Kennedy Space Center
Technology Transfer News

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Jacob Torres is a Horticultural Scientist in the Plant Growth Lab at the Kennedy Space Center

Photo credit: Tony Gray
Career in Review,
An Interview with Dave Makufka

Dave Makufka has worked at NASA for over 36 years, serving in a variety of different operational positions and leadership roles

Did you always want to work at NASA?

Growing up in a small town in central Pennsylvania, working for NASA was not something that I really ever thought about as a child. I watched the Apollo missions to the Moon, and saw the Space Shuttle on the news, but that was it. As I neared the end of my college work in Mechanical Engineering at Penn State University and began thinking about careers, the opportunity to work for NASA at the Kennedy Space Center somewhat serendipitously opened up right in front of me. I hesitated at first, not believing that this was something I could actually be a part of, but then I applied for the job and was granted an interview.

The rest is history…very good history.

How long have you worked at NASA?

I have worked for NASA for 36 years. As I mentioned, I was hired right out of college in 1984. It’s been a tremendous opportunity and the career of a lifetime. The excitement of the space program and being able to contribute to such an important national priority has been very satisfying and humbling.

How many roles have you had in your career at NASA?

When I first joined NASA in 1984, I was very fortunate to be assigned to one of the “Big 3” projects at the time – construction of Mobile Launcher Platform (MLP) #3. I worked as the field representative for the Lead Design Engineer, coordinating with more than 70 different system engineers to help solve
technical problems that arose during construction. Unfortunately, the Challenger accident occurred in 1986 and the project was put on hold. Once NASA was directed by Congress in 1987 to build the replacement Orbiter Endeavor, I was assigned as the Lead Engineer for the activation of MLP#3. After more than a year’s worth of work by a very talented and dedicated team, MLP#3 was successfully brought on line and into Shuttle operations.

For the next several years, I worked as the Solid Rocket Booster (SRB) Holddown Post system engineer. I was directly responsible for implementing a new design on the eight holddown posts that structurally connected the SRBs to the MLP prior to launch. My understanding of the loads induced into the holddown posts and MLP during the moments immediately before and after liftoff was critical to ensuring any modifications would be well within the safety limits of the vehicle and structure.

In 1992, I was selected for a one-year assignment at NASA’s Reston facility in Virginia to serve as the Lever 2 Manager for Ground Support Equipment (GSE) for the Space Station Freedom Program (as ISS was called then). In this role, I managed the program design requirements for all GSE being built to support Space Station construction and checkout. I worked closely with other NASA Field Centers and with international partners to coordinate, review and approve the design and development of Space Station GSE systems and hardware.

When I returned to KSC the next year, I was asked by the Director of Engineering to help establish the newly created technology development office at KSC. As I switched gears once again and began to focus on technology, I knew this was the place for me. I helped align requirements with funding sources to develop emerging technologies that addressed technical challenges at KSC. As time evolved, I became more and more interested with technology transfer until that became my primary focus. In 2006, I was selected to manage the KSC Tech Transfer program and have been doing so ever since.

What has been the most rewarding aspect of leading the Technology Transfer program?

By far, it’s the people. We have a dedicated Tech Transfer team that is very knowledgeable, creative and willing to help in any way they can. I’ve especially enjoyed working with the KSC researchers and engineers to share in the excitement of their innovations, and to help them connect with industry partners to see how their technologies can impact the world through commercialization. Companies are excited to work with NASA, and NASA researchers are excited to work with companies. It’s truly a positive work environment and a win-win-win situation!

What kind of positive changes have you helped enact in the Technology Transfer program?

Tech Transfer is a multi-faceted discipline that brings together knowledge of technical innovation, business practices, intellectual property management, partnerships, federal laws and many other aspects. It has many moving parts. Early in my Tech Transfer career, I worked on numerous agency-level teams and initiatives, including development of an agency wide database that integrates T2 data across NASA to provide an end-to-end process and data management tool for the program. More recently, I’ve focused on sharing my years of knowledge and experience with our younger staff, helping them to understand the nuances of this very unique, people-centric job. I’ve tried to be an enthusiastic role model for the team, emphasizing a people-first culture, maintaining a high level of integrity and being creative & forward thinking in everything that we do.

What do you hope your legacy will be within Technology Transfer and NASA as a whole?

I think part of my legacy will simply be about the knowledge and enthusiasm that I had for Tech Transfer that helped to bring the program to a higher level of success at KSC. I hope through my leadership that I was able to make a difference for NASA and have a positive impact on those around me. That would be a good legacy.
University Partnerships

Dynamic university relationships enrich the Technology Transfer program and foster an entrepreneurial spirit in students

Kennedy Space Center (KSC) has several initiatives with a mission to assist researchers and students at universities in understanding Kennedy’s research and technology portfolio, core capabilities, and research opportunities. The goal of these initiatives is to increase collaborations with University Principal Investigators and students and leverage KSC’s capabilities to assist them with their Small Satellite development activities.

The Florida Space Grant Consortium (FSGC) is a statewide network of colleges and universities supporting the expansion and diversification of Florida’s space industry through grants, scholarships, and fellowships to students and educators in Florida. KSC is partnering with the FSGC to facilitate selecting universities to work on NASA research topics as part of the student’s Senior Design Research Projects. KSC will provide topics that align with the agency’s research and technology areas to the FSGC who in turn put in a request for proposals to Florida universities and colleges. Final awards to students will be for the final semester of their senior year.

A Colloquium comprised of a series of talks is being planned during which KSC experts will speak at local Universities to engage Faculty and students. Topics will be vetted for mutual interest and availability of both parties and may include:

- Evolution of KSC from a Government Spaceport to a Multi-User Spaceport
- NASA’s evolving Commercial Gateway Business Model
- KSC’s Research & Engineering Capabilities
- Evolutions of Research using Small Satellites

KSC’s Technology Transfer Office continues to offer its Technology Transfer University (T2U) opportunity to professors and students at local colleges and universities. Teams of students are provided with information on KSC’s patented technologies. Teams select a technology and develop a commercialization and marketing plan and present the results to KSC’s Technology Transfer office and the inventors of the technology at the end of their study. This program has led to the startup of several companies over
the years that have licensed the patent rights and commercialized NASA’s technologies.

A NASA Centennial Challenge is being planned for later this year to encourage teams consisting of university, small businesses, startups and other organizations to submit proposals to develop and demonstrate novel technologies, systems or approaches for sustainable advanced food production that can be integrated into a larger food system for long duration deep space exploration missions. The Challenge will consist of three stages, an open call for registration, a qualification round and a competition round. The goal of the Challenge is the development of palatable, nutritious and safe food or food system that requires little to no processing time for crew members with low/limited resources.

The SPEARS technology was introduced to the Rollins College-NASA Entrepreneurship Scholar Distinction program – engaging Rollins MBA students in researching NASA technologies as part of their studies. Sergie “Serg” Albino, a Rollins College alum, met Dr. Quinn in 2011 while he working on the RESOLVE Lunar Rover Project at NASA, and became interested in Dr. Quinn’s work with the SPEARS technology. An engineer by training, Serg was naturally drawn towards the technology side of business development when he became an advisor to the students in the Rollins-NASA program.

When the SPEARS technology was introduced to the Rollins-NASA program, it seemed like a natural fit for Serg. For the SPEARS-related effort, Serg led the students in a study focusing on sales/financial projections and marketing strategies for the SPEARS technology, while he concentrated on the manufacturing aspects of the SPEARS.

Based on the results of the research, Serg Albino and R. Ian Doromal founded ecoSPEARS and attained the exclusive rights to manufacture and sell SPEARS in 2017. ecoSPEARS is an early stage clean technology company, envisioning a world where every human being has access to clean water, clean food, and clean air.
Considering the growing necessity of waste management on long duration space missions, a multi-disciplinary team comprised of early career researchers at NASA’s Kennedy Space Center, have been working on a solution to this problem. Building on previous research, this group prototyped a reactor, the Orbital Syngas Commodity Augmentation Reactor OSCAR, to convert space waste into useful gasses. OSCAR is an Early Career Initiative ECI project that was funded by NASA’s STMD Space Technology Mission Directorate in 2018.

OSCAR has a reactor that uses heat, oxygen and steam to convert astronaut waste into water and a gas mixture, known as synthetic gas or syngas. Molecules from syngas can be used to create beneficial products, like fuel for the spacecraft. The gasses can also be easily vented if they are not needed at the time.

Following a fast-paced development phase, the OSCAR team developed a prototype rig, which has now undergone a 2.2 second microgravity drop test at NASA’s Glenn Research Center and a suborbital flight test on Blue Origins New Glen. Both tests have yielded valuable data that will help the team as they move forward with this exciting project.

The team working on OSCAR includes a dynamic group of individuals, many of whom are Early Career Researchers.
Dr. Annie Meier leads this team in supporting various aspects of the OSCAR project. Gino Carro, Jonathan Gleeson, Evan Bell, Pri Thakrar, and Syrus Jeanes supported the mechanical and structural design of the OSCAR unit. Malay Shah, Michael Harris, and Cristina Oropeza Ph.D, support the fluids analysis testing aspects of the project. Joshua Santora runs the communications and PR operations. Jake Hochstadt, Jaime Toro Medina, Matt Nugent, and Emily Forrester work on DAQ, avionics and safety related procedures.

A couple of the team members offered some insight into the progression of this project and how they have each contributed individually to the team. Annie Meier spoke a little bit about the team dynamic and how everyone worked together. “I coordinate all of the awesome team members that we have. They’re multi-disciplinary, so we have everyone from Jake, who is electrical software, we have people from Safety, and we have people from Communications. For us, a young or early career team that is moving so fast and is trying to fight bureaucracy and kind of going outside of the norms of the NASA culture or even traditional workplace culture, I’d say is very unusual around this neck of the woods.” Annie Meier said.

Evan Bell is the lead mechanical engineer on the OSCAR project. His primary tasks were the structural design and analysis of the OSCAR drop tower and launch vehicle payloads, development of a myriad of prototype reactors, interfacing with Chief Engineers at various design reviews, keeping constant communication with Blue Origin’s mechanical design team to ensure smooth integration, and managing the fabrication of parts through the use of onsite manufacturing (prototype shop & LETF) and off site contractors. “With the help of the team, I kept the design of the structural and pneumatic systems on track from a back-of-a-napkin sketch to a fully assembled and tested payload. I also worked with Malay and others on the design analysis report to prove our system was safe to fly.” Evan Bell Said.

Johnathan Gleeson, an Aerospace Engineer working on the mechanical/structural design of OSCAR is one of the early career individuals involved with this project. “On OSCAR I had a variety of responsibilities. My main focus was working with Gino Carro on OSCAR’s Pressure Vessel System (PVS) approval. The system had to be approved by Kennedy Space Center, Glenn Research Center, and Blue Origin before it could be pressurized at those locations. The process for this involved creating a flow schematic (SMS) and PVS Bill of Materials (BOM) and compiling all of the pressure system’s certifications, specifications, analyses, and assessments into one data package for the Pressure Systems Manager to review and approve.” Johnathan Gleeson Said.

Jake Hochstadt is an AST Software Systems Computer Engineer working on the OSCAR project. “The work I did on the OSCAR project was primarily focused on designing and integrating the electrical portions of OSCAR. Other tasks included ensuring OSCAR was compliant with KSC IT Security requirements and integration with the payload controller provided by Blue Origin.” Jake Hochstadt Said.

Jaime Toro Medina is an Aerospace/Mechanical Engineer working for the Testing & Design Branch. “For the OSCAR project my principal role was to develop the data acquisition and control system. This system recorded all data from the OSCAR experiment and coordinate the execution of the experiment in an automated manner during the sub-orbital flight. In addition, I supported testing, integration, data analysis and optimization of the payload on KSC and during or launch vehicle.” Jaime Toro Medina Said.

This project has been evolving rapidly, though there was a lot of heritage knowledge from a prior trash-to-gas project, the OSCAR team had to start from scratch designing a waste reactor that could work in a micro-gravity environment. Meier talked about how the team went from concepts on whiteboards to designs on napkins, all the way to proper engineering schematics and paperwork, and eventually to building, prototyping, and testing, and now they are analyzing data. The microgravity testing and results have brought confidence in the design. The lessons learned from this work will advance ground-based designs for future microgravity infusion.
Go Green or Go Home

As NASA sets its sights on the Moon and eventually Mars, scientists at the Kennedy Space Center are working tirelessly to develop a reliable way to grow nutrient dense plants in space.

Before astronauts took that first historic bite of lettuce in space, every piece of equipment involved in growing that lettuce was designed and meticulously tested in the Space Station Processing Facility (SSPF) Plant Processing Area (PPA) and Space Life Sciences Lab at NASA KSC.

In support of VEGGIE and APH Lead Horticulturalist Lashelle Spencer and Technical and Horticultural Scientist Jacob Torres are doing their part to grow crops in space and develop techniques that will be used in future Artemis missions. In service of this goal, Jacob Torres is developing technology to support Lashelle’s experimentation on plant growth capable systems for microgravity. This work is critical because the biological systems supporting plant growth here on Earth, work differently in microgravity. The absence of gravity removes the plants internal growth compass. Researchers like Lashelle Spencer and Jacob Torres are dedicated to finding ways to overcome this challenge.

Jacob Torres became interested in horticulture and science at a very young age. “My mom is a school teacher, and was my first grade teacher. As part of her class, she would teach us how to get seeds started in a little zip lock bag with a wet paper towel. We would hang them in the window in our classroom and since then I have been fascinated with planting a seed and getting this amazing plant and crop out of it,” said Torres. “I am from a traditional farming community where my ancestors have grown crops to sustain their lives for centuries. Combined with my education as an engineer, growing crops is a fundamental aspect of who I am. It wasn’t until I began my research into Botanical Air Filtration at Purdue University as a graduate student, and later as a NASA NIFS intern at Kennedy Space Center, that I learned that these experiences could be applied professionally. I suppose that is how I evolved to become a plant scientist”. Said Torres.

Torres is working to create systems that will allow astronauts to grow nutrient dense food in space- as much of the packaged food that they will be bringing will lose some of its nutritional value during longer duration missions. Which means, as NASA plans to embark on deep space missions, to the moon, or
to Mars researchers like Jacob will have to identify ways to supplement the crews’ diets.

Making in-space plant growth a reality has been the tireless goal of dedicated researchers in the PPA. These innovations don’t just benefit astronauts. Vertical gardening (first developed at the Kennedy Space Center) has been used in a variety of urban settings—often with the help of light-emitting diodes or LEDs (also first used for plant growth at KSC).

The work and research in VEGGIE and the Advanced Plant Habitat (APH) on the ISS are a demonstration of crop growth in controlled environments. The ability to grow crops in an environment that does not freeze, or experience seasonal changes, allows farmers all over the world to increase crop production, provide more affordable food, and expand access to fresh crops. The specific crop research that NASA does helps farmers and universities worldwide to understand characteristics of their crops.

When designing systems for in-space use, there are three major considerations; size, power usage, and crew time. A plant growth unit must fit in the designated space on the International Space Station, and even before that it must fit aboard whichever launch vehicle it travels on. Second, it cannot use too much power once it arrives, otherwise it will draw power away from other necessary functions. Third, it cannot require too much crew time to maintain. Every minute of each crew member’s time is valuable and carefully rationed out between numerous mission critical operations.

With these requirements in mind, Spencer, Torres, and the PPA Team are working to develop irrigation methods for plants in microgravity. “Minus gravity, water and fluids behave very differently. An understanding of how this fluid behaves, and how to control it to deliver nutrients to plants roots in space, will be essential to the mission of supplementing astronaut’s diets in Low Earth Orbit (LEO), on the way to the Moon, Mars, and beyond.” Said Torres.

Taking key insights from the Porous Tube Nutrient Delivery System (PTNDS), developed by Dr. Thomas Dreschel, Torres designed a completely passive irrigation system for plants in microgravity. The Passive PTNDS has no moving parts and requires zero electricity. The system utilizes the capillary force of water and evapotranspiration to move water and nutrients to the plants. Torres said that the Passive PTNDS could be worked into the existing VEGGIE system, or incorporated into future NASA plant growth systems.

KSC is uniquely positioned to lead the field in microgravity plant growth research. KSC’s Utilization and Life Sciences Division has a number of ground research laboratories at the Space Station Processing Facility which are equipped with plant growth chambers of all sizes and the ability to simulate a high carbon dioxide ISS environment. These facilities are staffed by some of the most brilliant minds in applied chemistry, biology, microbiology, engineering and development, all of which are vital to developing systems that will allow plants to grow in microgravity.
Savvy Seed Starters

Christina Johnson, PhD wants to teach you how to handle, store and grow plants from seeds in your garden!

As a passionate botanist and avid home-gardener, Christina Johnson, PhD has a knack for bringing her work from home with her to the labs at KSC.

“My work at the Kennedy Space Center goes hand in hand with my home gardening efforts. I have learned a bunch of new horticultural skills at work that I have been able to apply at home. Before I started here I mainly grew plants outdoors and this research has shown me that I can bring plants inside, too.” Said Christina.

Christina is presently a fellow in the NASA Postdoctoral Program, working again with Dr. Raymond Wheeler and the food production team at Kennedy Space Center. Her project involves collaboration with the USDA to grow microgreens in simulated microgravity. “I have been interested in gardening since I was a child, my dad was an amateur horticulturalist, and I grew up with a veritable orchard in our suburban backyard. We grew a lot of our own produce. When I went away to college, I started studying languages. It wasn’t until I took a biology course with a botanist professor that I realized my skills working with plants could be anything other than a hobby. I switched to studying the plant sciences and haven’t looked back.” Said Christina.

“Being a scientist is all about answering questions about the world around you, through observation and experimentation. Anyone who notices things can be a scientist. A garden is a great place to start. Keep a journal with notes about your garden. Keep track of when things bloom and make note of where things grow best. If something isn’t thriving where you first put it, you can plant them someplace a little different the next time. You’ll start noticing trends, which will influence when and where you choose to plant things. You’ll find problems and you’ll start thinking creatively to solve them. You’ll find the challenge to be fun as you build a healthy, happy garden.”

“My work at KSC goes hand in hand with my home gardening efforts. I have learned a lot of new horticultural skills at work that I have been able to apply at home. Before I started here I mainly grew plants outdoors and this research has shown me that I can bring plants inside, too.” Said Christina.

Christina’s creativity led her to develop a unique origami-style folding method for collecting and storing seeds. You can collect seeds from vegetables that you grow at home, or from store bought produce. Christina stores her seeds in the Seed Pocket that she designed, seeds last longer if they are stored in a cool, dry place. In the lab, researchers store their seeds in a seed storage refrigerator, but you can just as easily store seeds in your refrigerator at home.

These seed pocket packets can be made out of anything. Christina has made them out of paper towels, bandanas, and lined notebook paper. This method can also be used to wrapped presents, it can be useful to know how to fold paper/fabric when you don’t have any tape or glue around.
1. Submit a request to release your project as Open Source to your center SRA (Software Release Authority) at https://softwarerelease.ndc.nasa.gov/.

2. After going through the SRA process, receive approval from your center SRA to release as Open Source.

3. Register on github.com/join using your NASA email address.

4. Submit a NAMS request by filling out the HQ AGCY NASA GitHub Collaborator Form. This will request you be added as a member or collaborator to https://github.com/nasa.

5. Reach out to us after submitting NAMS request. We can help you join NASA Org or answer any questions.

6. Transfer or import your source code into the NASA Org on GitHub.

7. Update the NASA Open Source Catalog via a pull request (repo here), or by our online form (behind NASA firewall) to register your project’s meta-data. Be sure to provide good tags for your code project & follow this government-wide guidance on specific tags to use if your code involves machine-learning or artificial intelligence.

Software release at NASA is governed by NPR 2210.1C. NPR 2210.1C establishes the roles, responsibilities, and procedures for reporting, reviewing, and releasing software under various conditions, including open source. Every center has a Software Release Authority (SRA). The SRA processes requests for software release and coordinates legal, export control, IT security, 508 compliance, and software engineering standards compliance reviews. Projects hoping to release software should contact their SRA early to discuss their goals and begin the reporting, review, and release process.

Contact the KSC SRA: ksc-dl-software-request@mail.nasa.gov

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Legal
It is important to ensure that NASA has appropriate rights in software, including subcomponents, before NASA releases that material outside the agency. Software is rarely developed in isolation. If your project uses external dependencies, you must provide details about such packages or sources when you report your software. (See NPR 2210.1C, Chapter 2 for details on reporting software.)

Export Control
The Export Administration Regulations (EAR) and the International Traffic in Arms Regulations (ITAR), among other laws and policies, restrict which NASA technology may be publicly disclosed. Software falling within the scope of these laws or policies cannot be released open source, and may be subject to release restrictions. Your local export control staff can help you determine whether export control laws apply to your technology.

508 Compliance
When developing, procuring, maintaining, or using Electronic and Information Technology (EIT), Federal agencies must ensure that Federal employees with disabilities have access to and use of information and data that is comparable to that for other employees.

For more detailed information visit: https://code.nasa.gov/#/guide

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To release code, it must go through a process run by the Software Release Authority or SRA. One initiates the software review process by reporting the software as described in NPR 2210.1C (e.g., submitting a description of the software to be released, the individuals involved in its creation, development timeline, available documentation, and related topics). Depending on center procedures, this information may be captured through the NASA Technology Reporting System or standard form NF1679. Contact your SRA for the specific procedure used at your center. Each piece of software is unique, and must be reviewed on a case-by-case basis. Generally speaking, however, the review process will address the following considerations:

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YOUR IDEAS MATTER

The ideas and innovations that you develop can have a profound effect on the global community. You can report new your inventions by submitting a New Technology Report to the Technology Transfer Office (https://invention.nasa.gov). These new technologies may be transferred to entrepreneurs, industry or academia, where they will produce commercial products and services that will have a substantive economic benefit as well as a technological advancement.

Many ideas have already been generated by Kennedy Space Center employees and transferred to industry by the Technology Transfer Office and are stimulating the global economy. These includes several technologies currently being developed and marketed by Florida based companies and universities.

If you have an idea or innovation and want to submit a New Technology Report, we are here to help. For further information contact one of our New Technology Representatives or stop by the Technology Transfer Office in Room 3054 of the Space Station Processing Facility (SSPF).

New Technology Representatives:
Megan Victor (megan.e.victor@nasa.gov)
Meredith Reeves (meredith.reeves@nasa.gov)

Spinoff 2020 is out!
Spinoffs is a collection of success stories of Technology Transfer, SBIR and industry partners. Spinoffs tells the story of Technology Transfer at NASA and highlights the important work that our innovators do here and how it has been used beyond NASA to benefit the country.

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