joe
Function	Unmanned capsule testing
Manufacturer	North American Aviation
Country of origin	United States
Cost per Launch	
Family	Mercury
Size	
Height	15.20 m (49.80 ft)
Diameter	2.03 m (6.66 ft)
Width	
Mass	12,700 kg (27,900 lb)
Stages	2
Capacity	
Payload suborbital	1,400 kg (3,000 lb)
Payload to LEO	
Payload to GEO	
Payload to TLI	
Payload to escape	
Launch history	
Status	Retired
Launch sites	Wallops Island, Virginia
Total launches	8
Successes	6
Failures	2
Partial failures	
First flight	August 21, 1959
Last flight	April 28, 1961
Notable payloads	Mercury Capsule

Boosters	
No. Boosters	4
Engines	Recruit rockets
Thrust	(167 kN) × 4 = (668 kN)
Isp	
Burn time	1.53 sec
Fuel	solid
Length	
Diameter	
First stage	
Engines	Castor
Thrust	(259 kN) × 4 = (1,036 kN)
Isp	
Burn time	37 sec
Fuel	Solid
Gross mass	
Empty mass	
Length	
Diameter	
Model	
Year Created	2018
Author	Wolfram Broszies
Parts count	16 (Rocket) 23 (Launchpad)
Diameter	5,1 cm
Height	12,4 cm
Weigth	11,8 g
Link	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1x 1x
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12
2x
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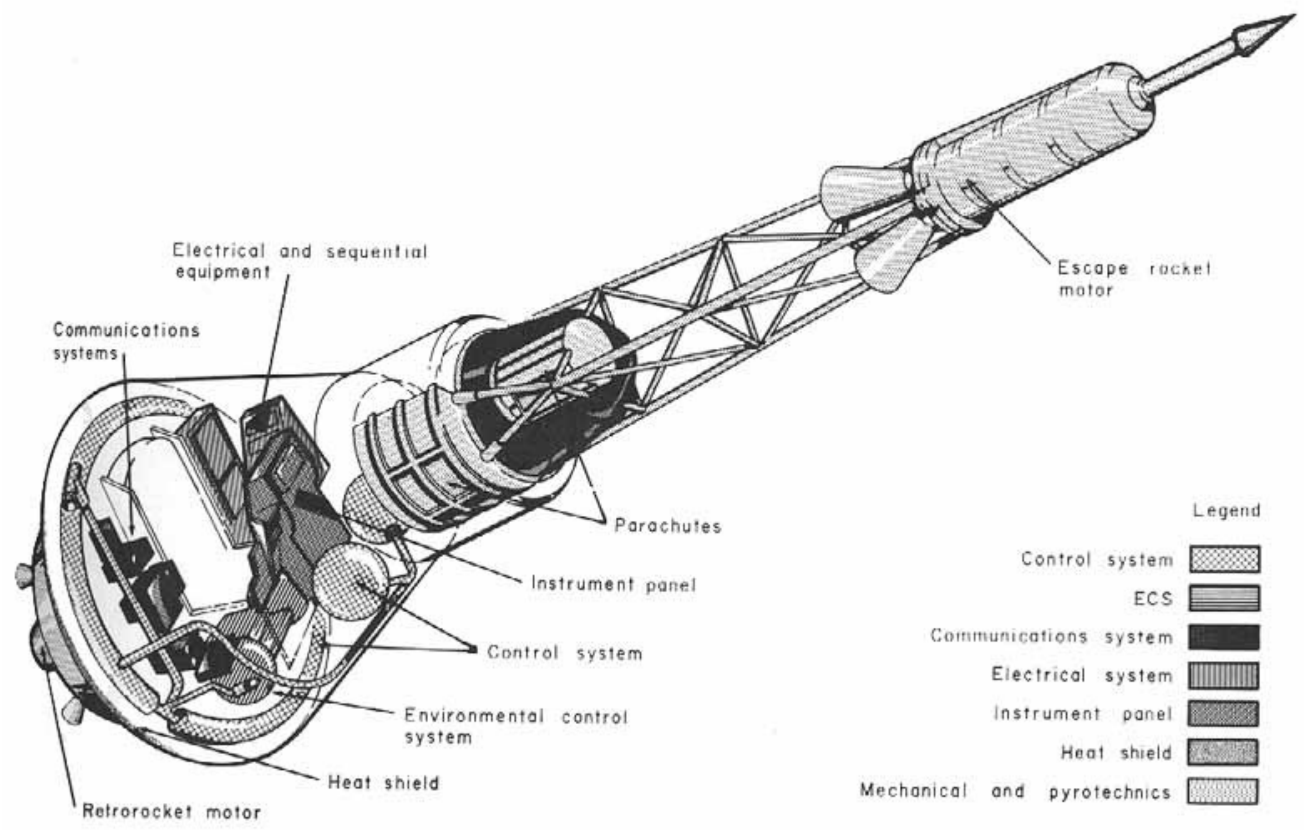
1x 1x

Redstone—Mercury

Project Mercury was the NASA program that put the first American astronauts in space. Astronauts made a total of six spaceflights during Project Mercury, of which two reached space and came right back down. These are called suborbital flights and were made using the Redstone rocket as a launch vehicle. The other four flights were using the Atlas rocket and went into orbit to circle Earth. The first of those six flights was made in 1961, the last in 1963.

NASA chose the U.S. Army's Redstone liquid-fueled ballistic missile for its suborbital flights as it was the oldest one in the US fleet, having been active since 1953 and had many successful test flights. The standard military Redstone lacked sufficient thrust to lift a Mercury capsule into the ballistic suborbital trajectory needed for the project. However, the first stage of the Jupiter-C, which was a modified Redstone with lengthened tanks, could carry enough propellant to reach the desired trajectory. Therefore, this Jupiter-C first stage was used as the starting point for the Mercury-Redstone design.

The most important change in making the Mercury-Redstone a suitable vehicle for an astronaut was the addition of an automatic in-flight abort sensing system. In an emergency where the rocket was about to suffer a catastrophic failure, an abort would activate the launch escape system attached to the Mercury capsule, which would rapidly eject it from the booster. Either the astronaut or the ground controllers could initiate an abort manually.

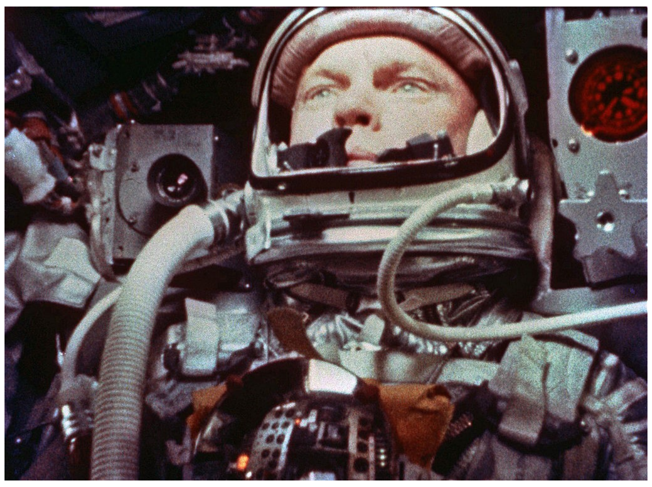


The Mercury space capsule was built by McDonnell Aircraft, and carried supplies of water, food and oxygen for about one day in a pressurized cabin. The spacecraft's principal designer was Maxime Faget, who started research for manned spaceflight during the time of the NACA. With 100 cubic feet (2.8 m3) of habitable volume, the capsule was just large enough for a single crew member. Inside were a mere 120 controls: 55 electrical switches, 30 fuses and 35 mechanical levers. The Mercury spacecraft did not have an on-board computer, instead relying on all computation for reentry to be calculated by computers on the ground, with their results (retrofire times and firing attitude) then transmitted to the spacecraft by radio while in flight. All computer systems used in the Mercury space program were housed in NASA facilities on Earth.

Mercury flights were launched from Cape Canaveral Air Force Station in Florida. The capsule was fitted with a launch escape rocket to carry it safely away from the launch vehicle in case of a failure. The flight was designed to be controlled from the ground via the Manned Space Flight Network, a system of tracking and communications stations; back-up controls were outfitted on board. Small retrorockets were used to bring the spacecraft out of its orbit, after which an ablative heat shield protected it from the heat of atmospheric reentry. Finally, a parachute slowed the craft for a water landing. Both astronaut and capsule were recovered by helicopters deployed from a U.S. Navy ship.

The Mercury project gained popularity, and its missions were followed by millions on radio and TV around the world. Its success laid the groundwork for Project Gemini, which carried two astronauts in each capsule and perfected space docking maneuvers essential for manned lunar landings in the subsequent Apollo program announced a few weeks after the first manned Mercury flight. In keeping with the classic theme of naming things, the project was named Mercury after the Roman messenger of the Gods.

Overleaf: Mercury-Redstone 2 (MR-2) launch with chimpanzee Ham aboard, 31 January 1961 . Monkeys had been flown into space before, but Ham was the first higher primate to test a spacecraft.
Credit: NASA



A camera aboard the "Friendship 7" Mercury spacecraft photographs Astronaut John H. Glenn Jr. during the Mercury-Atlas 6 spaceflight, 26 February 1962.
Credit: NASA

Datasheet Redstone-Mercury

General	
Name	Mercury-Redstone Launch Vehicle
Function	Human-rated sub-orbital launch
Manufacturer	Chrysler Corporation
Country of origin	United States
Cost per Launch	4.930 million.
Family	Redstone
Size	
Height	25.41 m (83.38 ft)
Diameter	1.78 m (5.83 ft)
Width	4.19 m (13.74 ft)
Mass	30,000 kg (66,000 lb)
Stages	1
Capacity	
Payload suborbital	1,800 kg (4,000 lb)
Payload to LEO	-
Payload to GEO	
Payload to TLI	
Payload to escape	
Launch history	
Status	Retired
Launch sites	Launch Complex 5, Cape Canaver-al, Florida
Total launches	6
Successes	5
Failures	1
Partial failures	
First flight	November 21, 1960
Last flight	July 21, 1961
Notable payloads	Mercury Capsule

First stage	
Engines	1 Rocketdyne A-7
Thrust	414.34 kN (93,147 lbf)
Isp	235 sec
Burn time	155 seconds
Fuel	LOX/ethyl alcohol
Gross mass	28,440 kg (62,690 lb)
Empty mass	3,125 kg (6,889 lb)
Length	17.58 m (57.67 ft)
Diameter	1.77 m (5.80 ft)
Model	
Year Created	2017
Author	Grand Passmore
Parts count	29
Diameter	4,8 cm
Height	22,8 cm
Weigth	25,8 g
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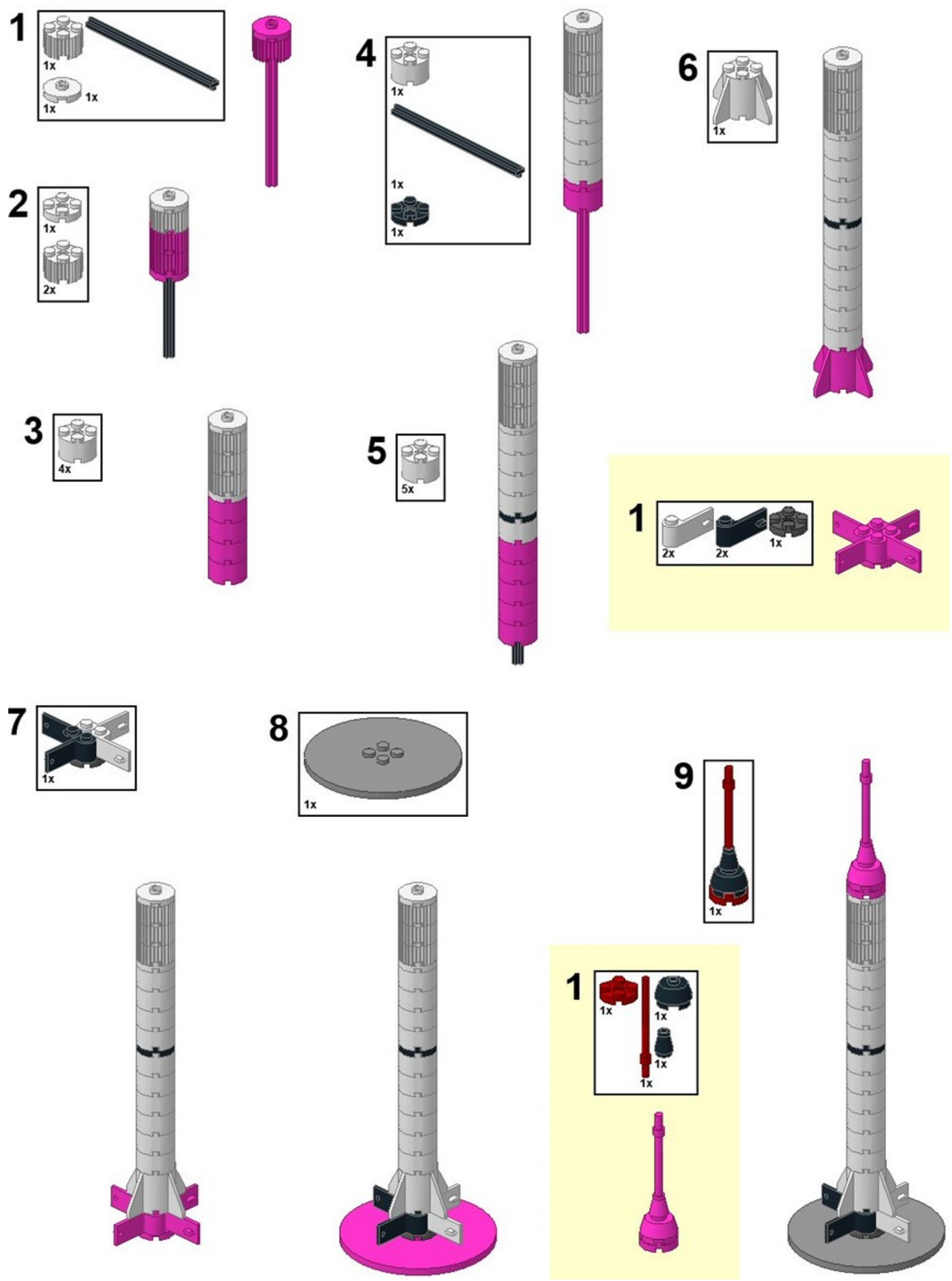
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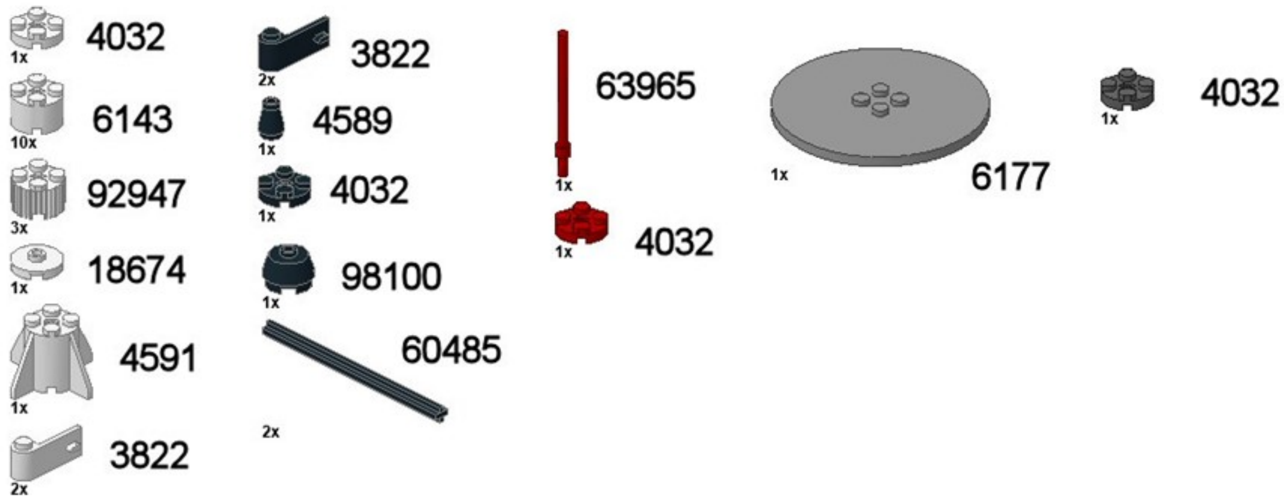

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Copy the graphic and wrap it around your model. Print as a sticker or use a smallpiece of tape to fixate it in order to give yourrocket the markings of the Mercury Redstone.

Launch Pad 5

The Air Force Base at Cape Kennedy was chosen as a suitable spot from which to launch to space, for it was one of the few available places offering a large body of water to the east, which would reduce the possibility of damages due to failed launches.

The Cape's first modest pads, LC (Launch Complrex) 1-4, had been clustered about 1 km northeast of the lighthouse. LC 5 was part of the first of many far-flung launch complexes built on the Cape after 1955. The first dedicated U.S. Army Ballistic Missile Agency (ABMA) Launch Complex at Cape Canaveral included LC 5, 6, 26A, and 26B. The site played a pivotal role in U.S. missile and space development. Launch Complex 5 hosted the first successful U.S. satellite and suborbital primate and human astronaut flights, as well as the first U.S. Intermediate Range Ballistic Missile (IRBM) flight.

Mercury-Redstone 3 (MR-3) Prelaunch Activities on the Mercury 5 launch pad., April 21st, 1961.
Credit: NASA

The Launch Complex reflects the early mobile launch concept work of Dr. Kurt H. Debus, Director of the ABMA Missile Firing Laboratory. During 1954-55, Debus oversaw development of the two pads at LC 5 and 6 to support Redstone testing. In 1956-57, Debus managed construction of adjacent LC 26, just north of LC 5 and 6. The two new LC26 pads were meant to add launch capacity for ABMA's Jupiter missile development program.

Eventually, Debus provided the Complex with three mobile service towers that moved about on an interconnecting double-track railroad plant. This design allowed the towers to move from pad to pad as needed. Debus went on to develop nearby LC30 for the ABMA Pershing program, LC 34 and 37 for NASA's Saturn 1, and LC39, the ultimate mobile launch complex, for Saturn 5. He was named director of NASA's Launch Operations Center (later Kennedy Space Center) in 1962 and served in that position until 1974.

A total of 23 launches were conducted from LC-5: one Jupiter-A, six Jupiter IRBMs, one Jupiter-C, four Juno Is, four Juno IIs and seven Redstones. The first launch from the complex was a Jupiter-A on July 19, 1956 and the final launch was Gus Grissom's Liberty Bell 7 capsule on July 21, 1961

Designers Notes:
The centerpiece of the set is the Noble Company's Redstone service tower which features the four access platforms used to prepare the Mercury-Redstone for launch. The Noble company had built other similar platforms for the unmanned Redstone based rockets but this tower needed a couple of unique modifications. Platform 3 was given a semi clean room to minimize dirt and dust being brought into the capsule. Platform 4 was used to work on the launch escape tower. The rocket motors in the tower could not be made safe so Platform 4 included blast deflectors to protect personnel working on the tower.

The Launchpad and Mercury-Redstone Rocket.: The long umbilical to the capsule and booster only rest against the sides of the rocket. It may be necessary to twist the pistol at the end of the umbilical to make it sit centrally on the rocket.

The Gantry:
1. It is important that the fixed sections of each platform are aligned centrally on the axles between the A-Frame connections . The connections also need to be evenly spaced from either side of the fixed platform. Check the attachment points against the pins on the A-frame and adjust before snapping them into position.

2. Do the above settings for the two middle platforms before they are joined together. Once joined they provide a four point connection to the A-Frame which stabilizes the frame and stops any sideways movement. By folding the frame down you can check your alignment as the rear of the fixed platforms goes into the channel on the base of the gantry.

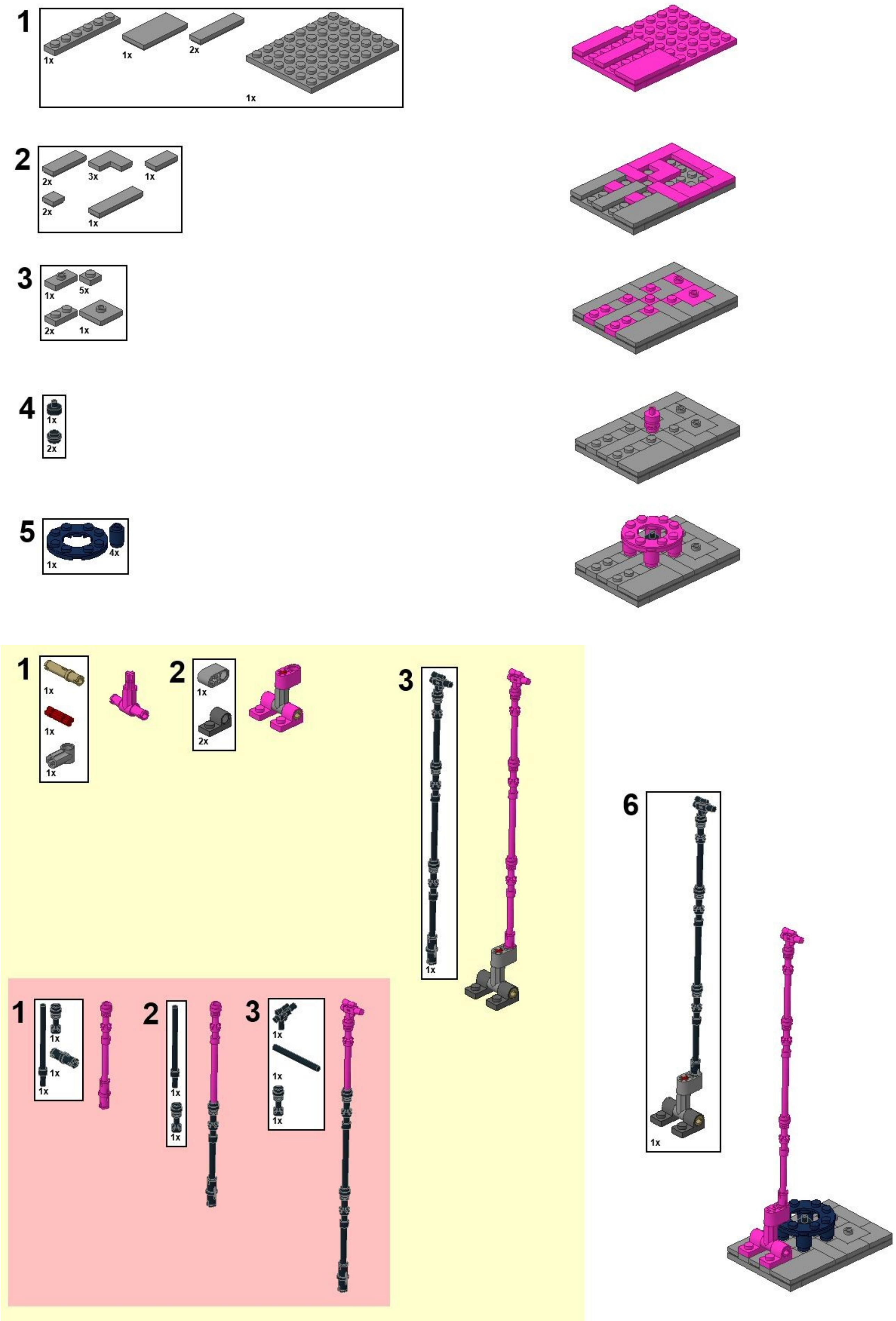
3. The studs on the back row of the platform go under the 'gliding groove' on the 2x8 piece on the fixed part of the platform. Slide the platforms all the way in - they will stop in at the mid point. Make up the end stops from the 1x2 roof tiles and 1x2 angular plates and attach them to the ends of the fixed platform's 1x12 plates. On the middle section guide the end stops over the technic connectors to the A-frame before they can be clicked into place.

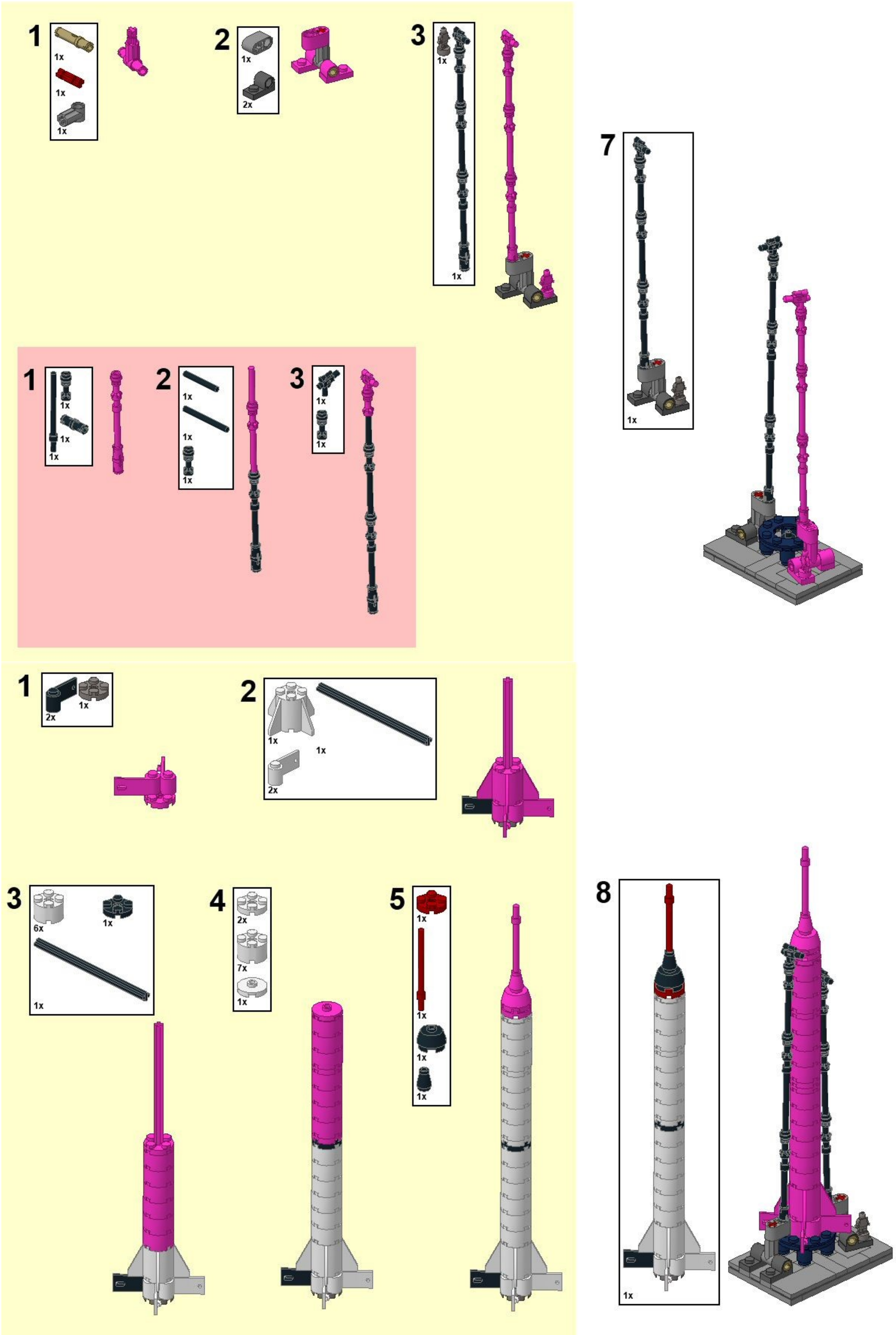
The Cherry Picker: The hinge pieces need to be new and have a lot of friction to hold the long arm of the cherry picker with the cab at the capsule.

The Transfer Van. Fun fact: Only the astronaut had a seat in the van, the technicians had to stand. The vehicle was driven slowly to the pad and driver made announcements over an intercom to warn the people in the van when he was going to turn or brake so they could brace themselves.

The Mercury-Redstone booster for flight Mercury-Redstone 4 (MR-4) is here being erected on the launch pad. Photo published on July 16, 1961, but probably taken much earlier, since the booster was normally erected weeks before the launch date.
Credit: NASA

Kennedy Space Center, Launch Pad 5

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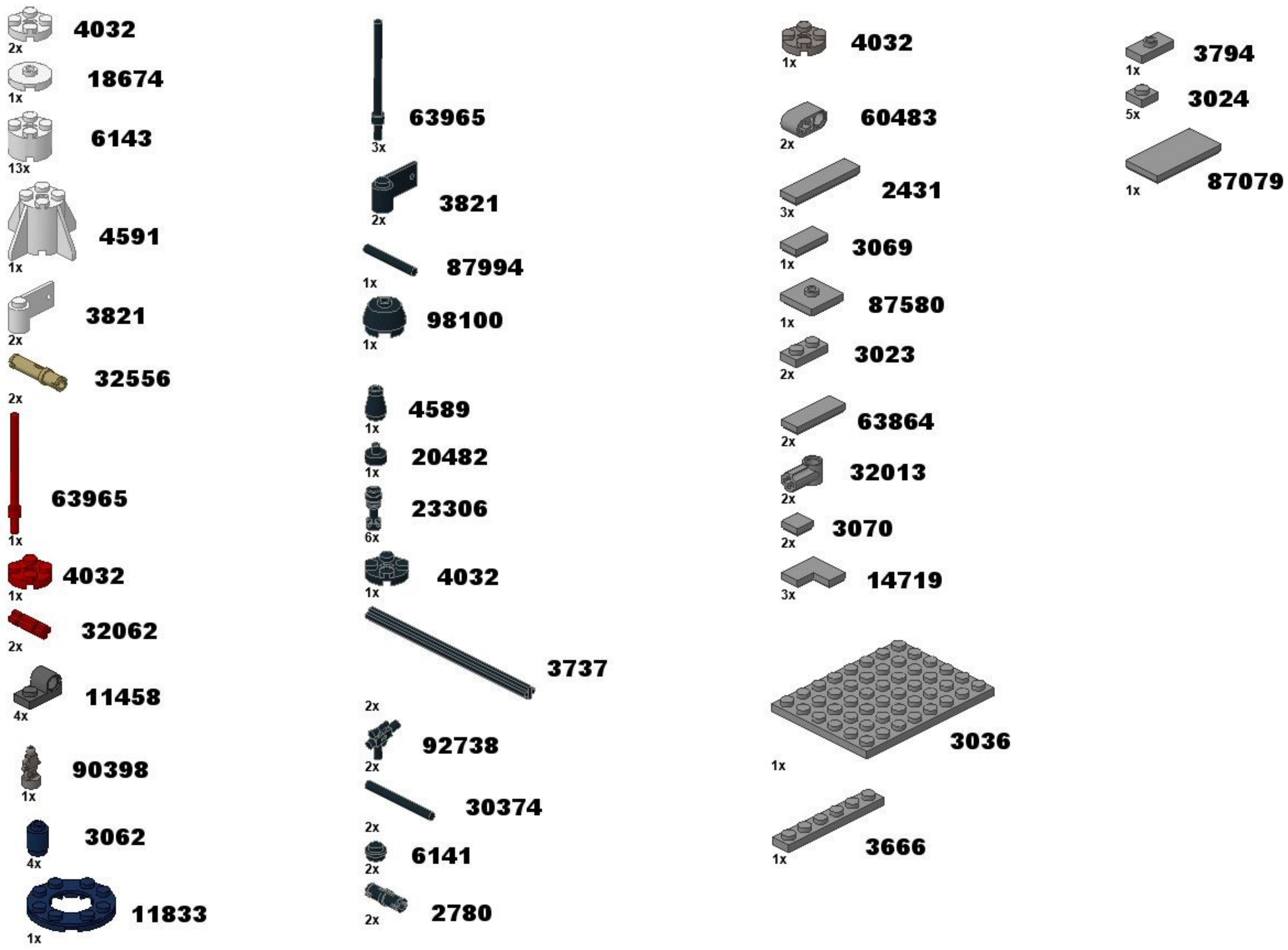
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4x 3062
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3x 63965
2x 3821
1x 87994
1x 98100
1x 4589
1x 20482
6x 23306
1x 4032
2x 3737
2x 92738
2x 30374
2x 6141
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3x 2431
1x 3069
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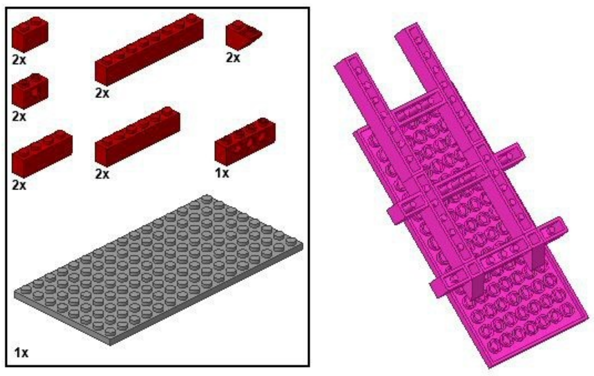

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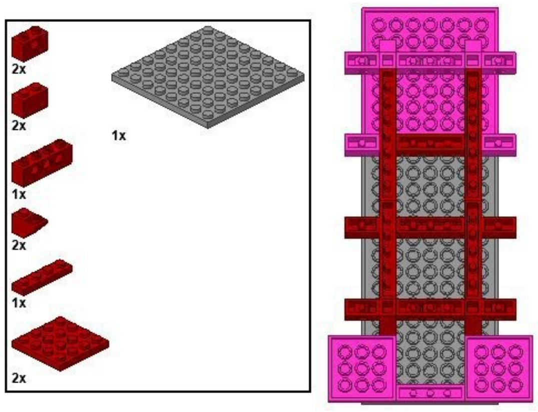

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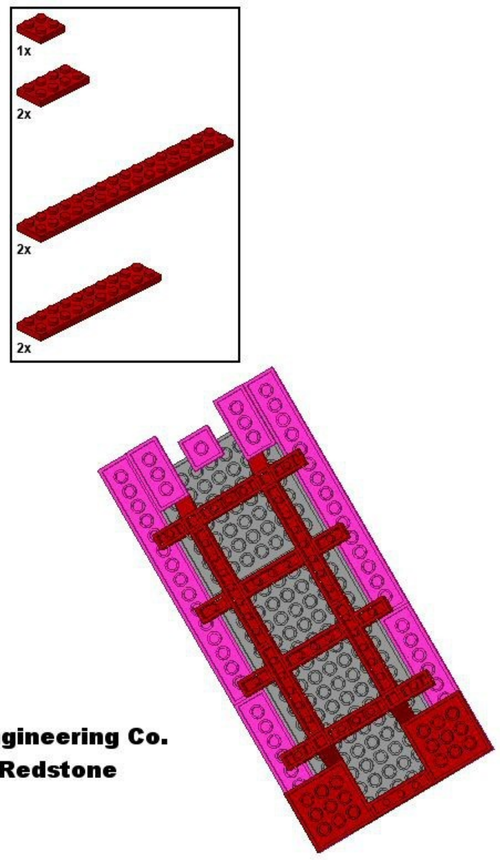
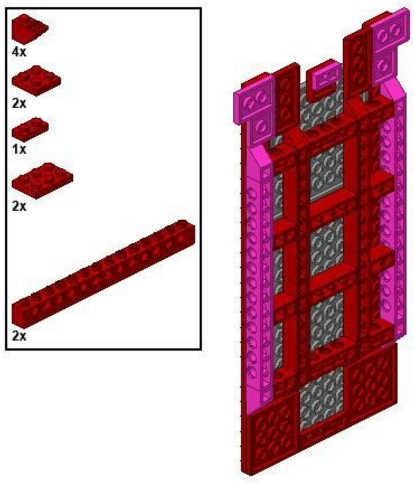


Noble Engineering Co.
Mercury-Redstone
Gantry
by
Eiffleman (C)2019

4



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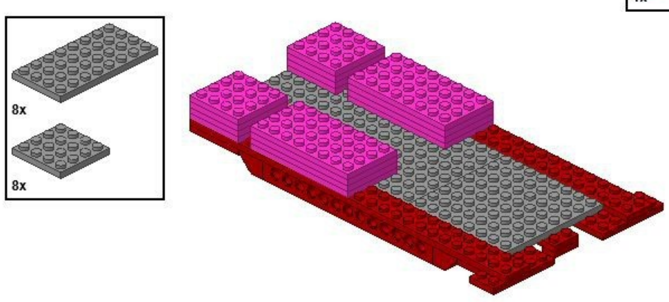

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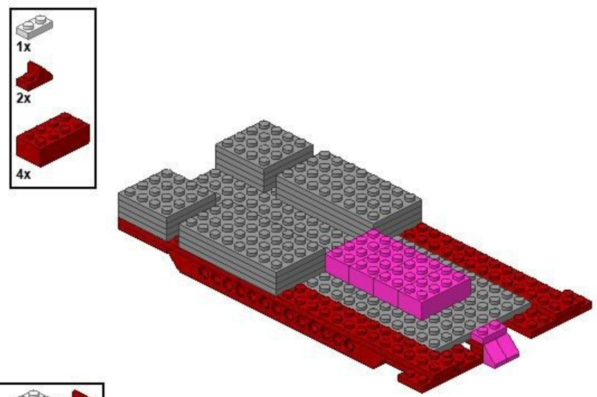

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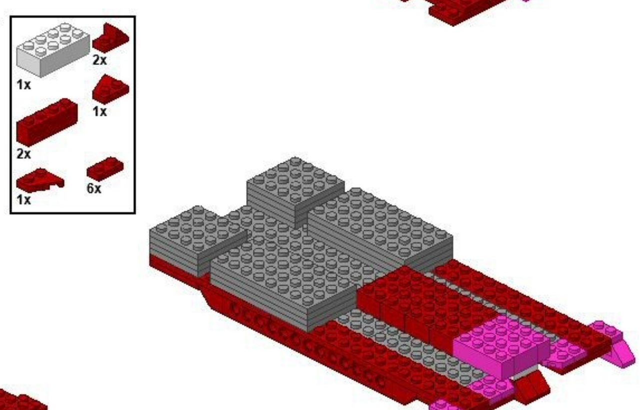

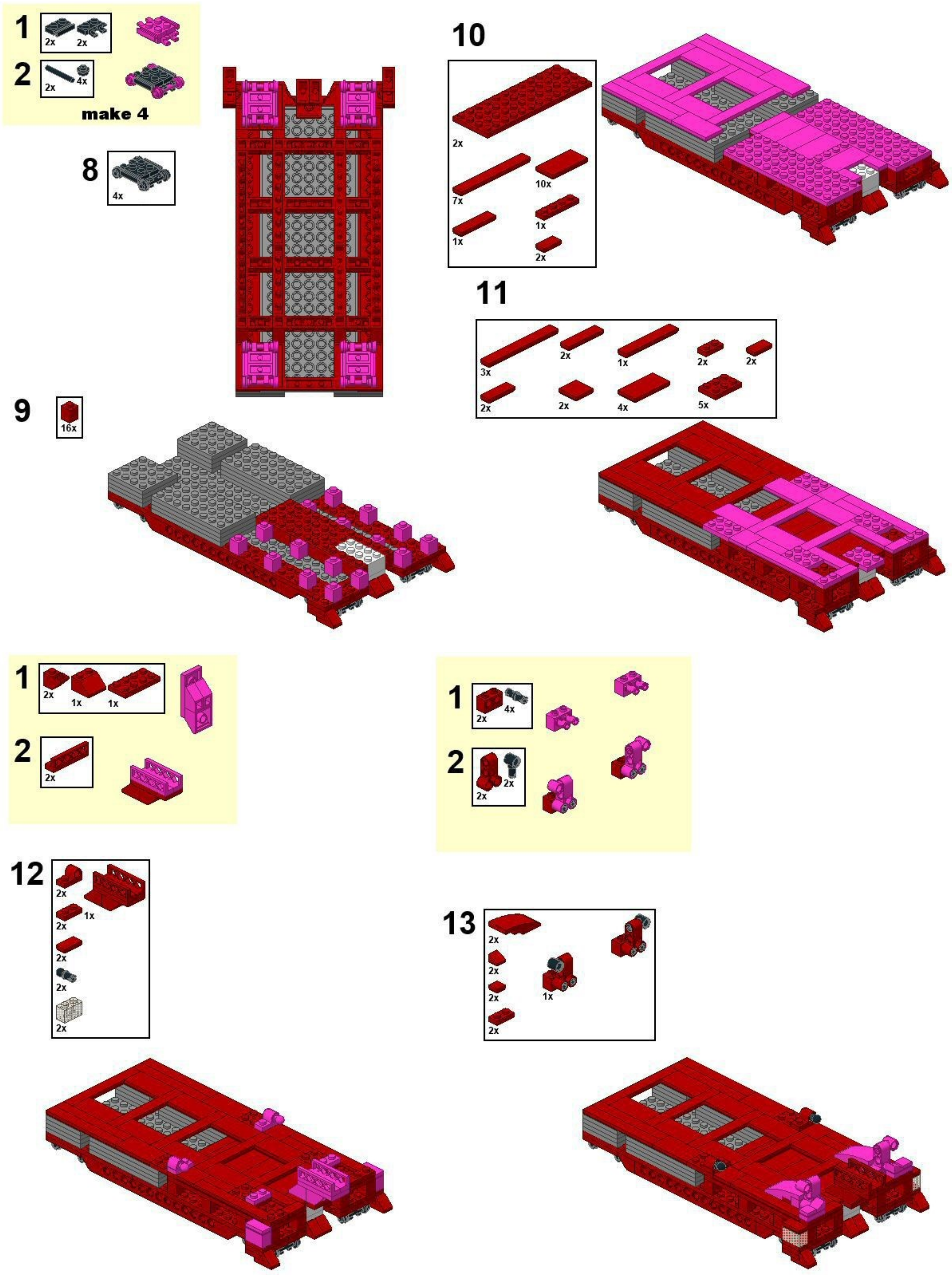
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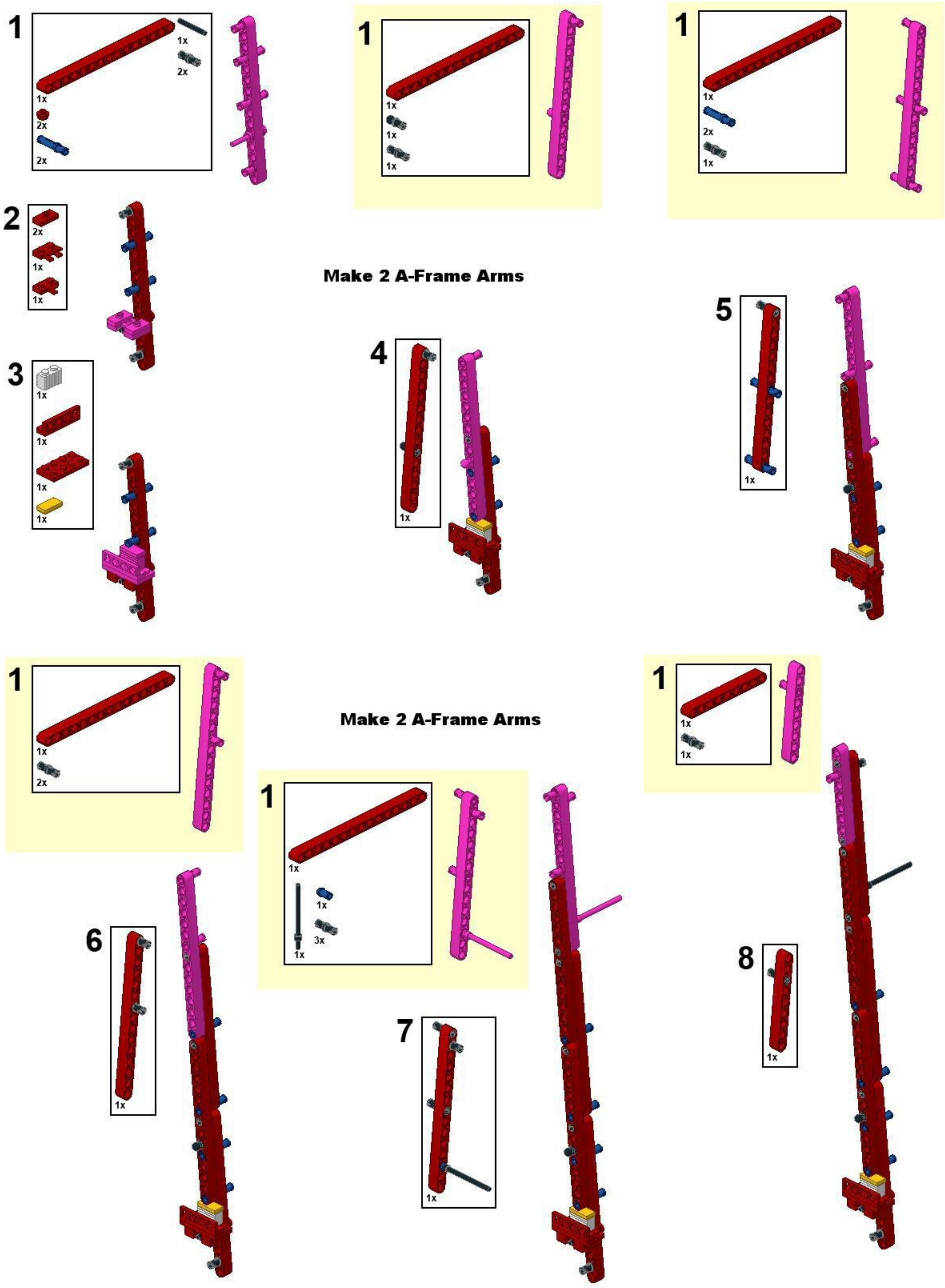
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1
Make 2 A-Frame Arms
1
1
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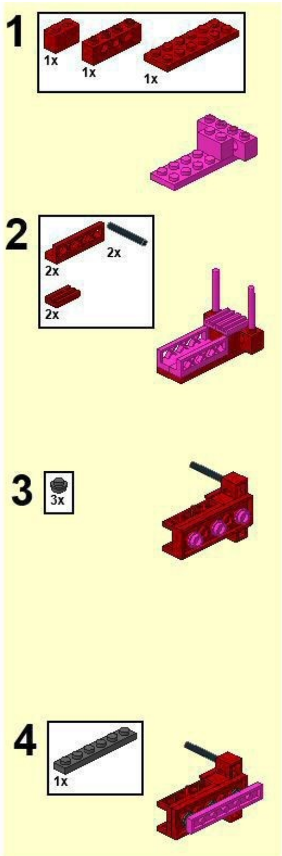
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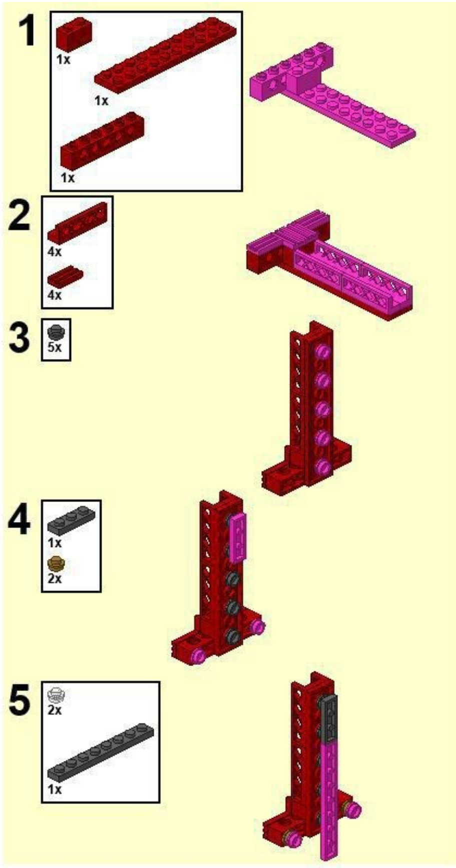
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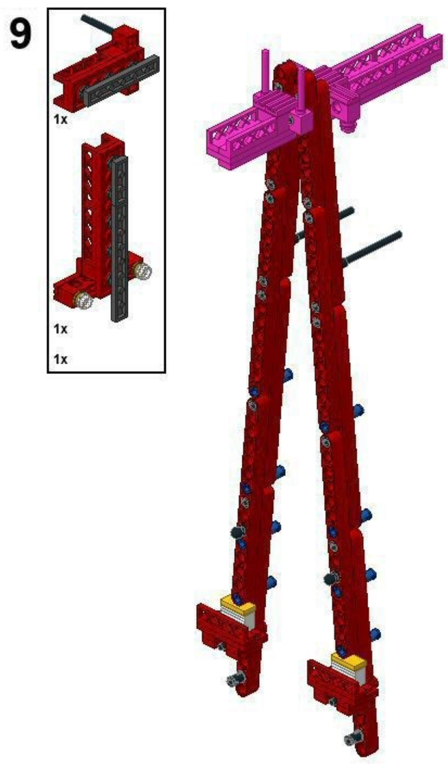
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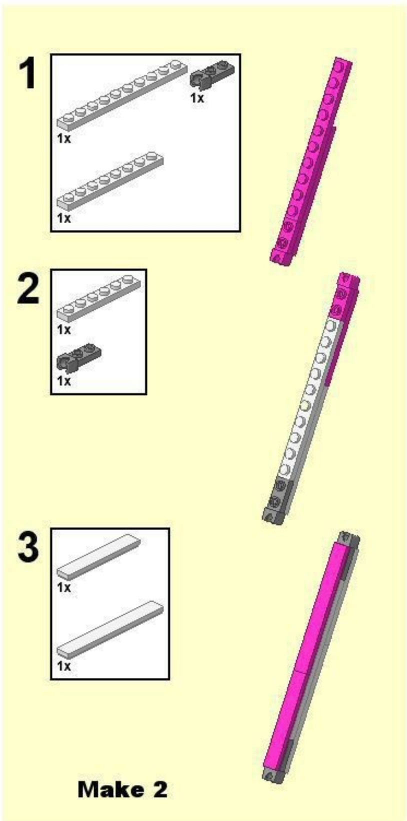
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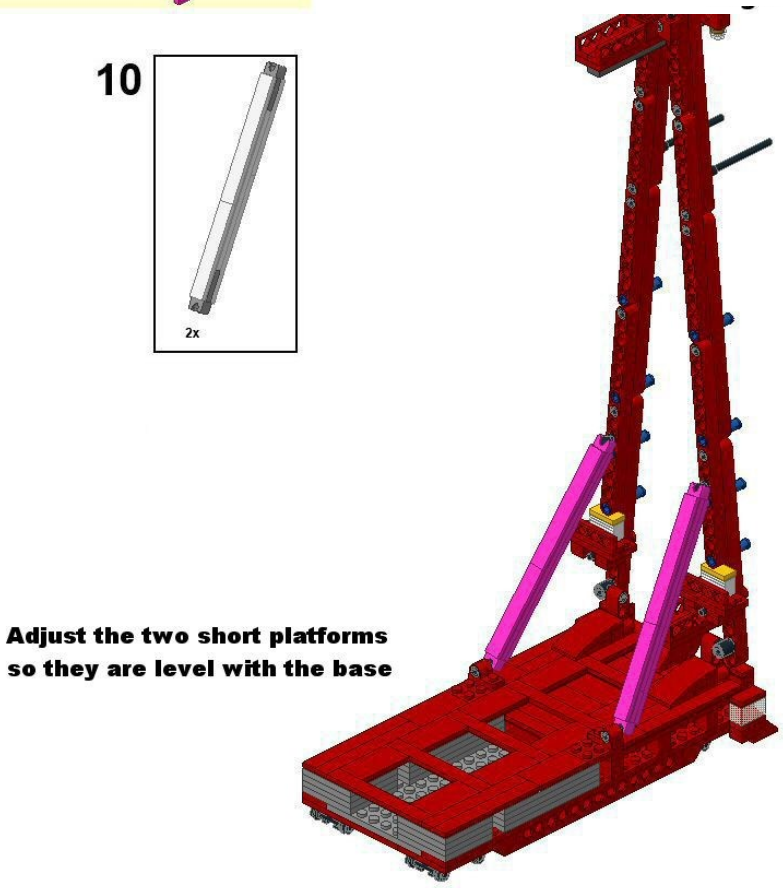
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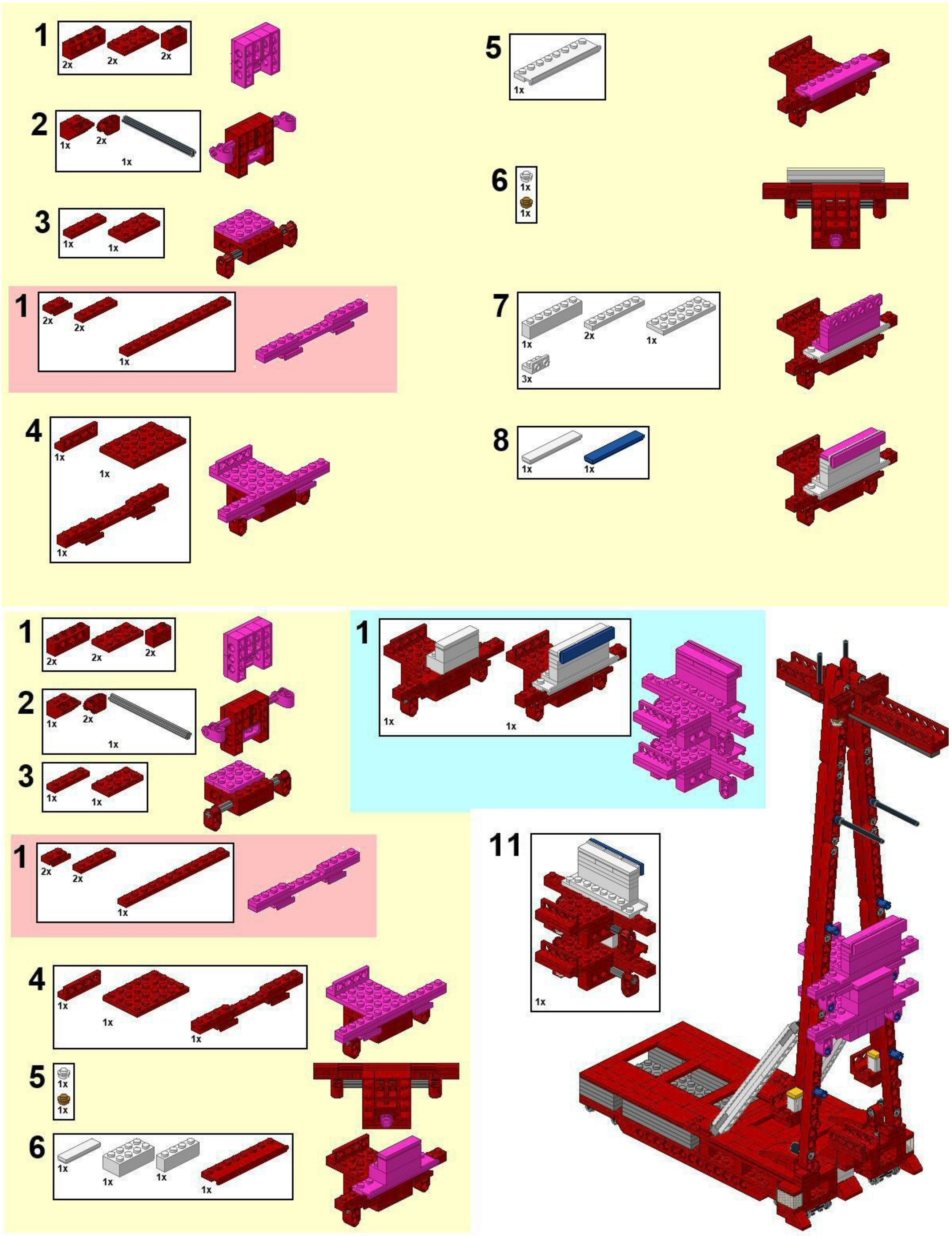
Adjust the two short platforms
so they are level with the base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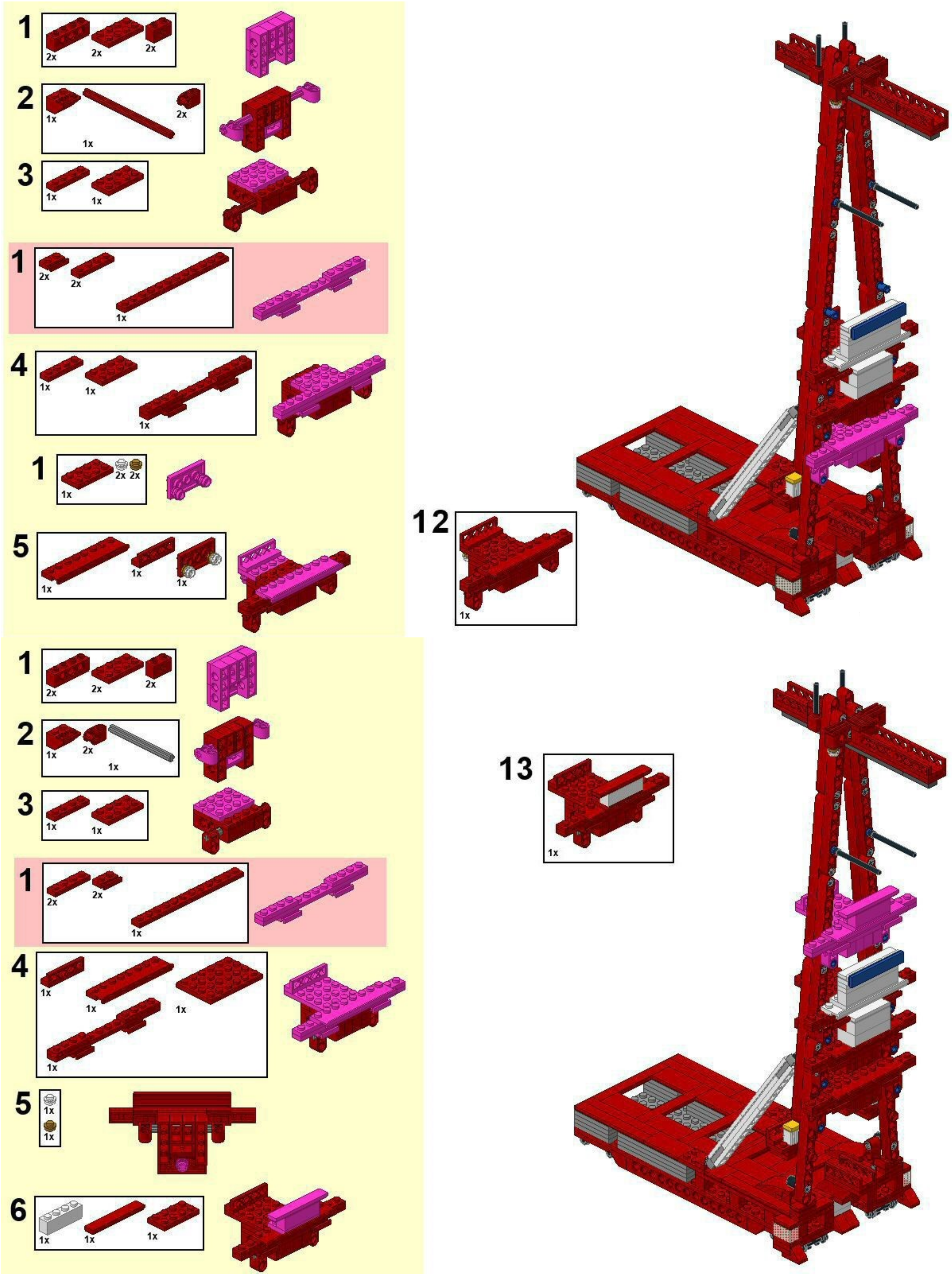
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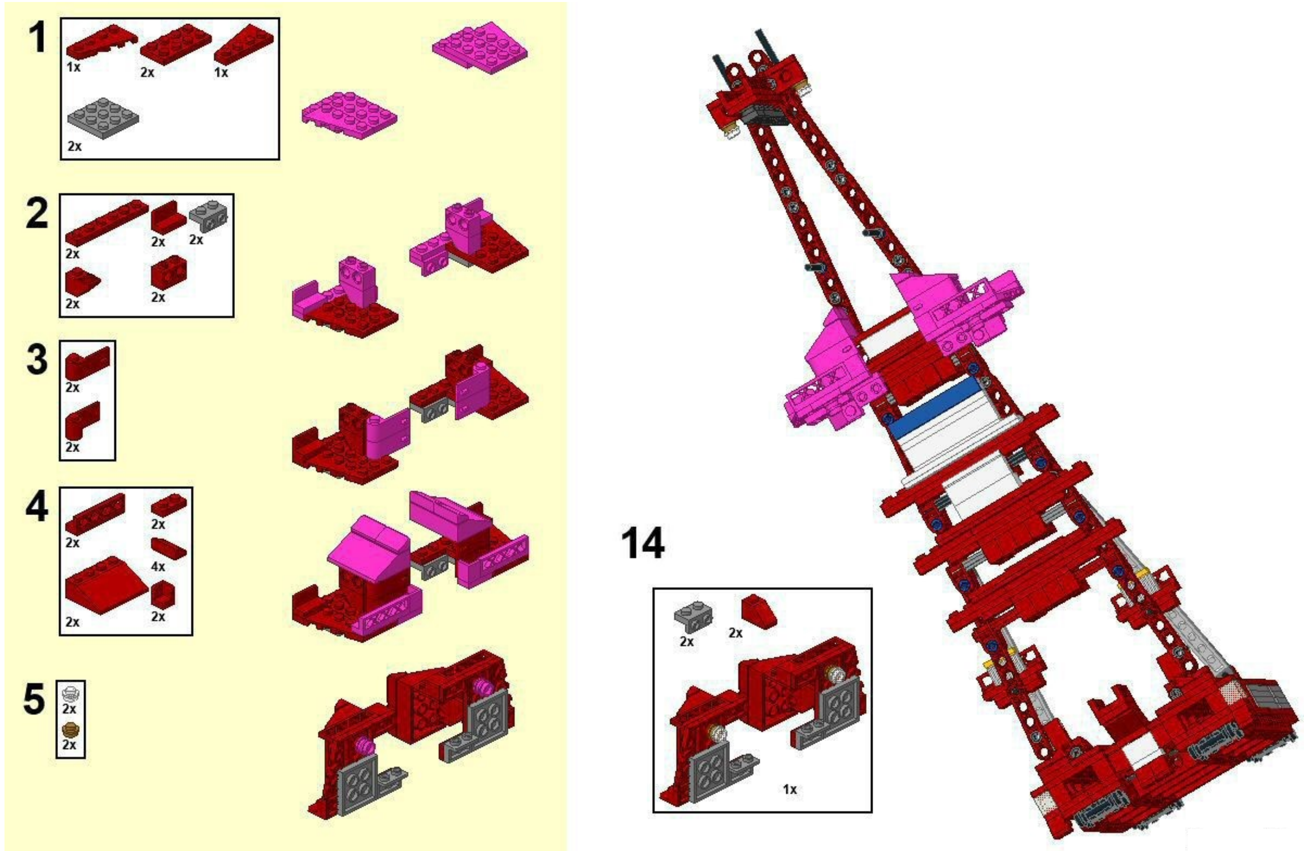
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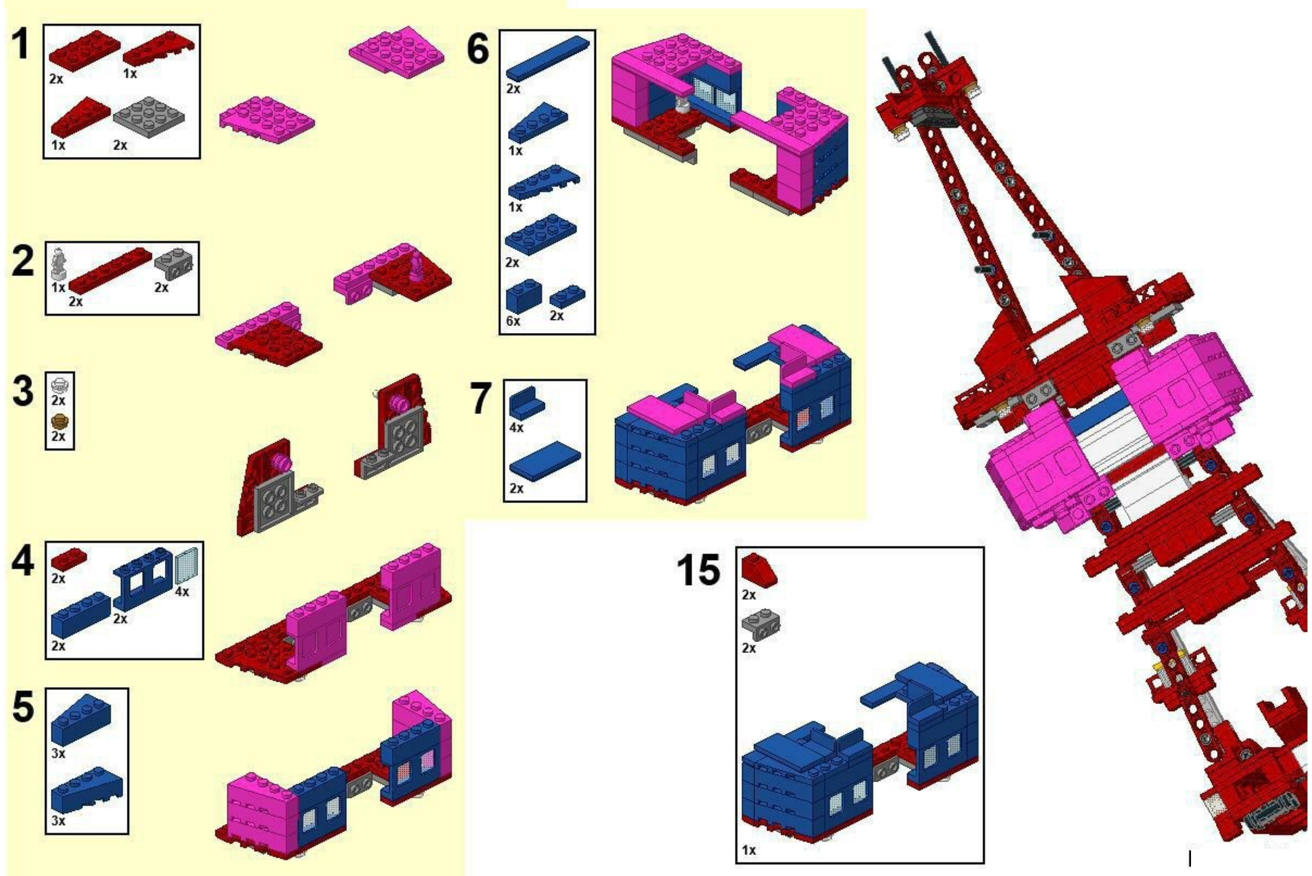
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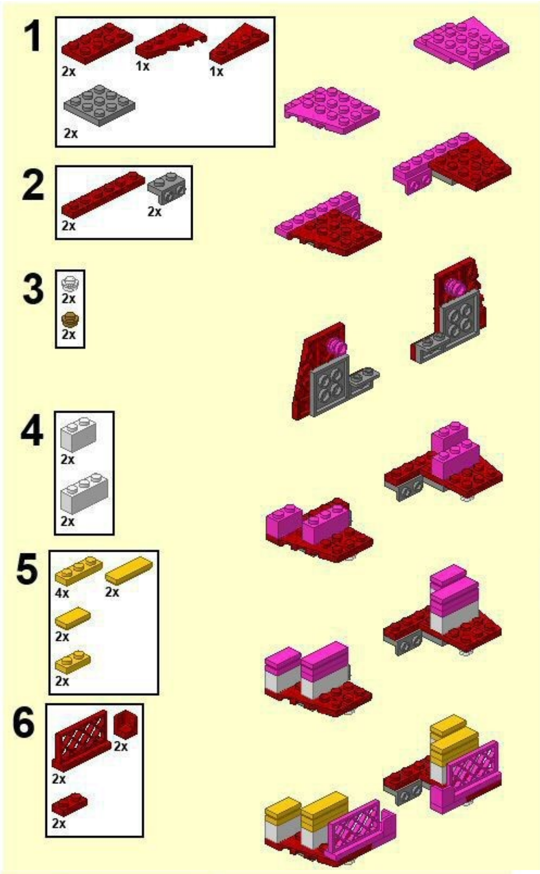
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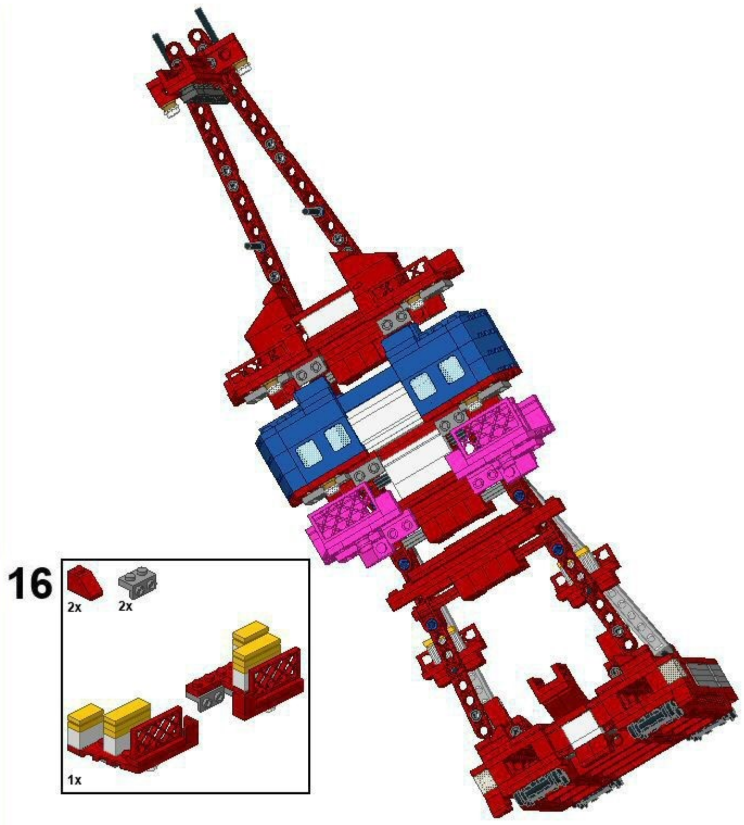
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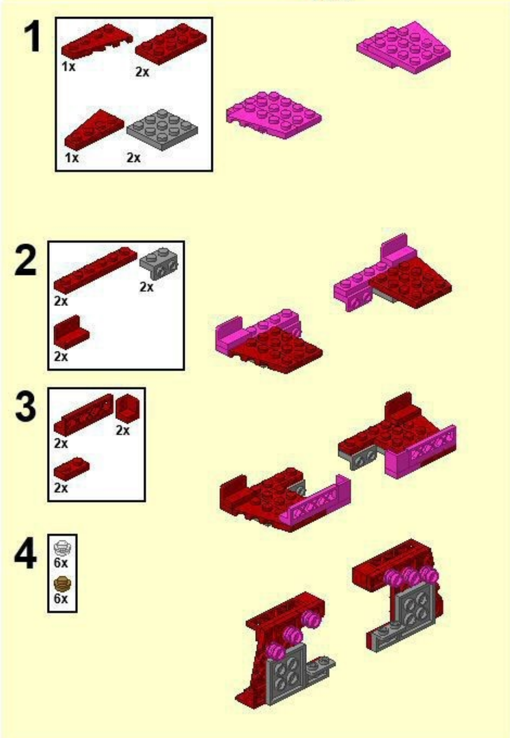
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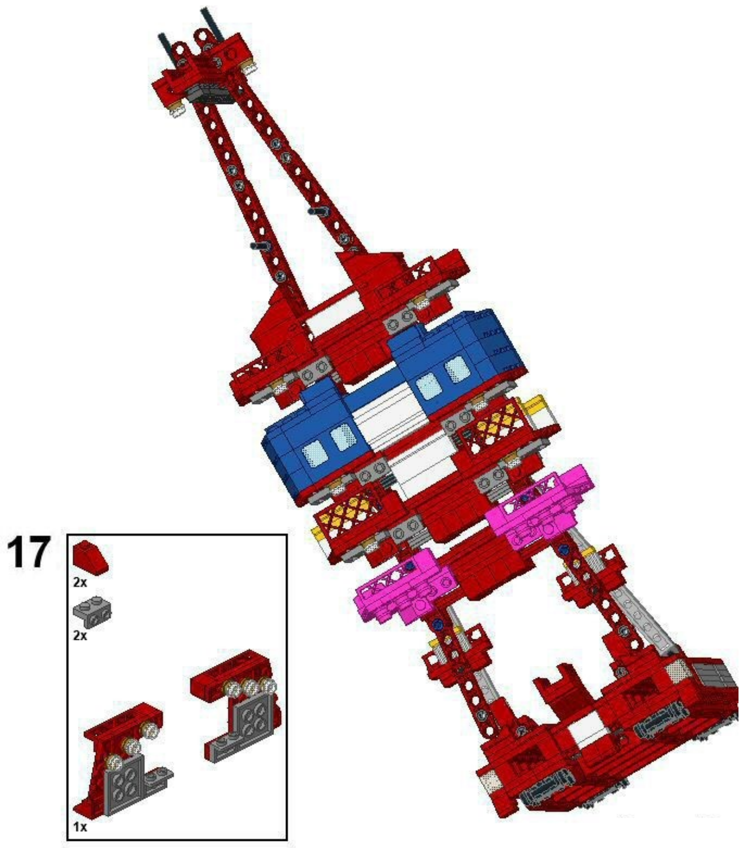
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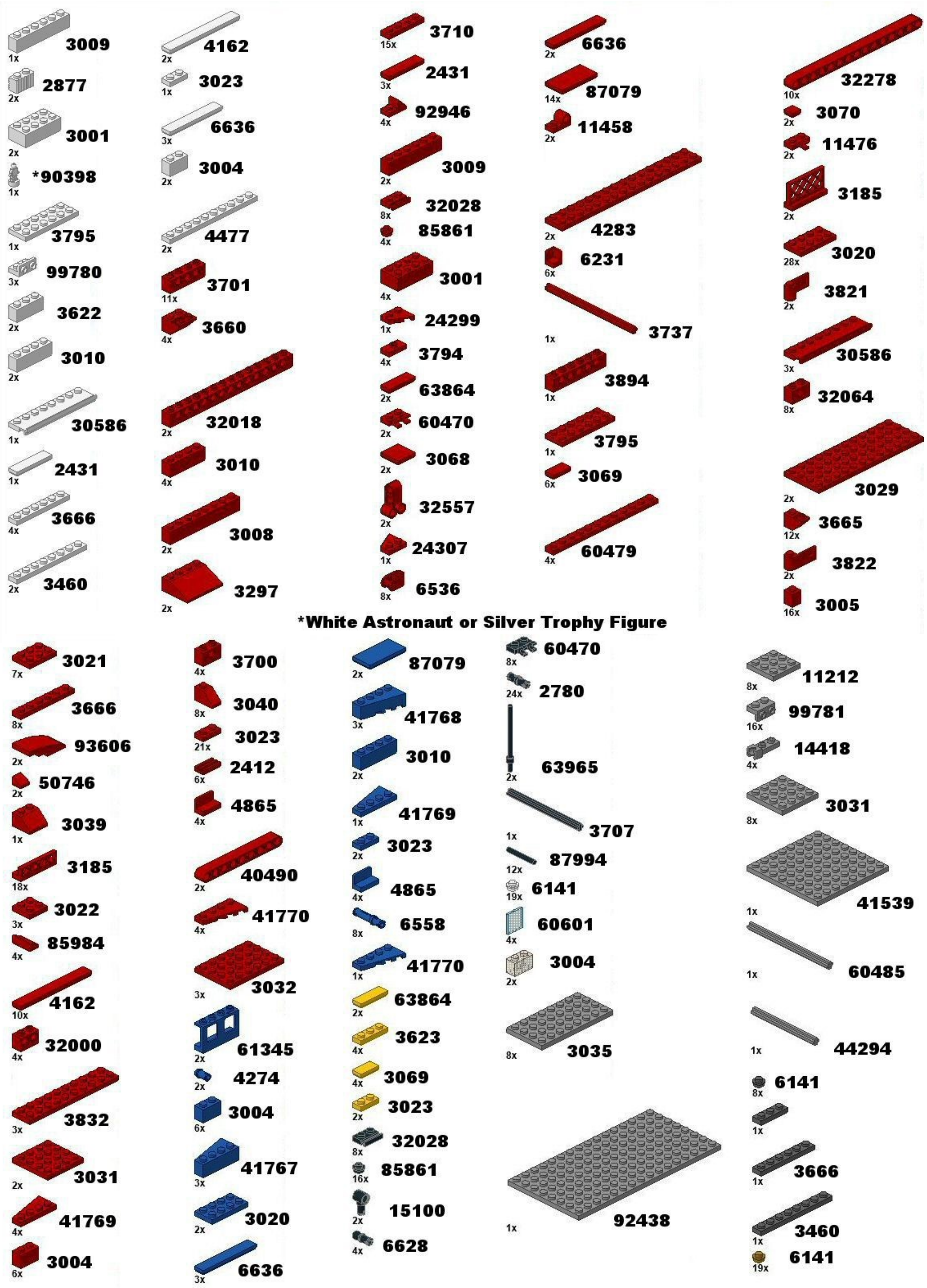
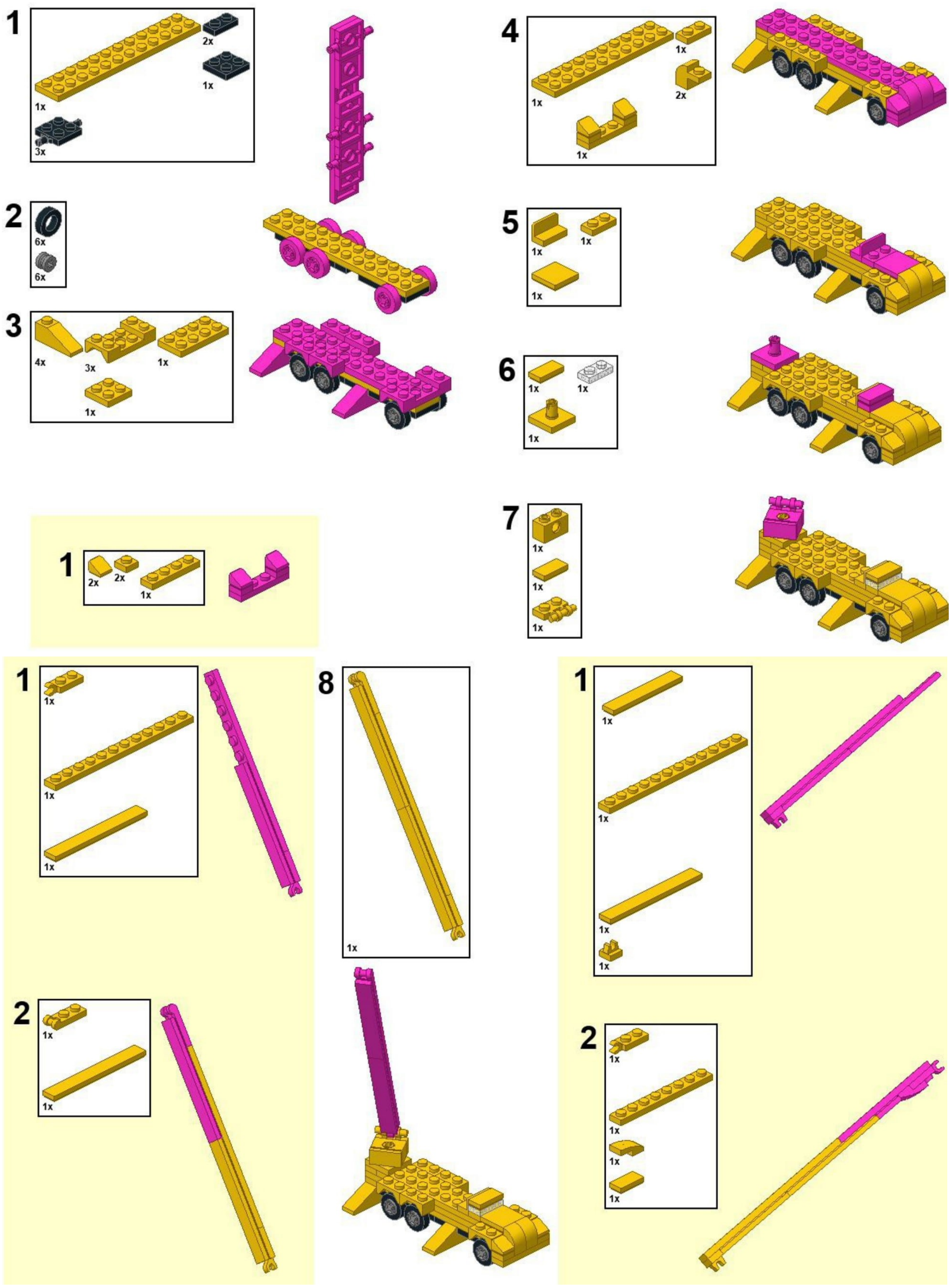


*White Astronaut or Silver Trophy Figure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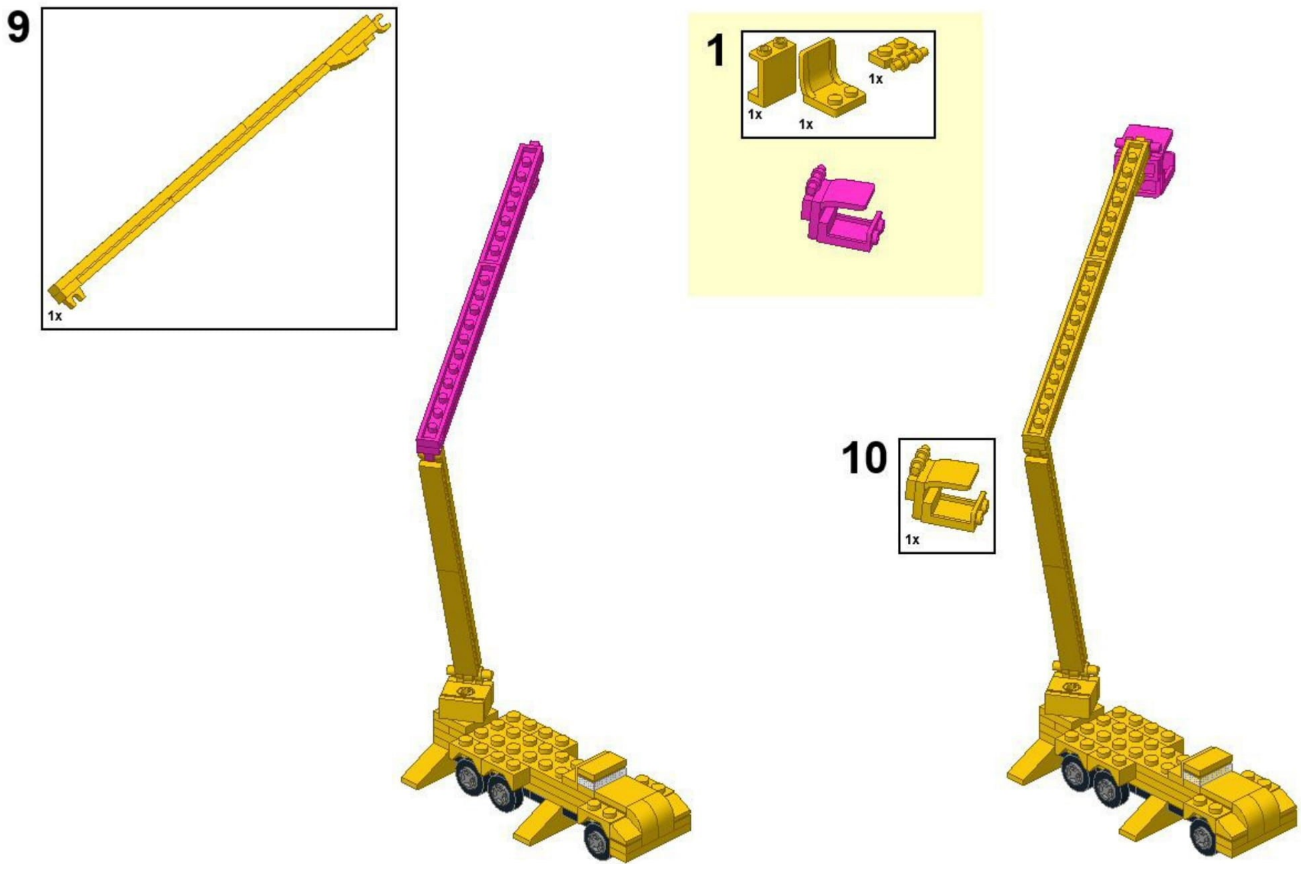
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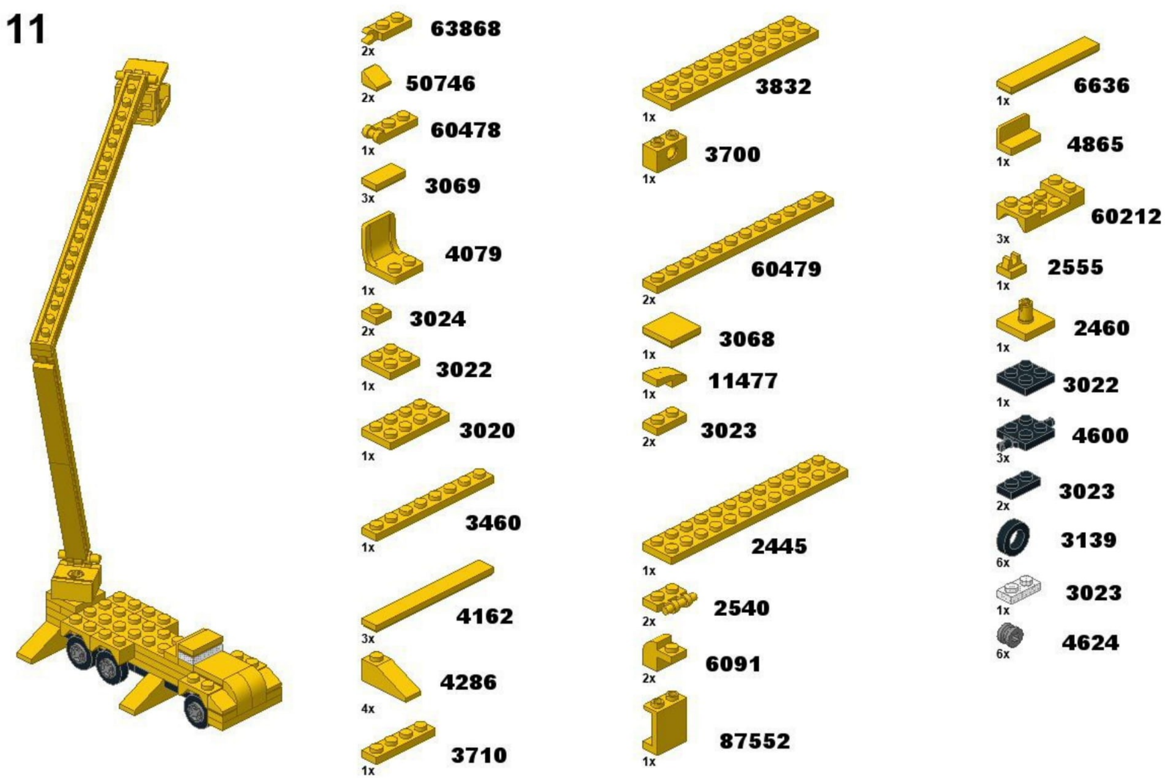
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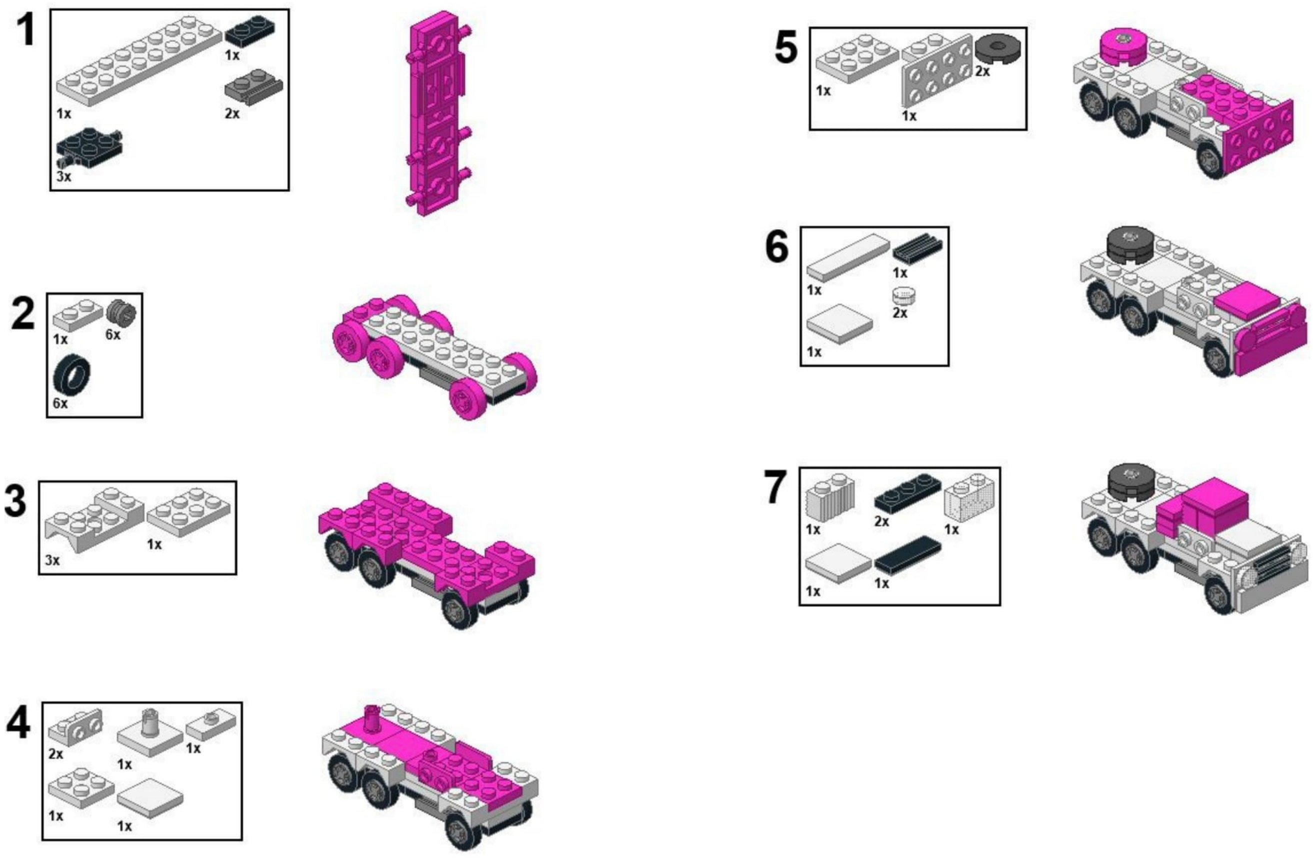
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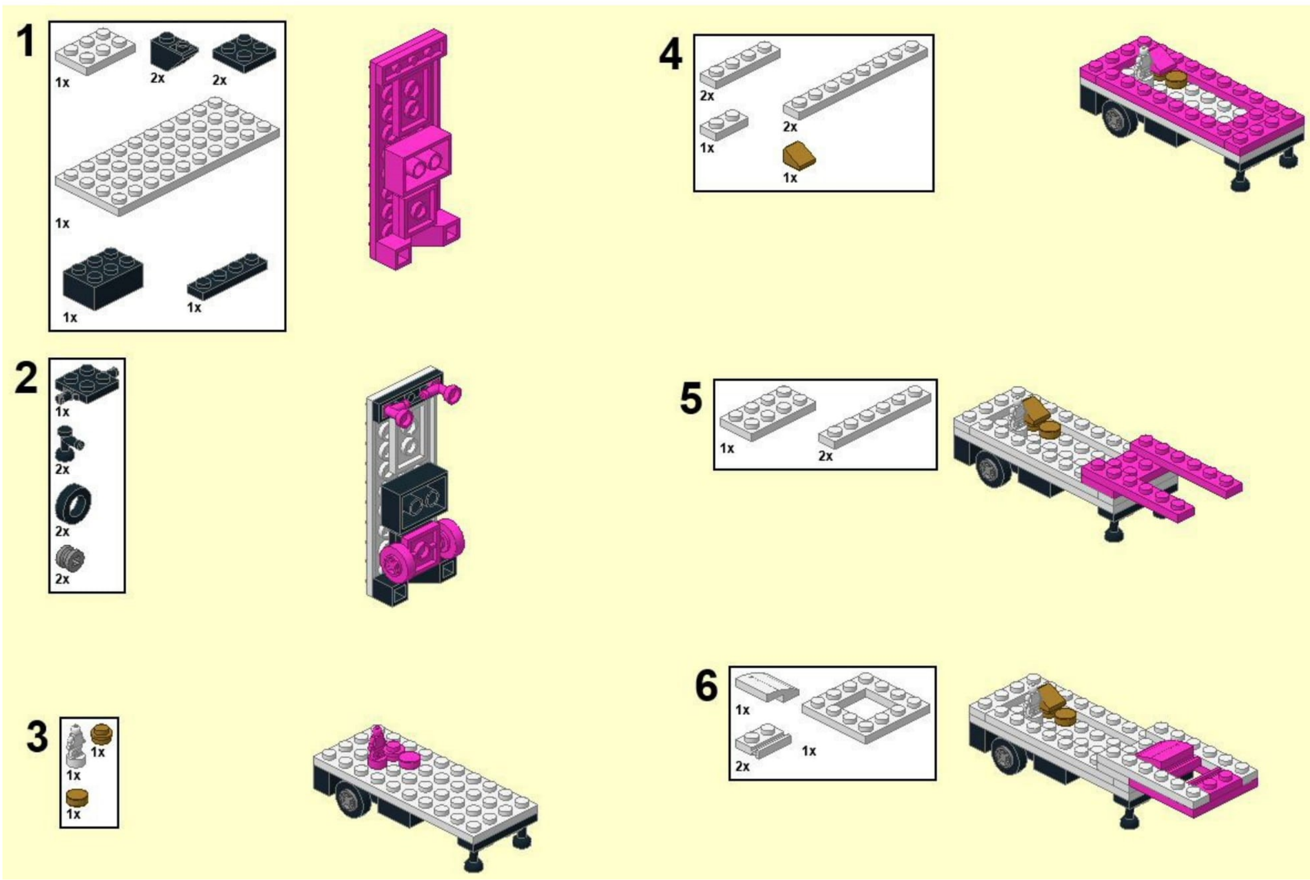
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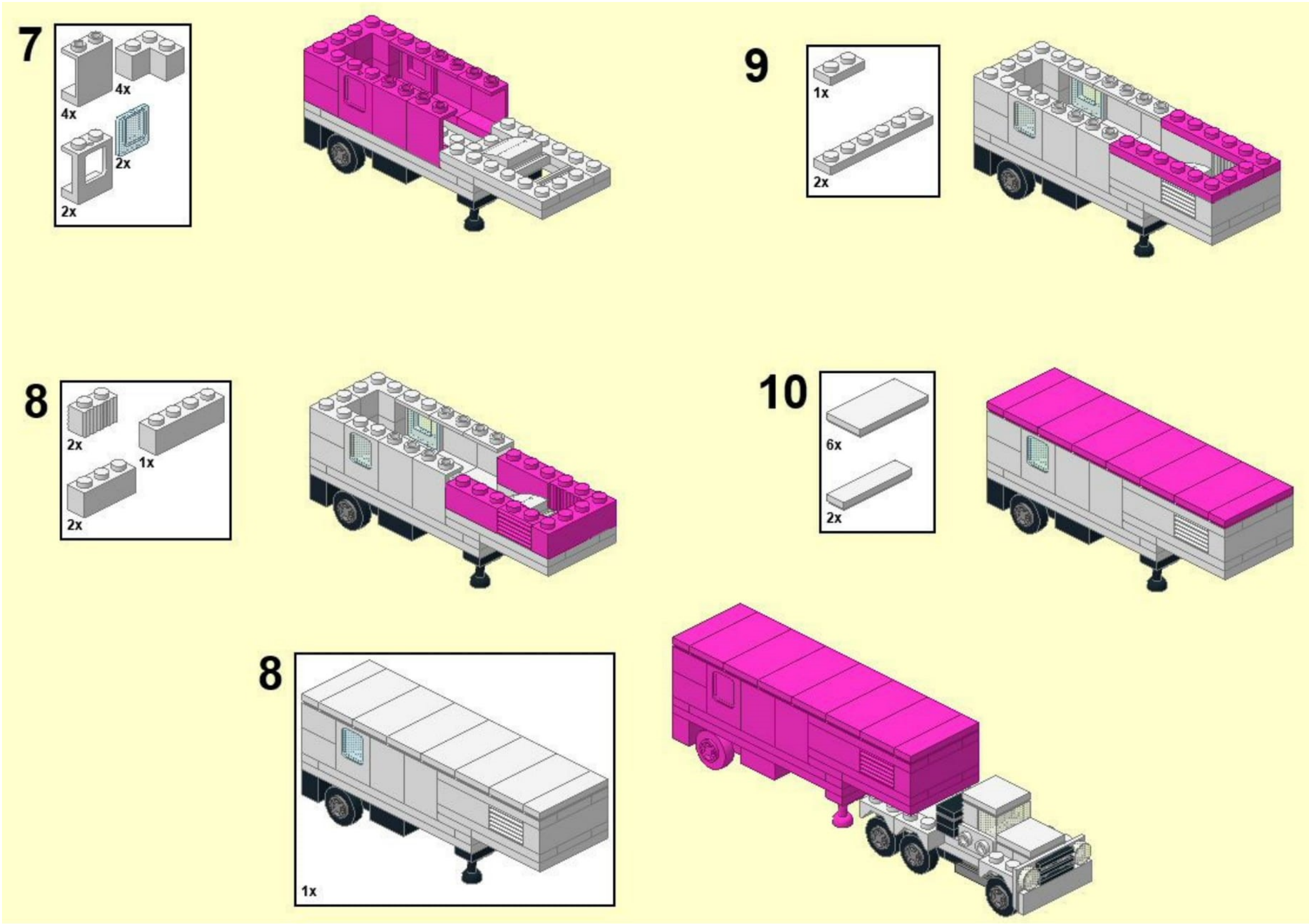
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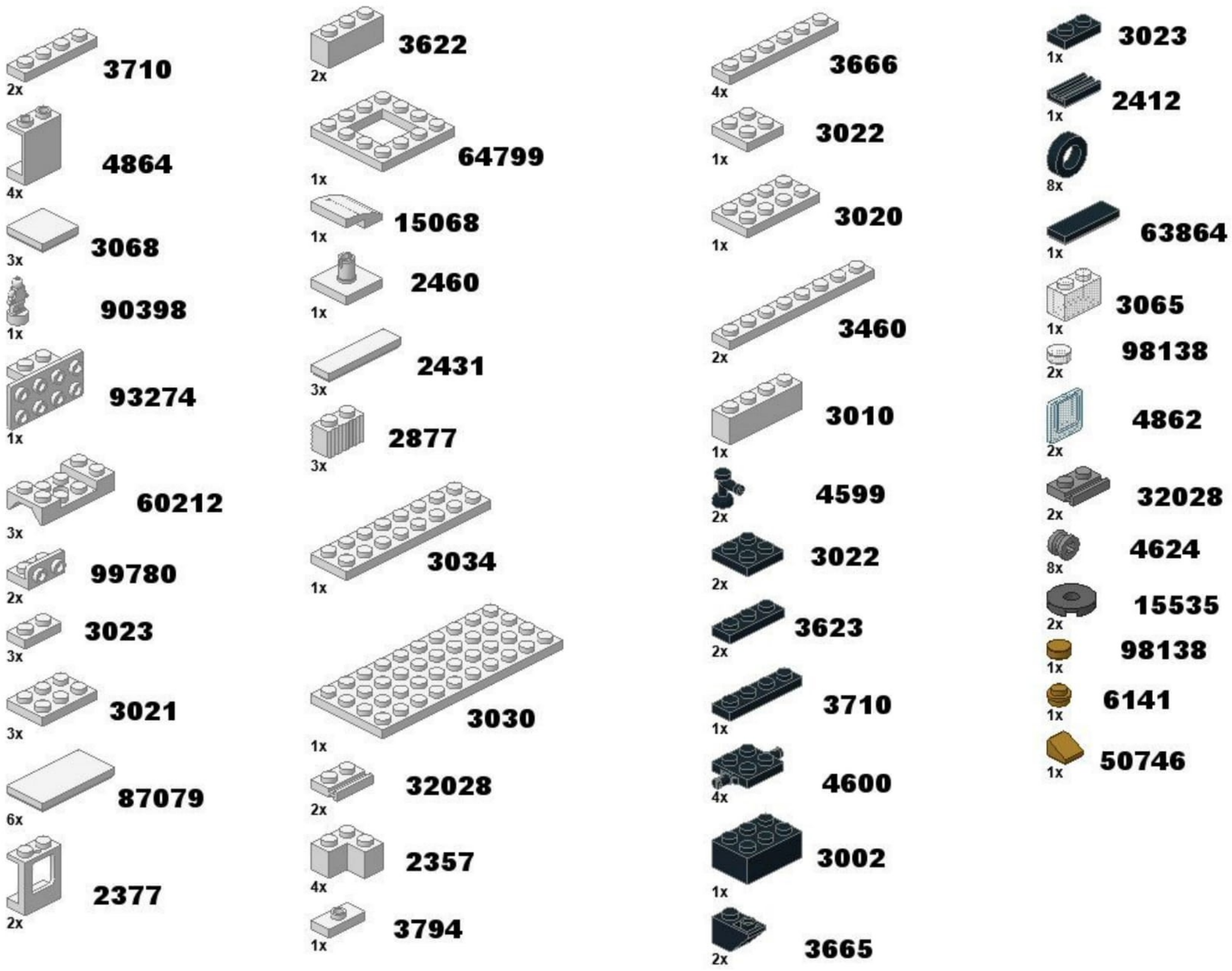
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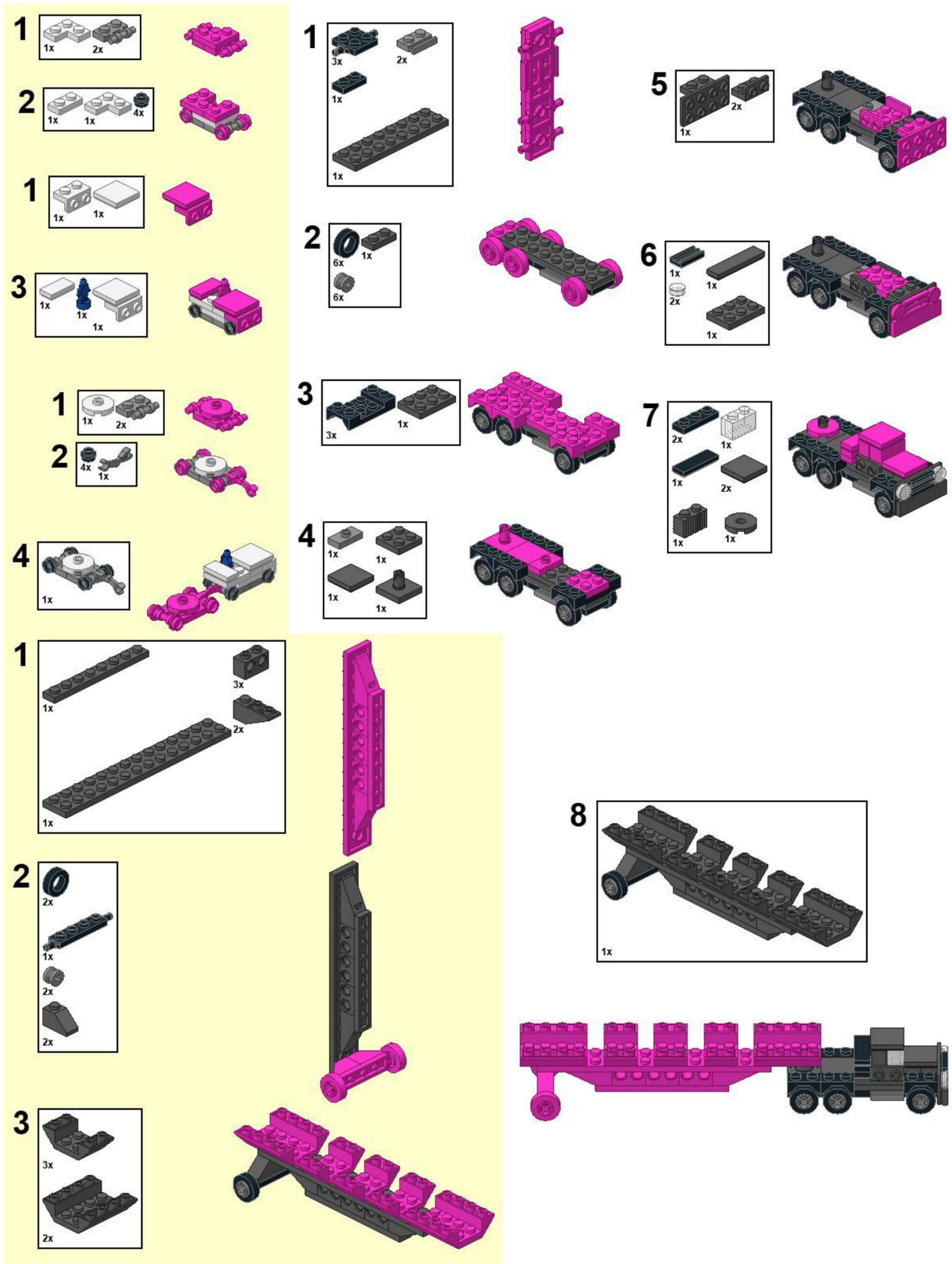

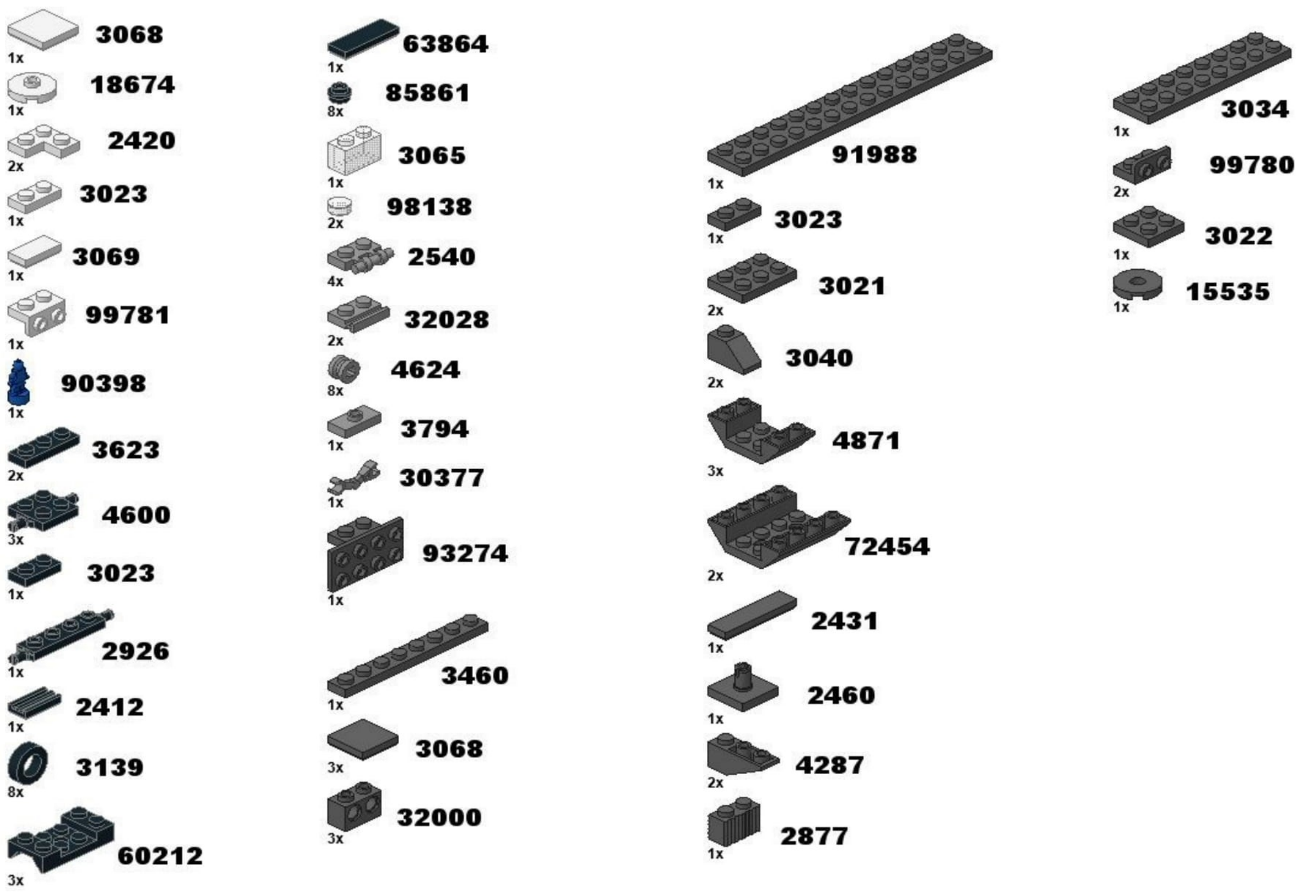

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2x 32028
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1x 3794
1x 30377
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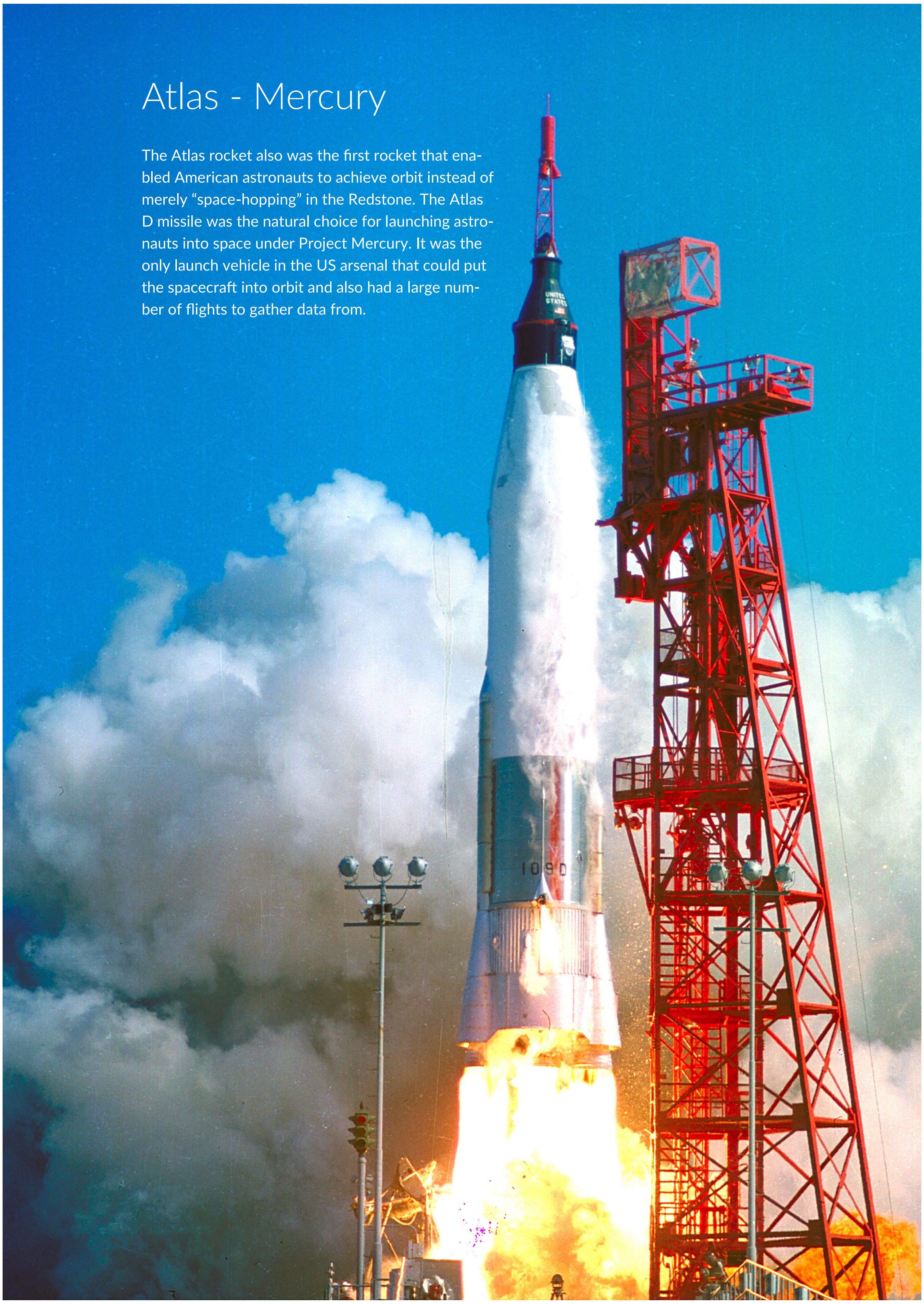
Atlas - Mercury

The Atlas rocket also was the first rocket that enabled American astronauts to achieve orbit instead of merely “space-hopping” in the Redstone. The Atlas D missile was the natural choice for launching astronauts into space under Project Mercury. It was the only launch vehicle in the US arsenal that could put the spacecraft into orbit and also had a large number of flights to gather data from.



The Atlas reliability was far from perfect, and Atlas launches ending in explosions were an all-too common sight at Cape Canaveral. Thus, significant steps had to be taken to human-rate the missile and make it safe and reliable unless NASA wished to spend several years developing a dedicated launch vehicle for crewed programs or else wait for the next-generation Titan II ICBM to become operational.

Prior to Project Mercury, there was no protocol for selecting astronauts. At the end of 1958, various ideas for the selection pool were discussed privately within the national government and the civilian space program, and also among the public at large. Although NASA planned an open competition for its first astronauts, President Dwight D. Eisenhower insisted that all candidates be test pilots. Because of the small space inside the Mercury spacecraft, candidates could be no taller than 5 feet 11 inches (180 cm) and weigh no more than 180 pounds (82 kg). Other requirements included an age under 40, a bachelor's degree or the professional equivalent, 1,500 hours of flying time, and qualification to fly jet aircraft.

Jerrie Cobb poses next to a Mercury spaceship capsule. Although she never flew in space, Cobb, along with twenty-four other women, underwent physical tests similar to those taken by the Mercury astronauts
Credit: NASA

Overleaf: Launch of Friendship 7, the first American manned orbital space flight on 20 February 1962
Credit: NASA

On April 9, 1959. NASA announced the first seven astronauts chosen to pitol its spacecraft, the "Mercury Seven", also referred to as the Original Seven or Astronaut Group 1. These seven original American astronauts were Scott Carpenter, Gordon Cooper, John Glenn, Gus Grissom, Wally Schirra, Alan Shepard, and Deke Slayton.

Members of the group flew on all classes of NASA manned orbital spacecraft of the 20th century — Mercury, Gemini, Apollo, and the Space Shuttle. Gus Grissom died in 1967, in the Apollo 1 fire. The others all survived past retirement from service. John Glenn went on to become a U.S. senator and flew on the Shuttle 36 years later to become the oldest person to fly in space. He was the last living member of the class when he died in 2016 at the age of 95.

View of Mercury Control Center prior to the Mercury-Atlas 8 (MA-8) flight of the Sigma 7. Photo credit: NASA
Credit: NASA

The NASA Quality Assurance Program meant that each Mercury-Atlas vehicle took twice as long to manufacture and assemble as an Atlas designed for uncrewed missions and three times as long to test and verify for flight. All of the six manned Mercury flights were successful, though some planned flights were cancelled during the project. The main medical problems encountered were simple personal hygiene, and post-flight symptoms of low blood pressure.

On April 12, 1961 the Soviet cosmonaut Yuri Gagarin became the first person in space on an orbital flight. Alan Shepard became the first American in space on a suborbital flight three weeks later, on May 5, 1961. John Glenn, the third Mercury astronaut to fly, became the first American to reach orbit on February 20, 1962, but only after the Soviets had launched a second cosmonaut, Gherman Titov, into a day-long flight in August 1961. Three more Mercury orbital flights were made, ending on May 16, 1963 with a day-long, 22 orbit flight.

These seven men, wearing spacesuits in this portrait, composed the first group of astronauts announced by the National Aeronautics and Space Administration (NASA). July 1960,
Credit: NASA

Datasheet Atlas Mercury

General	
Name	Atlas LV-3B
Function	Crewed expendable launch system
Manufacturer	Convair
Country of origin	United States
Cost per Launch	
Family	Atlas
Size	
Height	32.10 m (105.30 ft)
Diameter	10.0 feet (3.0 m)
Width	3.05 m (10.00 ft)
Mass	140,000 kg (300,000 lb)
Stages	2½-4½
Capacity	
Payload suborbital	
Payload to LEO	2,200 pounds (1,000 kg)
Payload to GEO	1,540 pounds (700 kg)
Payload to TLI	850 pounds (390 kg)
Payload to escape	575 pounds (261 kg)
Launch history	
Status	Retired
Launch sites	CCAFS LC-14
Total launches	9
Successes	7
Failures	2
Partial failures	
First flight	29 July 1960
Last flight	15 May 1963
Notable payloads	Mercury
Boosters	**Atlas MA-2**
Engines	2 x LR-89-5
Thrust	1,517.422 kN (341,130 lbf)
Isp	282 s
Burn time	135 s
Fuel	LOX/RP-1
Gross mass	3,050 kg (6,720 lb)
Empty mass	3,050 kg (6,720 lb)
Length	5,20 m (17.00 ft)
Diameter	4.90 m (16.00 ft)

First stage	Atlas D
Engines	1 x XLR-105-5
Thrust	363.218 kN (81,655 lbf)
Specific impulse	309 sec
Burn time	303 sec
Fuel	LOX/Kerosene
Gross mass	113,050 kg (249,230 lb)
Empty mass	2,347 kg (5,174 lb)
Length	21.20 m (69.50 ft)
Diameter	4.90 m (16.00 ft)
Model	
Year Created	2017
Author	Grant Passmore
Parts count	82
Diameter	6,8 cm
Height	25,2 cm
Weigth	67,3 g
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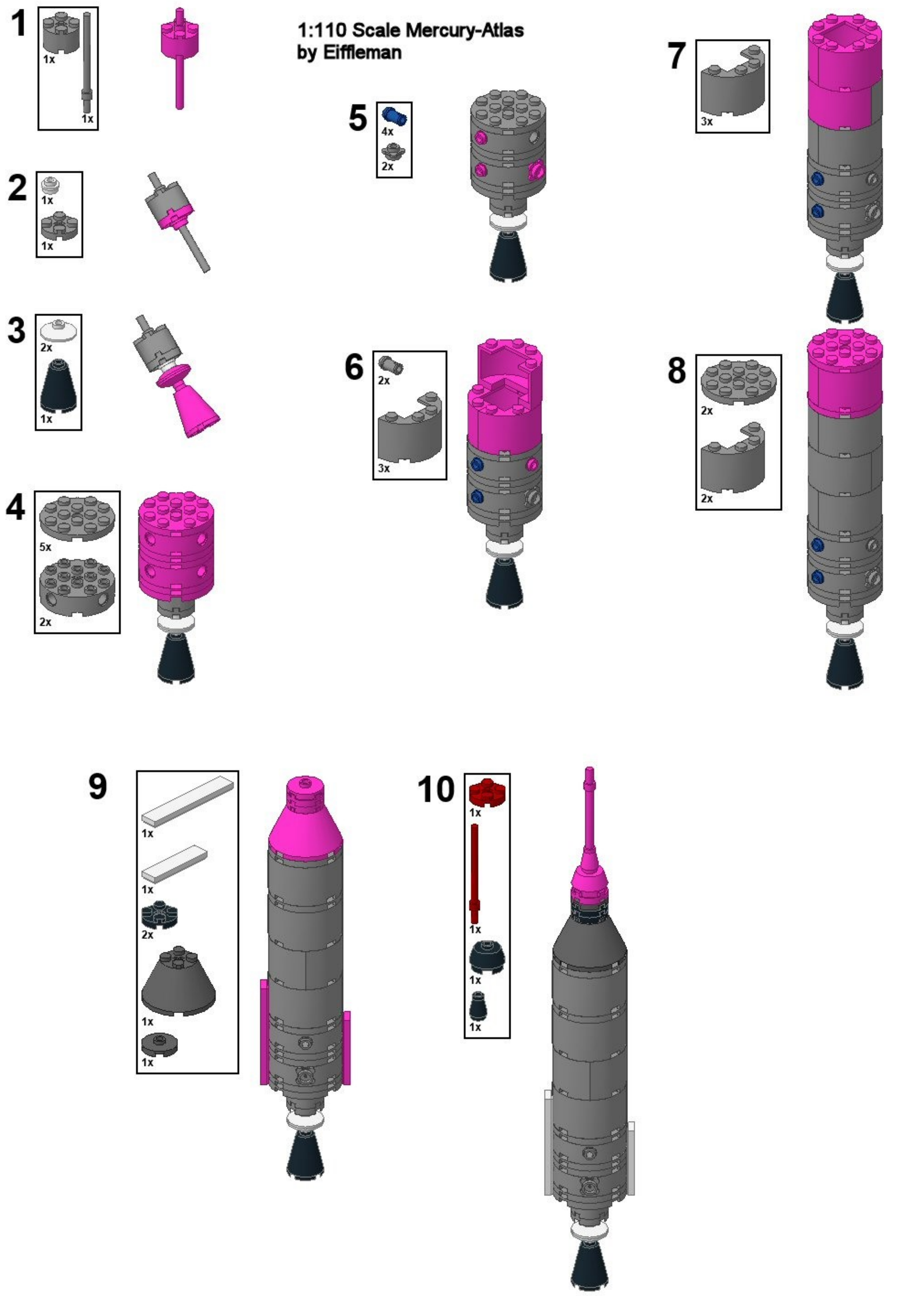
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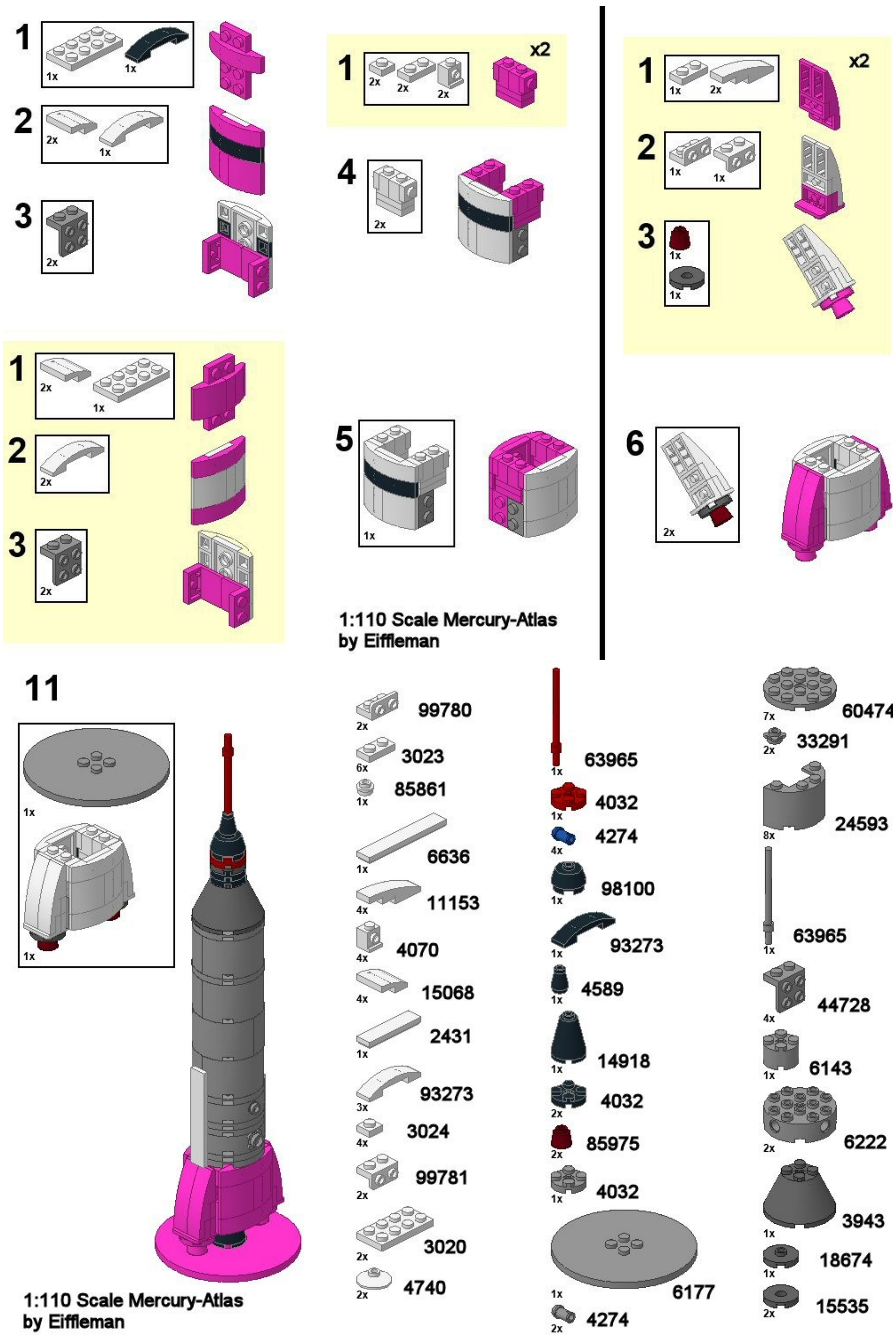
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3x 93273
4x 3024
2x 99781
2x 3020
2x 4740
1x 63965
1x 4032
4x 4274
1x 98100
1x 93273
1x 4589
1x 14918
2x 4032
2x 85975
1x 4032
1x 6177
2x 4274
7x 60474
2x 33291
8x 24593
1x 63965
4x 44728
1x 6143
2x 6222
1x 3943
1x 18674
2x 15535

An Note on Parts

With the new Harry Potter Hogwarts sets Lego introduced a new 4x2x3 half cone (38317). This piece is better suited for the Mercury-Altas rocket. To use it with the existing build remove the 8 off 4x2x2 cylinders and 3 4x4 round plates that make up the upper section of the rocket. Rebuild just uisng the cylinder pieces and finish with the new half-cone pieces.

There are a couple of pieces which are avaialble in new colours which would improve the model. The 2xs2 round plate with one stud that holds the capsule in place is now available in black. The two smaller engines which used the dark red Fez pieces are also available in black. All of these pieces are fairly rare on the secondary parts market so they are a little more expensive.

Gemini - Titan

On May 9th, 1961, four days after John Shepard had made his first suborbital hop, and months before the manned Atlas reached orbit, US president Kennedy stunned the world with his plan to send men to the moon within a decade. NASA quickly realized that a follow-on to the Mercury program was required to develop certain spaceflight capabilities in support of the moon program, Apollo. Drafts for such a case already had been made by Jim Chamberlin, the head of engineering at the Space Task Group (STG), and project Gemini was launched and approved within months, to be publicly announced on January 3, 1962.

The major objectives of Gemini were:

- Test endurance of humans and equipment in spaceflight for extended periods
- Practice rendezvous and docking with another vehicle, and to maneuver the combined spacecraft using the propulsion system of the target vehicle
- Learn and practice Extra-Vehicular Activity (EVA), or space-"walks”

A time-lapse photograph shows the configuration of Pad 19 up until the launch of Gemini 10 on 18 July 1966.
Credit: NASA

Overleaf: NASA successfully completed its first rendezvous mission with two Gemini spacecraft-Gemini VII and Gemini VI-in December 1965.
Credit: NASA

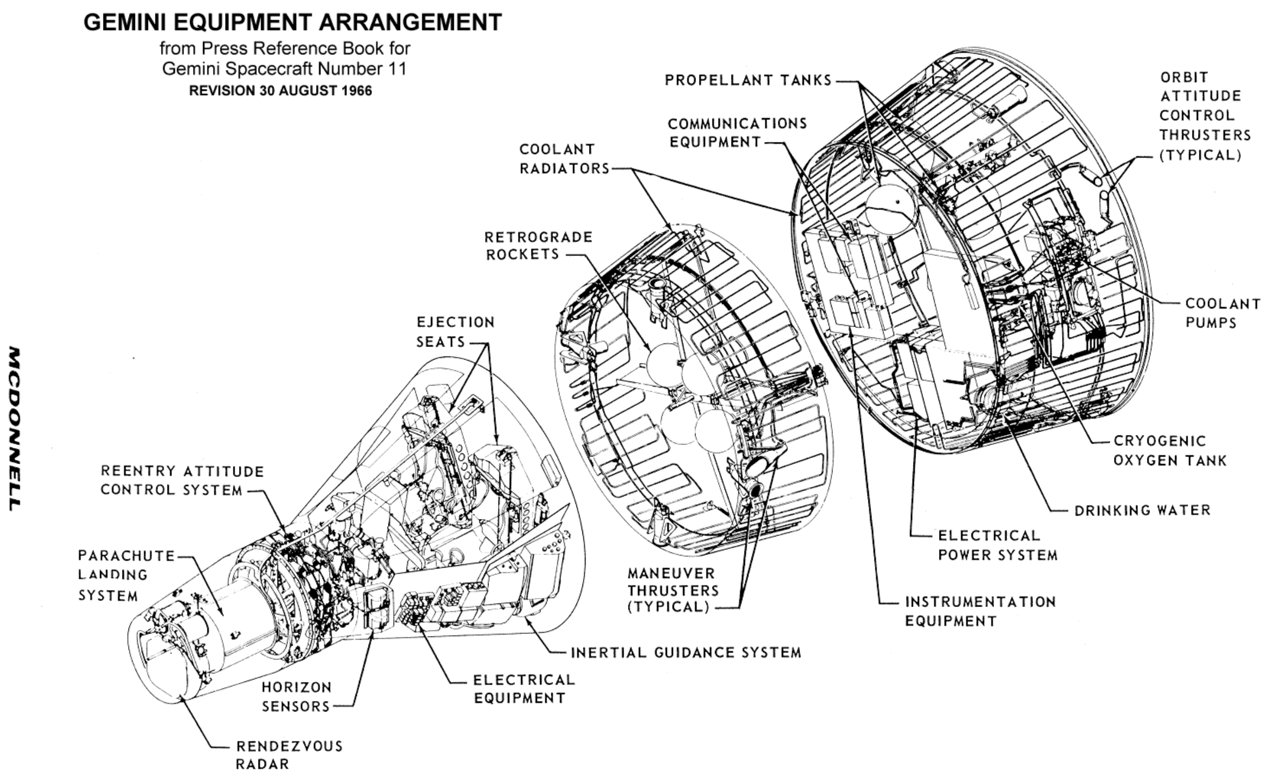
The Titan II had debuted in 1962 as the Air Force's second-generation ICBM to replace the Atlas. By using hypergolic fuels, it could be stored for long periods of time and be easily readied for launch in addition to being a simpler design with fewer components, the only caveat being that the propellant mix was extremely toxic compared to the Atlas's liquid oxygen/RP-1. The Titan II was 50% heavier than the Titan I, with a longer first stage and a larger diameter second stage.

The first flight of the Titan II was in March 1962 and the missile, now designated LGM-25C, reached initial operating capability in October 1963. The Titan II carried one W-53 nuclear warhead with a yield of 9 megatons over a range of 16,000 kilometres. The 54 deployed Titan IIs formed the backbone of America's strategic deterrent force until the LGM-30 Minuteman ICBM was deployed en masse during the early to mid-1960s.

The Gemini crew capsule (referred to as the Reentry Module) was essentially an enlarged version of the Mercury capsule. Unlike Mercury, the retrorockets, electrical power, propulsion systems, oxygen, and water were located in a detachable Adapter Module behind the Reentry Module. A major design improvement in Gemini was to locate all internal spacecraft systems in modular components, which could be independently tested and replaced when necessary, without removing or disturbing other already tested components.

The astronaut corps that supported Project Gemini included the "Mercury Seven", "The New Nine", and the 1963 astronaut class. During the program, three astronauts died in air crashes during training, including the prime crew for Gemini 9. This mission was flown by the backup crew, the only time that has happened in NASA's history to date.

Gemini in Latin means "twins" or "double", which reflected that the spacecraft would hold two astronauts. Gemini is also the name of the third constellation of the Zodiac and its twin stars, Castor and Pollux. In 1964 and 1965 two Gemini missions were flown without crews to test out systems and the heat shield. These were followed by ten flights with crews in 1965 and 1966. All were launched by Titan II launch vehicles.



Datasheet Gemini – Titan II

General	
Name	Titan II GLV
Function	Human-rated launch vehicle for Gemini spacecraft
Manufacturer	Martin
Country of origin	United States
Cost per Launch	16.389 million in 1969 dollars.
Family	Titan
Size	
Height	109 feet (33.2 m)[1]
Diameter	10 feet (3.05 m)
Width	3.05 m (10.00 ft)
Mass	340,000 pounds (154,200 kg)
Stages	2
Capacity	
Payload suborbital	
Payload to LEO	7,900 pounds (3,580 kg)
Payload to GEO	
Payload to TLI	
Payload to escape	
Launch history	
Status	Retired
Launch sites	Cape Canaveral LC-19
Total launches	12
Successes	12
Failures	0
Partial failures	0
First flight	April 8, 1964
Last flight	November 11, 1966
Notable payloads	Gemini Capsule

First Stage	Titan II—1
Engines	1 LR87-AJ-7
Thrust	430,000 pounds-force (1,913 kN)
Specific impulse	258 sec
Burn time	156 seconds
Fuel	Aerozine 50/N2O4
Gross mass	117,866 kg (259,850 lb)
Empty mass	6,736 kg (14,850 lb)
Length	22.28 m (73.09 ft)
Diameter	3.05 m (10.00 ft)
Second Stage	**Titan II—2**
Engines	1 LR91-AJ-7
Thrust	100,000 pounds-force (445 kN)
Specific impulse	316 sec
Burn time	180 seconds
Fuel	Aerozine 50/N2O4
Gross mass	28,939 kg (63,799 lb)
Empty mass	2,404 kg (5,299 lb)
Length	7.86 m (25.78 ft)
Diameter	3.05 m (10.00 ft)
Model	
Year Created	2018
Author	Grant Passmore
Parts count	85
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Height	25 cm
Weigth	74,7 g
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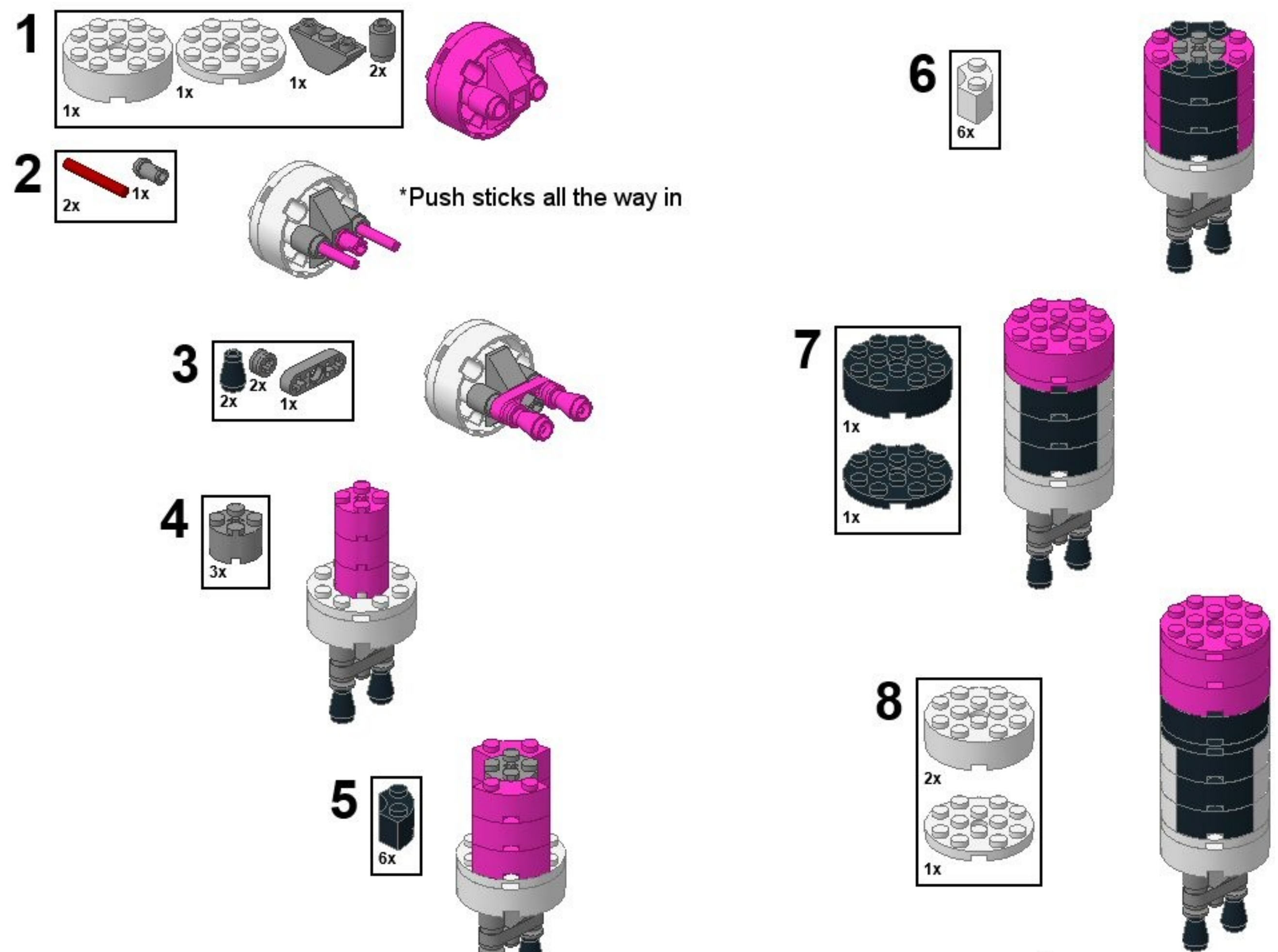
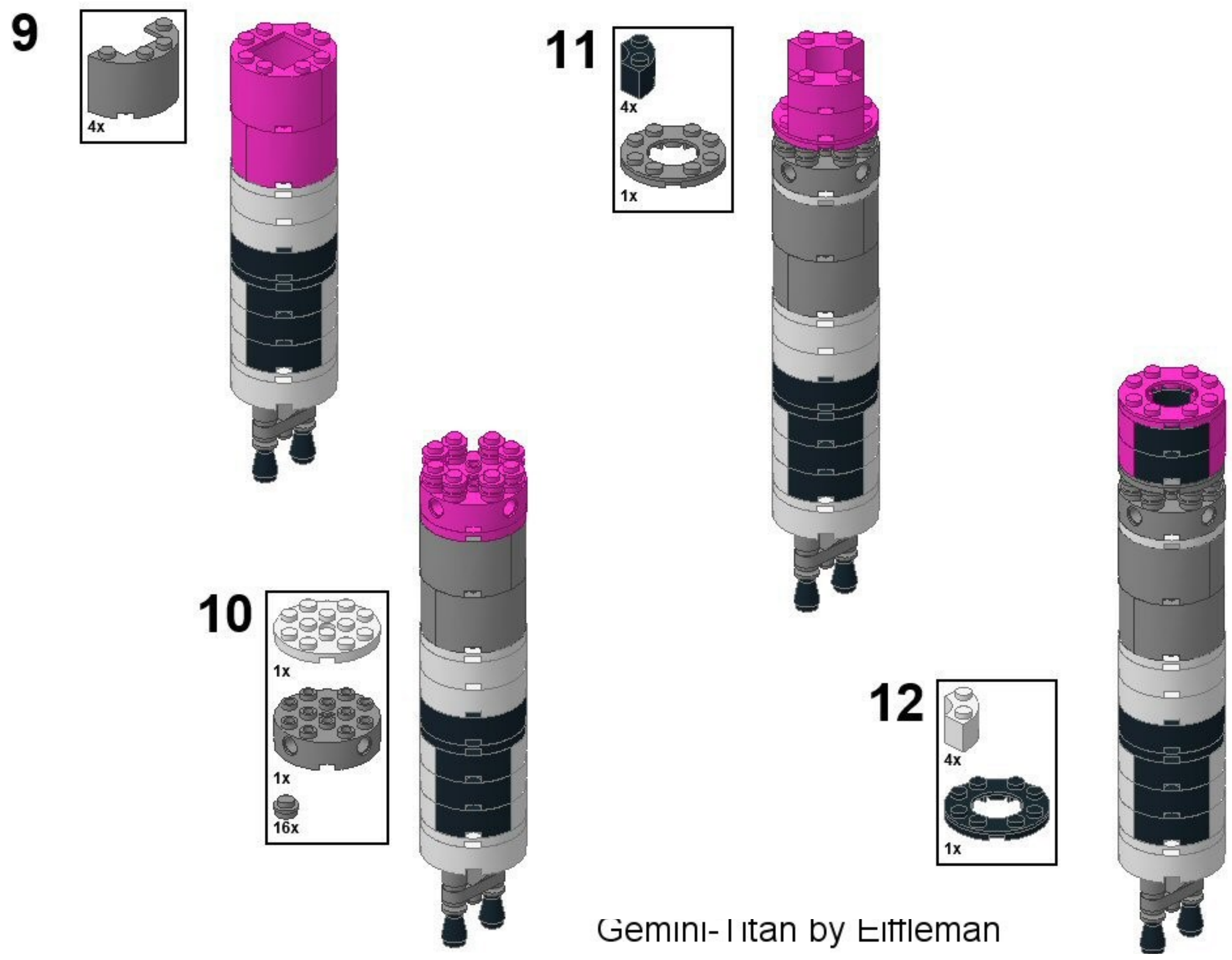


Gemini-Titan by Eiffleman



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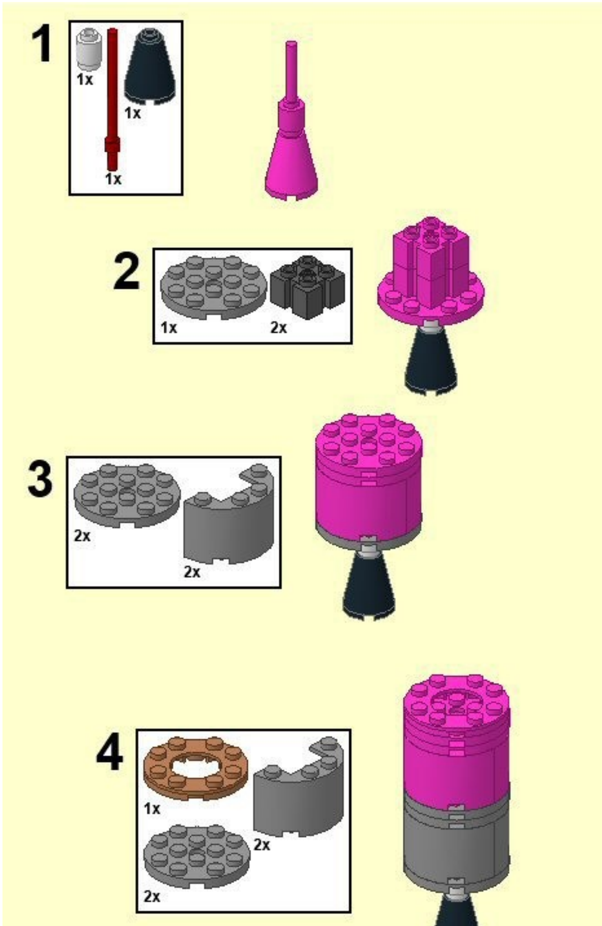

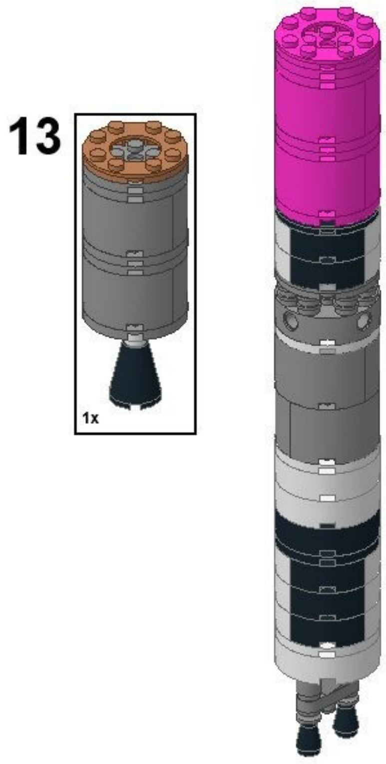

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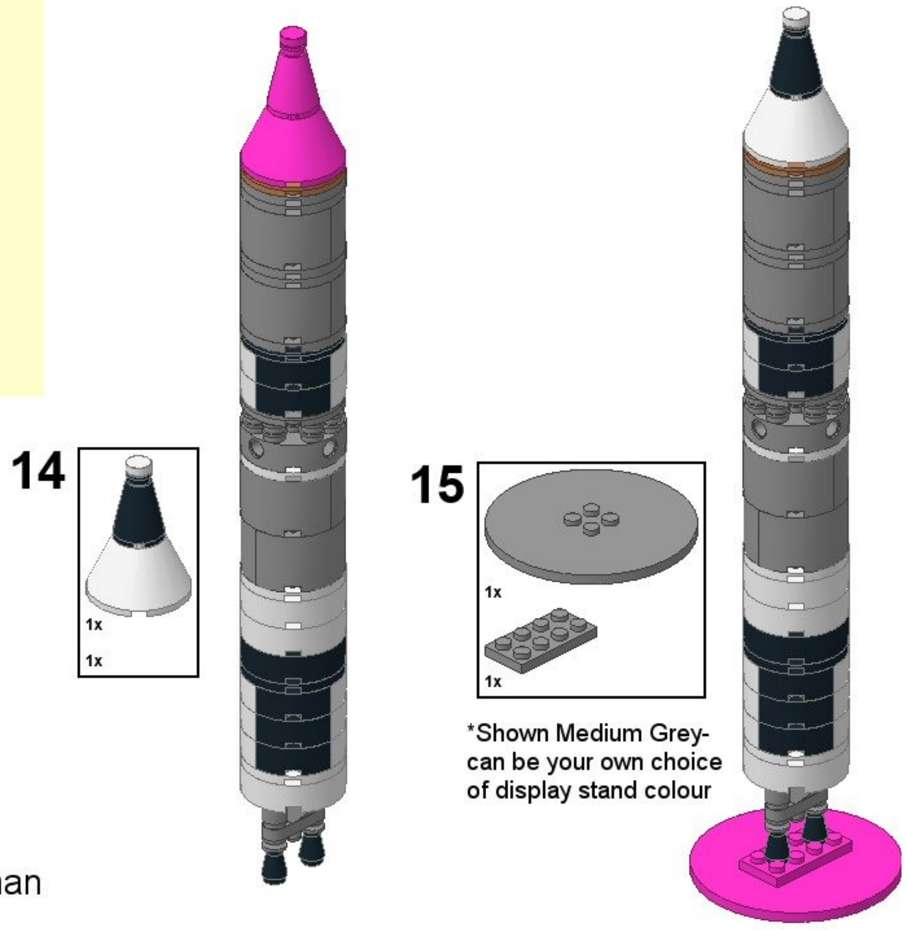

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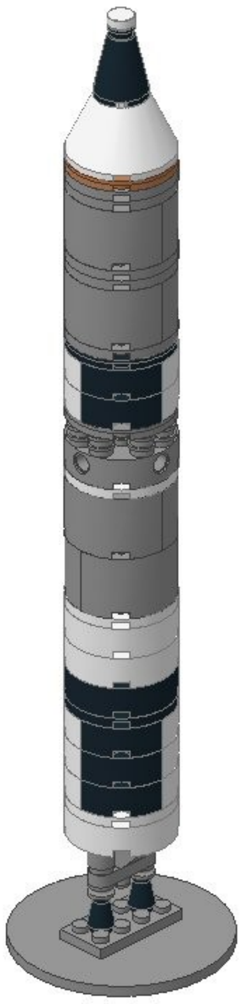

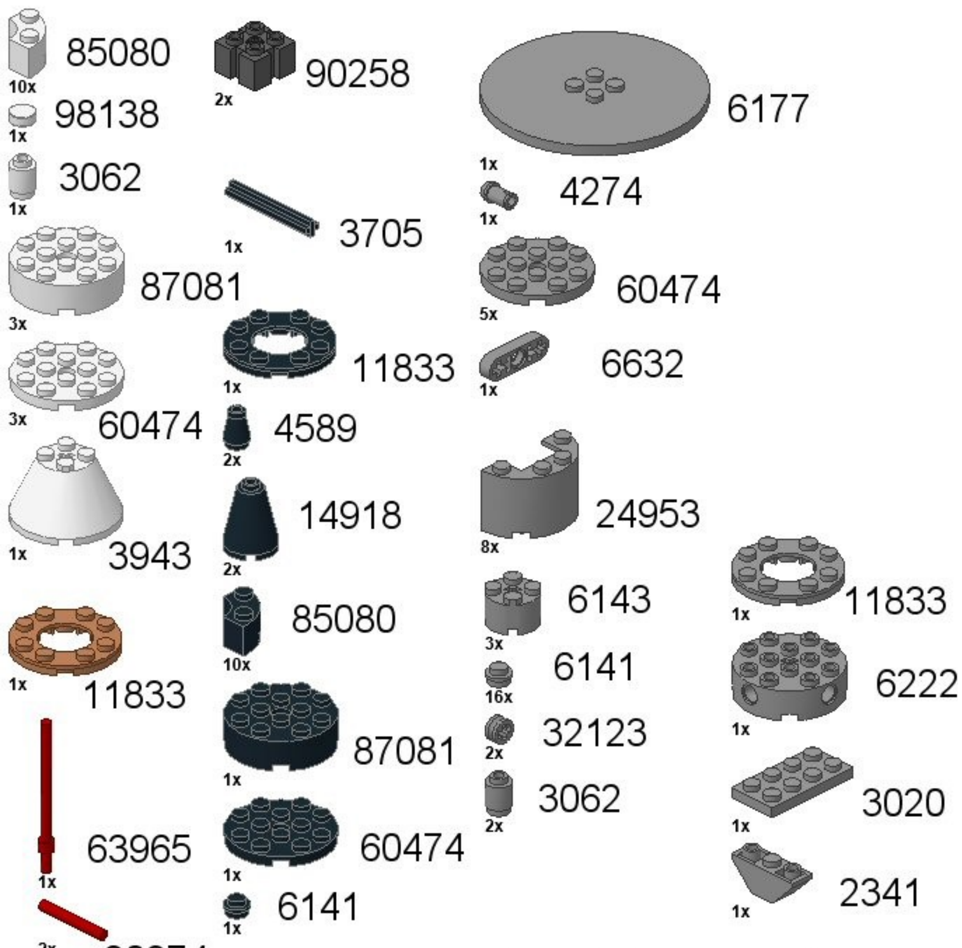

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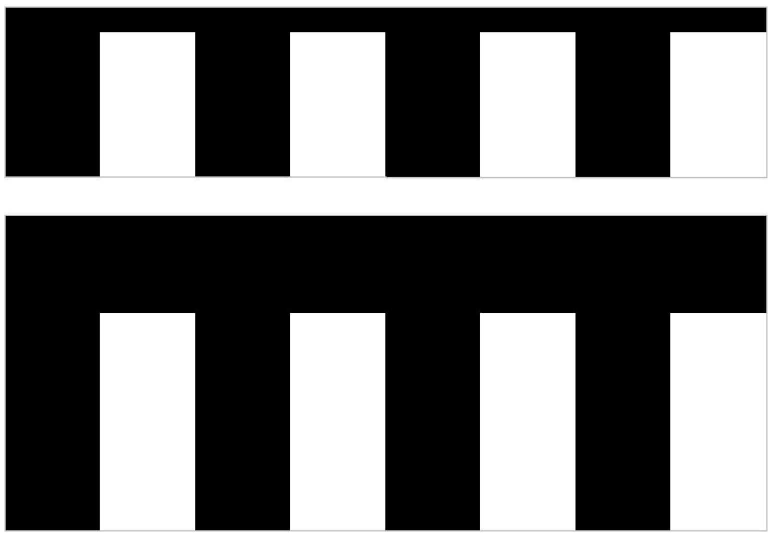
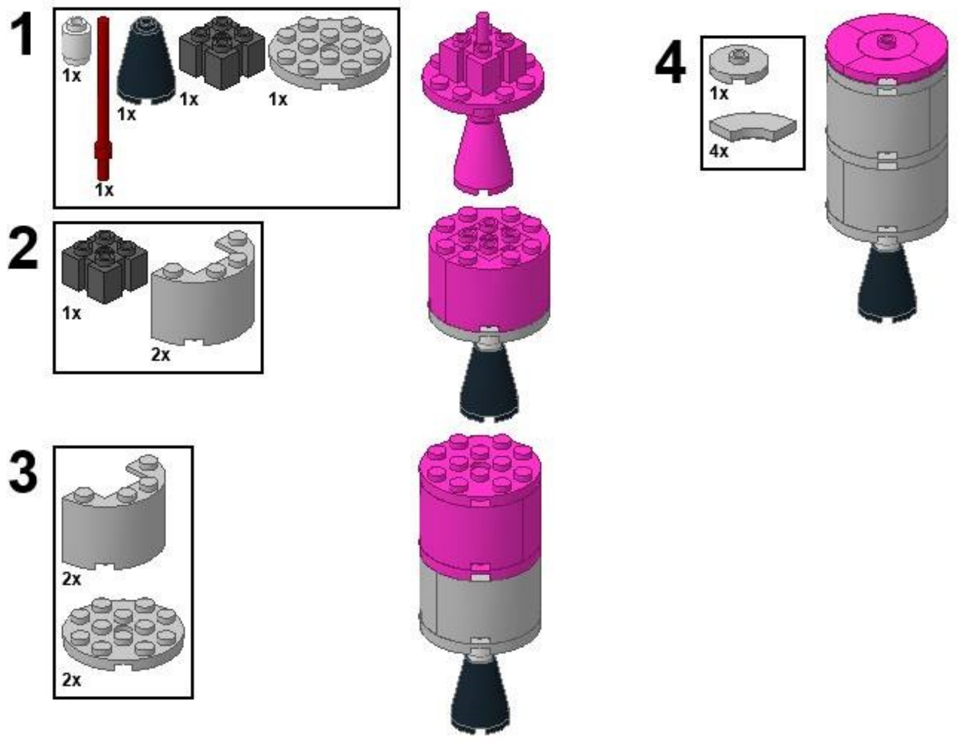
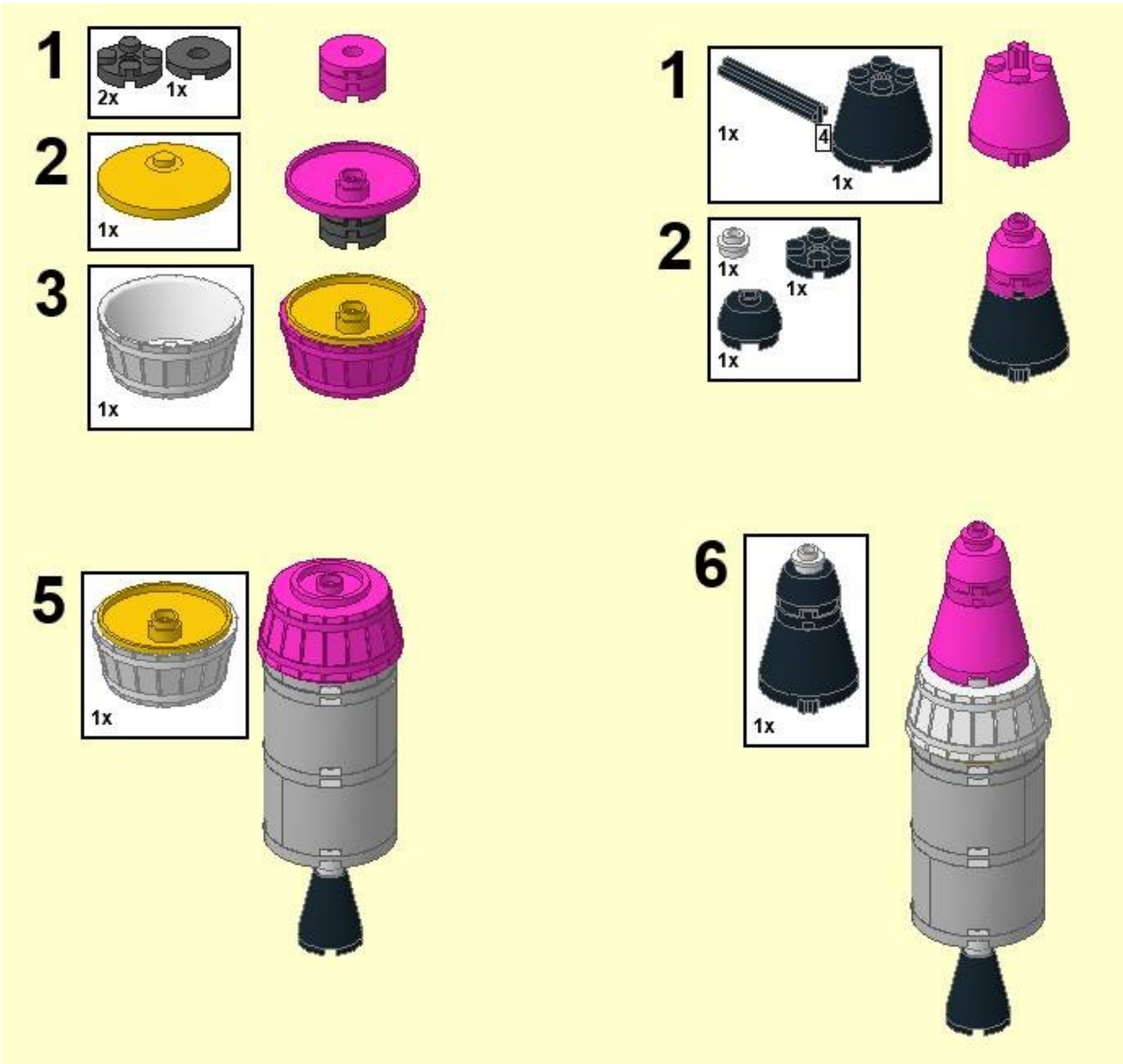


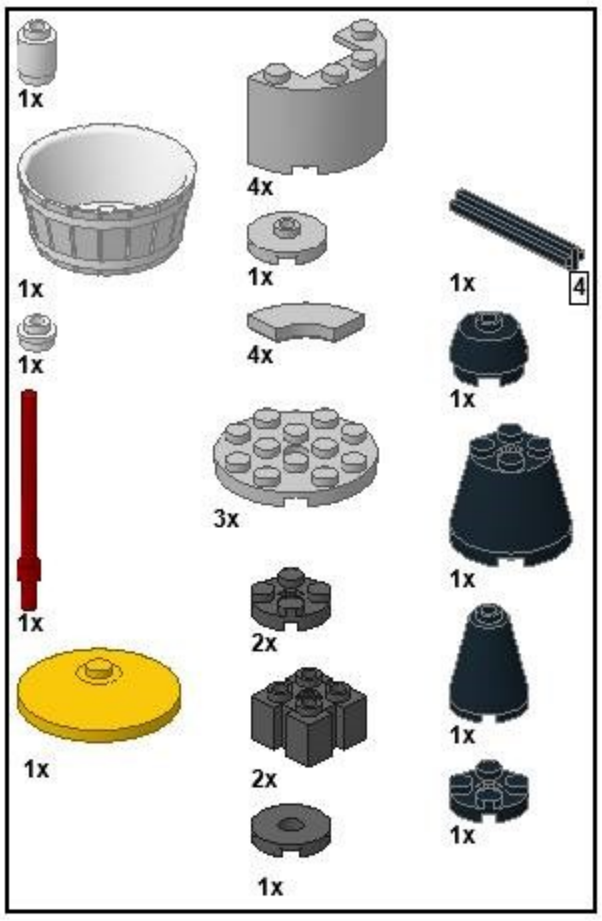
Copy the graphic and wrap it around your model. Print as a sticker or use a smallpiece of tape to fixate it in order to give yourro-cket the markings of the Mercury Redstone.

Alternative Capsule build

By David Welling/luxordeathbed



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The Rocket Garden

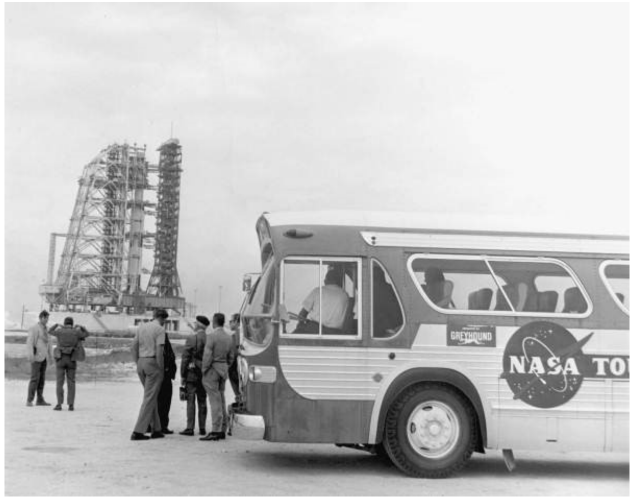
The Rocket garden of the Kennedy Space Center Visitor Complex in Florida is one of the biggest outdoor displays of rockets. Building the rocket garden creates an adequate and apt space to display the models built in the previous chapters.

The Visitors' center and entrance at Kennedy Space Center - Cape Canaveral Florida, 1967
Credit: Florida Department of Commerce collection

Overleaf: NASA's Rocket Garden at the Kennedy Space Center Visitor Complex , July 2003.
Credit: Ad Meskens

The complex had its beginning in the 1960s in a small trailer containing simple displays on card tables. As the American space programs' popularity grew with the Mercury Program and Alan Shepard's historic launch, large numbers of press and public flocked to the Cape Canaveral area to get a close up view. NASA Administrator James Webb was urged by U.S. Rep. Olin Teague of Texas to create a visitors program. The first solution was a drive-through tour of what was then known as Cape Kennedy, now called Cape Canaveral Air Force Station. On Sunday afternoons from 1 to 4 p.m., the public could drive their own vehicles on a predetermined route that provided a glimpse of the launch pads and facilities. Despite the limited access, the tours proved immensely popular.

Spaceport USA, as it was soon titled, hosted 500,000 visitors in 1967, its first year, and one million by 1969. As NASA neared the moon, popularity grew. By 1969, the visitor center was the second most visited Florida attraction, behind Tampa's Busch Gardens. Even during the gap between the Apollo and Space Shuttle programs, attendance remained at over one million guests and it ranked as the fifth most popular tourist attraction in Florida.



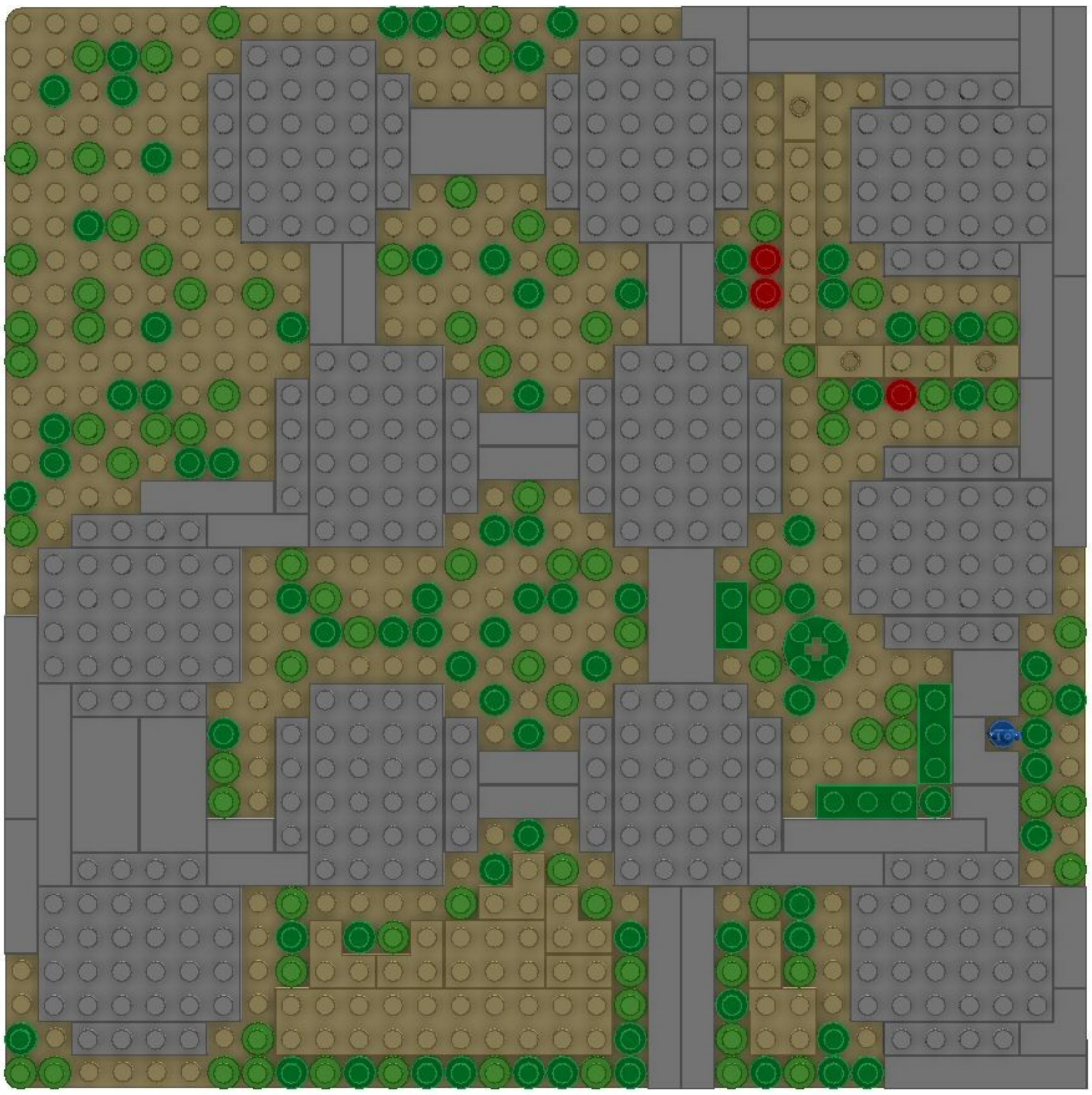
NASA tour of the Kennedy Space Center. 1970.
Credit: Florida Department of Commerce collection

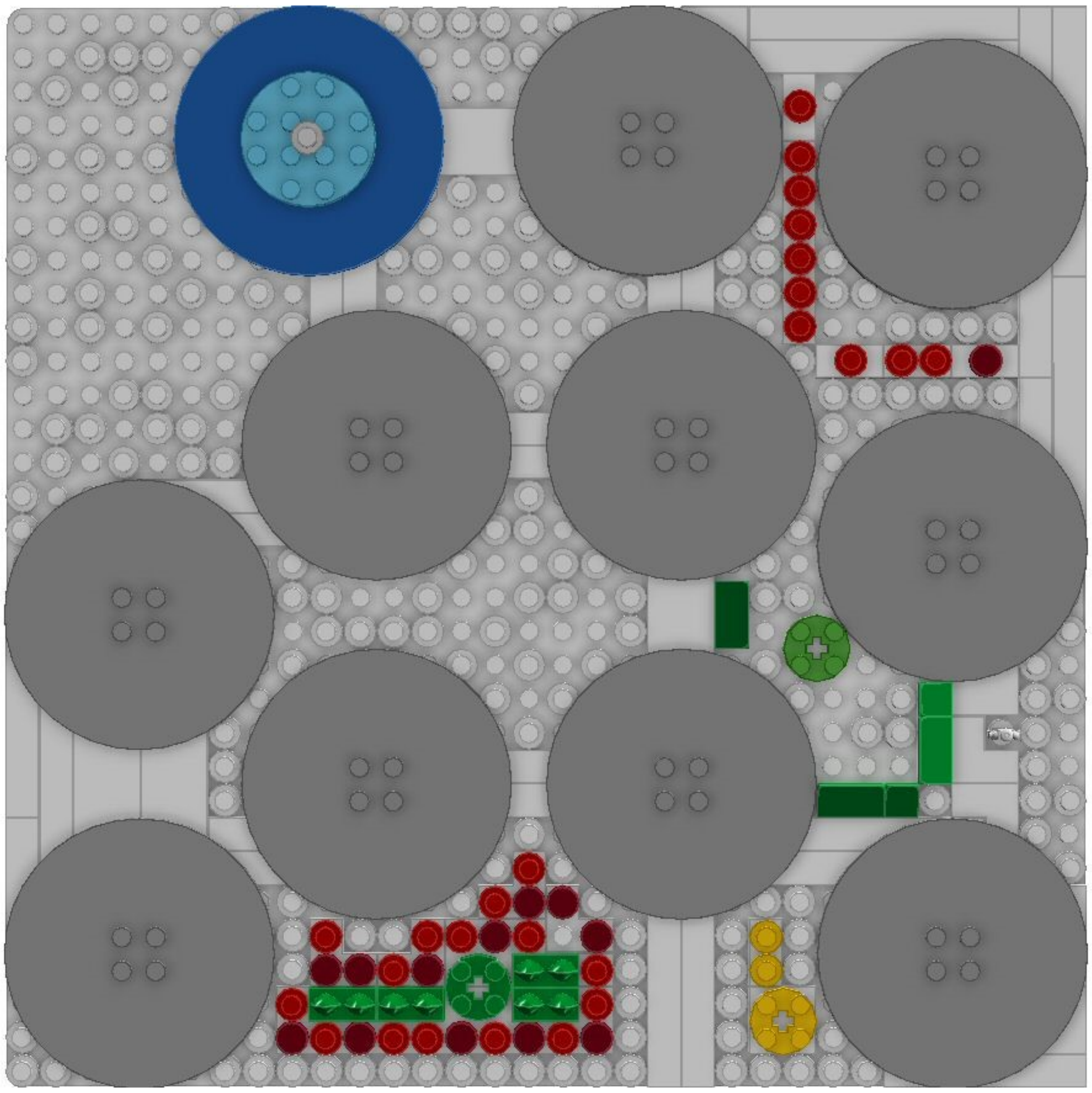
When nearby Walt Disney World opened in 1971, visitors center attendance increased by 30 percent, but the public was often disappointed by the comparative lack of polish at KSC's tourist facilities. Existing displays were largely made up of trade show exhibits donated by NASA contractors. Later that year, a $2.3 million upgrade of the visitor complex began with added focus on the benefits of space exploration along with the existing focus on human space exploration.

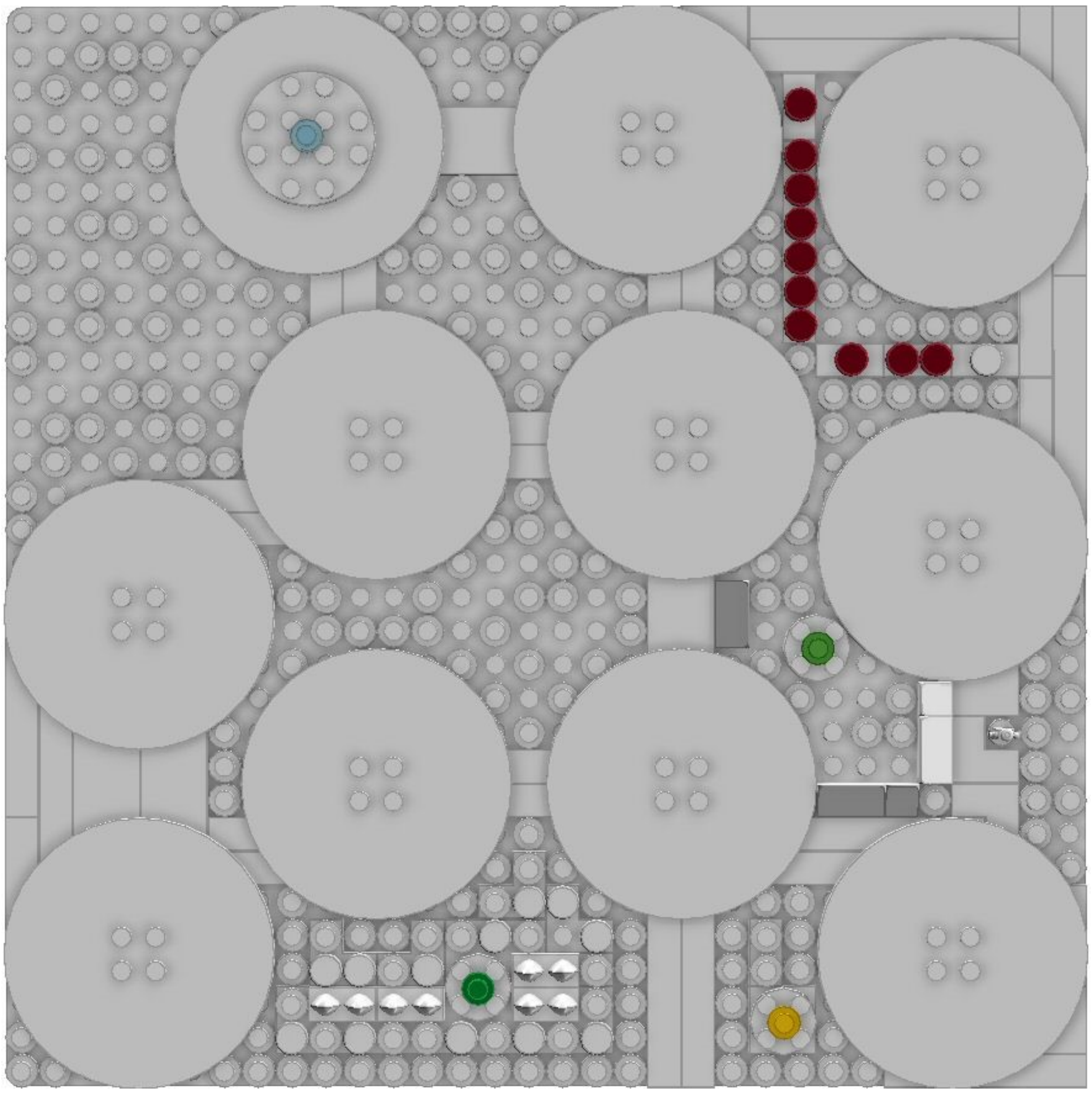
In 1991, The Space Mirror Memorial, also known as the Astronaut Memorial, was dedicated. The black granite monument is emblazoned with the names of each of the 24 astronauts who made the ultimate sacrifice, including the crews of Apollo 1, STS-51L/Challenger and STS-107/ Columbia, as well as seven other astronauts who died in jet and commercial plane crashes.

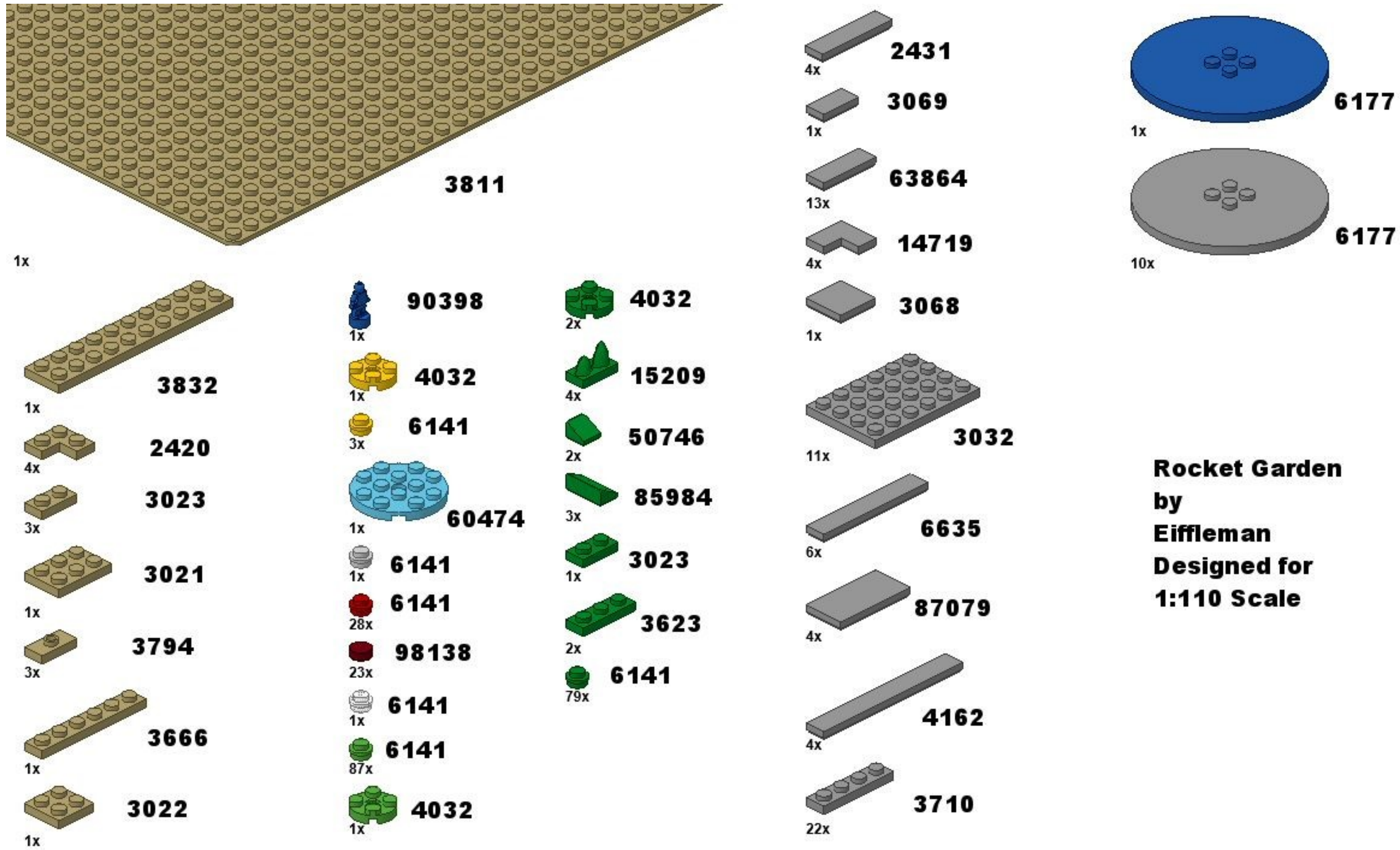
In 1995, Delaware North Companies was selected to operate the visitor center. Between 1995 and 2007, the visitors center went through many changes, including the improvement of restaurants, retail shops, buses, and new exhibits. It is also when the visitor complex got its current name, Kennedy Space Center Visitor Complex. The rocket garden has models of significant rockets on display: The Juno I on display is painted with serial number "UE" like the one that launched the first US satellite, Explorer I. A Juno II launched the first American probe to escape Earth's gravity and fly past the Moon. Atlas-Agena rockets launched early probes to the Moon, Venus, and Mars, as well as the Agena target vehicles used in rendezvous and docking by Gemini spacecraft—a necessary technique for the following Apollo missions. The Thor-Delta was one of the most reliable and frequently-used launch vehicles. The Titan II on display is a refurbished Air Force ICBM with a replica Gemini spacecraft, painted to resemble the Gemini 3 booster..The Saturn IB on display is SA-209 which was designated for a possible Skylab rescue mission.

The Rocket garden in the Kennedy Space Center, 13 April 2007.
Credit: flickr.com/yeowatzup





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Rocket Garden
by
Eiffleman
Designed for
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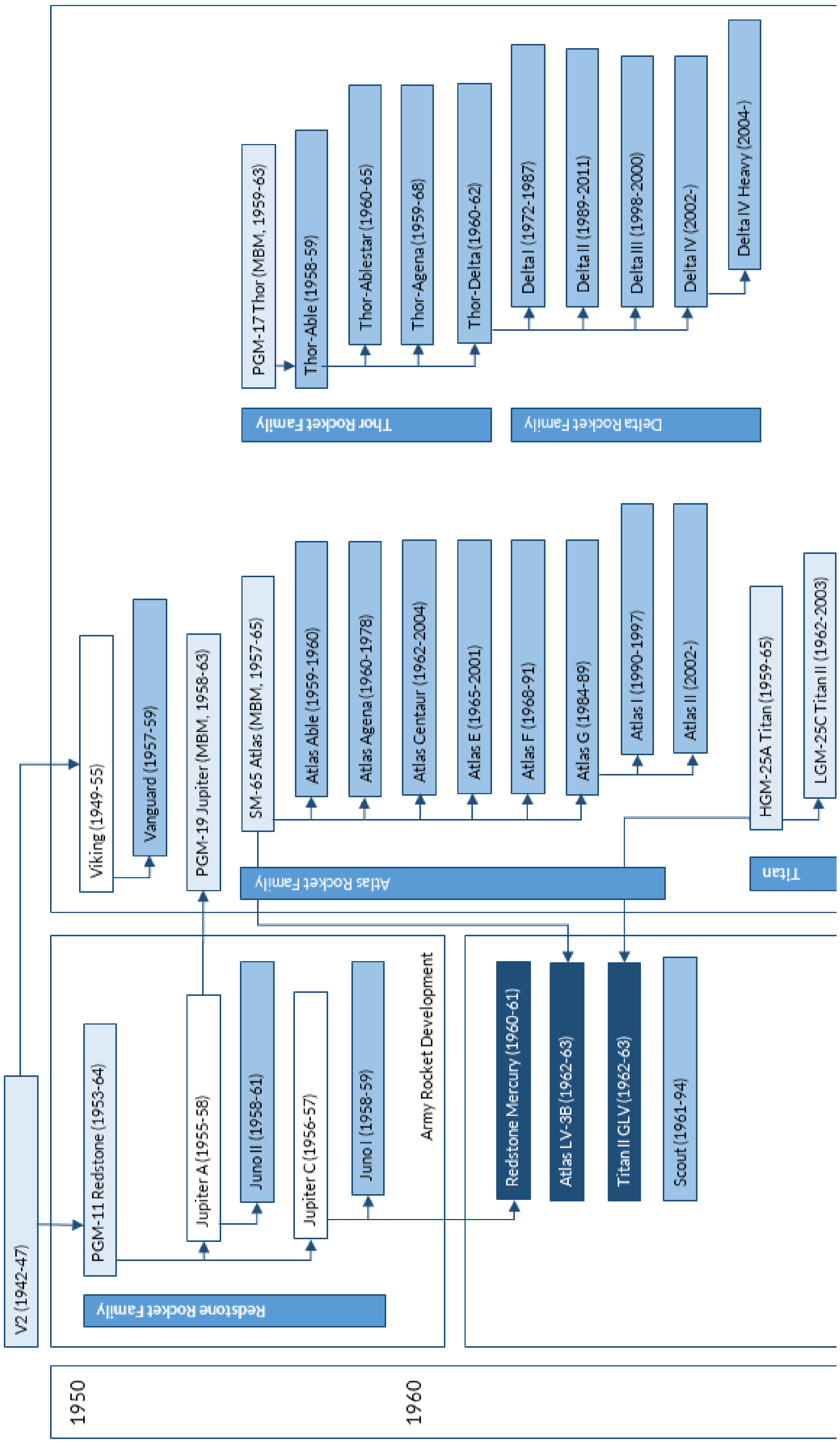
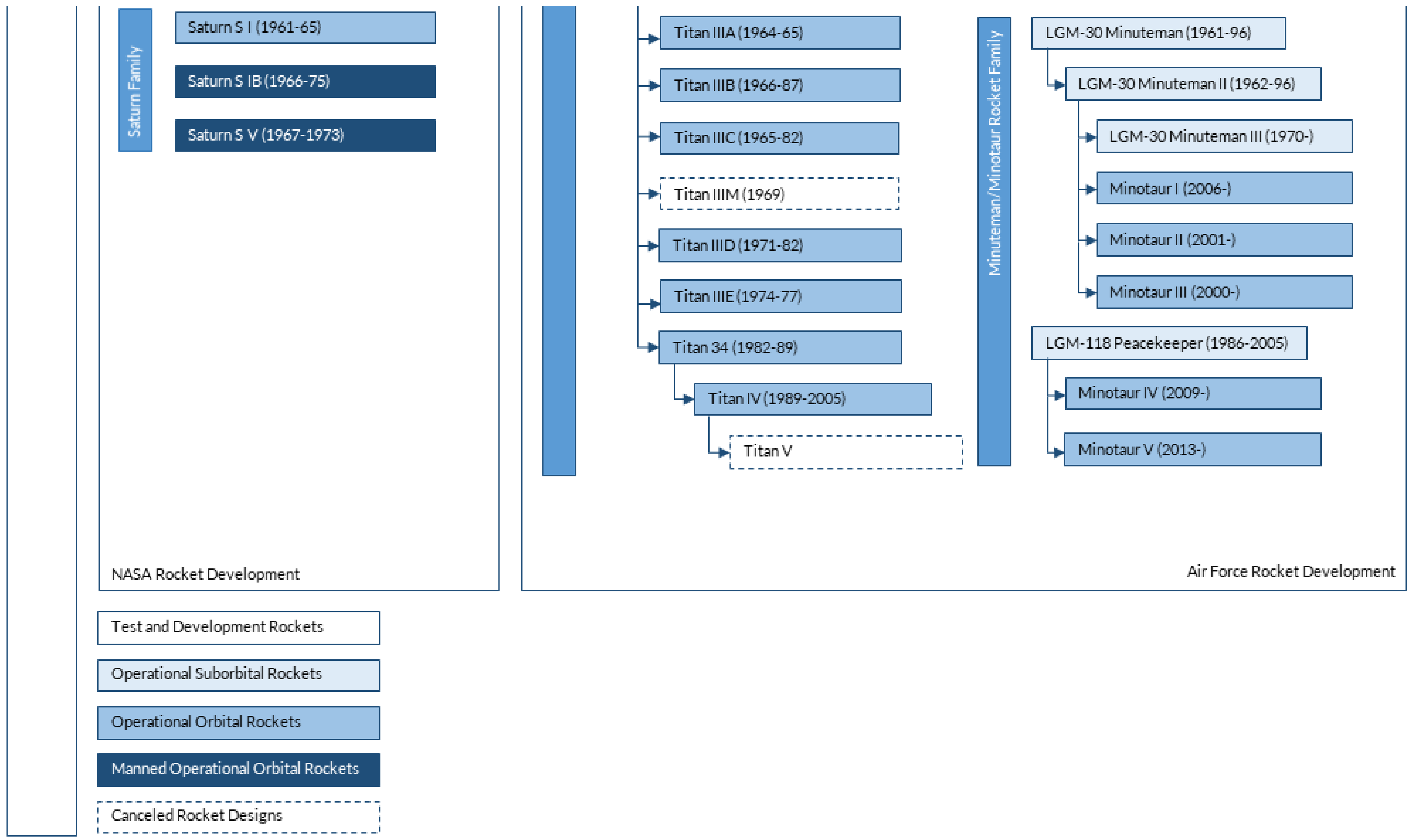
Appendix: US Rocket Families





Saturn Family
Saturn S I (1961-65)
Saturn S IB (1966-75)
Saturn S V (1967-1973)
NASA Rocket Development
Titan IIIA (1964-65)
Titan IIIB (1966-87)
Titan IIIC (1965-82)
Titan IIIM (1969)
Titan IIID (1971-82)
Titan IIIE (1974-77)
Titan 34 (1982-89)
Titan IV (1989-2005)
Titan V
Minuteman/Minotaur Rocket Family
LGM-30 Minuteman (1961-96)
LGM-30 Minuteman II (1962-96)
LGM-30 Minuteman III (1970-)
Minotaur I (2006-)
Minotaur II (2001-)
Minotaur III (2000-)
LGM-118 Peacekeeper (1986-2005)
Minotaur IV (2009-)
Minotaur V (2013-)
Air Force Rocket Development
Test and Development Rockets
Operational Suborbital Rockets
Operational Orbital Rockets
Manned Operational Orbital Rockets
Canceled Rocket Designs

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Lego Ideas - https://ideas.lego.com
The crowdfunding platform enabling users to post their own plans and models and let others support them. Birthplace of the Saturn V model.

NASA History Office - https://history.nasa.gov.
Provides countless histories, documentations and multimedia files on the history of human space flight.

NASA historical images
Nasa has more than 40 different accounts on Flirck, many focused on individual missions and programs. Most notable from a historical view are "Nasa on the Commons" https://www.flickr.com/photos/nasacommons/ with a wide range of iconic historical images and Project Apollo Archives - https://www.flickr.com/photos/projectapolloarchive/ with images from all Apollo missions, but there are channels for each individual Space Shuttle, and even for individual facilities.

Astronautix—http://www.astronautix.com
Mark Wade's encyclopedia is the definitive reference for any rocket that was ever dreamt up, designed, or built to fly. Don't let the aging design fool you.

Lego Digital Designer—https://www.lego.com/en-us/ldd
The original LEGO CAD software by Lego, designed to enable users to create digital LEGO models and share their creations. Unfortunately, LEGO decided to discontinue the development of this software in 2017, so even though it is in widespread use, no updates to its brick database are forthcoming.

Bricklink/Stud.io—https:// bricklink.com/
One of the biggest marketplaces for used and new Lego bricks and sets, Bricklink has created its own LEGO CAD software, the Stud.io. Intuitive, with a nice user interface and an updated brick database, it can also import LDD files and designs by the various older open source programs like LDraw.

LDraw—http://www.ldraw.org/
This was the first popular open standard for LEGO CAD programs that alloed the user to create virtual LEGO models and scenes. Although still in use with many, its slightly clunkier interface and trouble with "illegal" connections limit its use compared to newer LEGO CAD software. However, Instructions generated by blueprint based on LDraw files are still the most beautiful in the field.

Blueprint - http://blueimaging.wikia.com/wiki/Bluerender_and_Blueprint_LEGO_Imaging_Wikia
A small Java program that can be used in conjunction with LDraw to render professional looking instructions as JPGs or PDFs.

Lego Saturn V mod Facebook Group—https://www.facebook.com/groups/saturnvmods/
Created by Liem Bahneman in 2017, the group serves at the main hub for new ideas and MOCs with 1:110 related NASA and Space MOCs. Its 2000+ members as of February 2019 are eager to support and help anyone getting into Space modelling with LEGO.

Reddit Link Collection—https://www.reddit.com/r/lego/wiki/links
While the NASA Space modelling community never was strong on the ubiquitous Reddit, their general Lego community hosts a lot of information on Lego in general and more links to the world of LEGO MOCs.

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With the new century and the retirement of the Space Shuttle new players have entered the arena. SpaceX “Falcon Heavy” and the Chinese “Long march” are only one of several challengers to the venerable Russian Proton rocket or the new NASA “Ares” system. Watch history unfold!

About the Author

Wolf Broszies was born in 1972 in Kaiserslautern, Germany. His father is a reverend, his mother a high school teacher. He graduated in 1991 and, after compulsory military service, studied history and philosophy in various European cities for much longer than necessary. Wolf works as a product owner in an IT company and is married with two kids.

Having kids allowed him to return to his childhood toys and his fascination with space exploration and science fiction. Enjoying catalogues and compilations, this is his first work for the Lego community.

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During the Cold War, few things united so many people as their fascination with space, and the attempts of both Superpowers to "win" the Space Race. Volume I of "Bricks in Space" presents twelveLEGO-builds of US rockets that helped propel NASA—and humankind—into space. From the infamous V2 to the Redstone nuclear missile and the Titan Gemini, explore space history—with LEGO!
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