

Annotated Bibliography

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Arrighi, R. (2022). First Microgravity Experiment Flown on Project Mercury. *NASA*.

<https://www.nasa.gov/history/first-microgravity-experiment-flown-on-project-mercury/>

During NASA's Aurora 7 Mission of the Mercury Project in 1962, astronaut Scott Carpenter conducted the first microgravity fluid experiment of a long duration. This experiment was designed by NASA Lewis Research Center, and it involved placing a baffle inside a glass ball that was filled with dye water. The goal of this experiment was to see how fluids would behave in microgravity and how liquid propellants would act in space since the Lewis Research Center was in charge of what propellants would be used to fuel certain rockets and understand how they would move within the gas tanks. Even with spacecraft movements and speed changes, it was confirmed by Carpenter's inflight observations and video surveillance that the fluid remained stable throughout the mission. According to Arrighi (2022), "The Lewis experiment was significant in that it confirmed predictions that the tube provided sufficient surface tension to stabilize the liquid and, perhaps more importantly, demonstrated that neither spacecraft movement nor change of speed had any significant effect on the liquid's position." This experiment would serve as the basis for hundreds of other fluid movements in space studies, expanding to areas like combustion and biotechnology.

This article highlights the past work of NASA about additional early experiments they conducted during major past missions like Project Mercury. This experimentation was crucial because it demonstrated the desire of NASA to tackle potential problems that may arise during missions, specifically with the movement of fluids in microgravity

when it comes to liquid propellants fueling tanks for space travel. By confirming that fluid remained stable in this experiment and that these patterns could be predicted, this likely played an integral role in creating better, more efficient spacecraft designs for future missions. The design of the liquid engine rocket was greatly influenced by this discovery and this would assist in NASA's goal of creating better rocket designs.

Additionally, this study in particular was very important because, being one of NASA's earliest experiments, this impacted their thought process to continue researching this matter. Their past work seems to have influenced later works as well with hundreds more experiments on the shuttle and space station alongside other ones of different subject matter.

Cholula, N. (2024). NASA to Test Technology for X-59's Unique Shock Wave Measurements. *NASA*.

<https://www.nasa.gov/image-article/nasa-to-test-technology-for-x-59s-unique-shock-wave-measurements/>

NASA will soon be testing a shock-sensing probe that they have designed to measure the shock waves produced by its X-59 aircraft, which they are hoping to be quieter. The probe was developed by researchers at NASA's Armstrong Flight Research Center with two different versions in order to capture shockwaves from different distances from the aircraft. One version of the probe aims to measure near-field shock waves close to the aircraft while the other version strives to measure mid-field shock waves at altitudes between 5,000 and 20,000 feet. This tool is integral for NASA's Quesst mission in which they are trying to greatly reduce the noise of sonic booms to become much quieter. As

NASA's principal investigator of the probe, Mike Frederick explained, "A shock-sensing probe acts as the truth source, comparing the predicted data with the real-world measurements" (Cholula, 2024). Their current designs of the probe have also addressed previous design issues that caused delays and inaccurate readings of the probe's pressure transducers being too far away and fluctuations caused by temperature, which they fixed by making them closer and creating a built-in heating system. As the probe is designed to pick up on small pressure changes and collect very precise pressure data overall, it will help to validate computer models that predict the shockwaves the X-59 aircraft will produce.

The article clearly shows NASA's strong efforts and dedication toward advancing quiet supersonic flight and how such travel may impact the environment. Within this present work of NASA, their adaptability and willingness to address change in order to create a better product are evident. Given how previous probe designs faced issues with temperature fluctuations and traducer distance causing delays and inaccuracy, their new design emphasizes their ability to address challenging complex issues for effectiveness. This demonstration of mindset relates to the present goals of NASA in which, within this case, they try to change the landscape of air travel by making supersonic flight more sustainable. Furthermore, their continuous refinement of shock wave measurements with this probe shows how they aim to apply their innovations to meet new needs and stay as accurate as possible through intrinsic measurement. Similar to their other efforts, the probe's design and creation seem to be used in measurement for future projects and used for many different applications as well.

Cranford, N. (2021). The Menu for Mars: Designing a Deep Space Food System. *NASA*.

<https://www.nasa.gov/humans-in-space/the-menu-for-mars-designing-a-deep-space-food-system/>

As a future exploration goal in the Artemis era, NASA is attempting to create a sustainable food system for long-duration space missions, especially those to Mars. The space system's current system involves frequent resupply missions that bring food to those on board. On the other hand, due to the much greater distance from Earth, Mars missions would require food that remains safe and nutritious for years as resupply missions would be implausible. NASA scientists have outlined key criteria for a Mars food system alongside other deep space explorations, including safety, stability, palatability, reliability, resource efficiency, and many more. For example, in relation to reliability, NASA scientist Grace Douglas emphasizes its importance by stating, "One of the big concerns with growing food is that if it doesn't grow and you were depending on it, now you have insufficient food, which can be a very, very big concern when you're going on these missions" (Cranford, 2021). To meet this future goal of a stable food system in relation to longer missions, alongside exploring innovations and testing space-ready appliances, NASA is also putting out initiatives like the Deep Sea Food Challenge for potential ideas.

The article shows how NASA's advancements regarding food systems relate to their future long-term goals for sustainable space exploration when going deeper into space. By addressing challenges like food preservation and degradation over time, NASA is already preparing for Mars missions that require independence from Earth, especially

in the matter of food. It is seen how NASA is considering and attempting to address various facets in their approach to eventually conducting further exploration missions when their dates come around and show the organization into their thought process, taking these potential aspects into account early to find the best possible solutions.

Additionally, the emphasis on food variety and reliability reveals NASA's commitment to ensuring the well-being of their astronauts and how they tie that greatly towards mission success. It is also very interesting to see NASA take on a unique approach in setting up initiatives to come up with ideas for food systems, looking towards external support in hopes of possible advancement in achieving their future goal.

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