Lunar Surface Innovation CONSORTIUM

JOHNS HOPKINS APPLIED PHYSICS LABORATORY

Volume 3 | Issue 12

December 2022

LSIC Newsletter

The Lunar Surface Innovation Consortium is administered by the Johns Hopkins Applied Physics Laboratory, and operates in collaboration with the NASA Space Technology Mission Directorate under the Lunar Surface Innovation Initiative. Its purpose is to harness the creativity, energy, and resources of the nation to help NASA keep the United States at the forefront of lunar exploration. To find out more, sign up to participate, or access past additions of this newsletter, please visit lsic.jhuapl.edu.

DIRECTOR'S UPDATE

Director's Update

As another year winds down, I would like to take a few minutes to thank you all for everything you have done to help LSIC grow into a vibrant community. It was a joy to see many of you last month, and to meet some of you for the first time. I invite those of you who attended to fill out a short post-meeting survey (https://app.sli.do/event/iJoJienEEZ2bpbzqNVR9W2). When we kicked off the consortium in early 2020, it was exciting, but everything seemed very abstract. In almost three years, we have seen NASA's high-level goals become more clearly framed, through the Moon to Mars Objectives, and have seen innovative advancements from you, in the community, that make it clear that you are ready to contribute creative solutions for power grids, resource extraction, and more.

For those who were not at the Fall Meeting, I wanted to let everyone know that Power's own Dr. Wes Fuhrman has now stepped up into the role of APL LSII Lead, as Dr. Ben Bussey has left us to support the return to the Moon by serving as the Chief Scientist at Intuitive Machines. We are grateful for Ben's leadership, but also happy for both him and IM. Wes and I are already very eager to take what he has learned, through direct interactions with the community, and work together to make sure we keep evolving our LSIC content and strategy to provide value to the community. I am also both happy (and a little sad) to let the community know that our dear Andrea Harman has moved into a new role, in a position more aligned with her fantastic communication skills. Fortunately for all of us (especially us at APL), this role is at APL, so she will continue to support us at our Spring and Fall Meetings. However, you will probably start getting more of the periodic updates from me, or others, instead. I know we won't be able to match her kindness and warmth, but we'll do our best! Please join me in thanking Andrea for everything she did to help LSIC become what it is. We love you, Andrea!

Next year will bring many new challenges, but we will continue to work with all of you to help NASA identify how to keep momentum and ensure that key gaps are being addressed. As always, if you have suggestions about what we can do to help you succeed, please reach out to us. I hope everyone has a chance to get a bit of a break this holiday season, and that you all have a happy new year!!

Rachel Klima
Director, Lunar Surface Innovation Consortium
SES-LSIC-Director@jhuapl.edu

Focus Areas

Monthly Telecon Schedule

Dust Mitigation (DM)
Third Thursdays at 12PM Eastern

Excavation & Construction (E&C)
Fourth Wednesdays at 2PM Eastern

Extreme Access (EA)
Second Thursdays at 3PM Eastern

Extreme Environments (EE)
Second Tuesdays at 3PM Eastern

In Situ Resource Utilization (ISRU)
Third Wednesdays at 3PM Eastern

Surface Power (SP)
Fourth Thursdays at 11AM Eastern

LSIC General Updates

As a reminder, If you don't have access to LSIC's Confluence wiki, please email SES-LSIC-Web@jhuapl.edu to get signed up.

Focus Group Updates

Dust Mitigation

The Dust Mitigation (DM) Focus Group held its monthly focus group meeting on November 17th. The focus group meeting centered on the topic of "Lunar Dust and Human Health" and featured a technology presentation by Torin McCoy, Moon2Mars Deputy Chief Health and Performance Officer at NASA Johnson Space Center on "Crew Health and Lunar Dust: What To Know Before You Go." This was followed by a great discussion on the risks and challenges of lunar dust on human health. In addition, we also discussed monthly LSIC updates, future opportunities, and recap from the LSIC Fall Meeting.

You can view the recording, slides, and notes from November's DM FG meeting and previous meetings at our LSIC Dust Mitigation Focus Group page on the LSIC website: https://lsic.jhuapl.edu/Our-Work/Focus-Areas/index.php?fg=Dust-Mitigation.

Our final focus group meeting of 2022 will be held on Thursday, December 15th at 12:00 pm Eastern Time. The meeting will include featured technology presentations along with a discussion session. We look forward to seeing you then!

Excavation & Construction

The Excavation and Construction (E&C) Focus Group is consolidating our November and December 2022 meetings into one final meeting as we round out the end of the calendar year. On **Wednesday, December 14th at 2:00 pm Eastern Time**, E&C will host a meeting on the topic of **Establishing a Community-Derived Early Infrastructure Framework**, followed by breakouts into the four subgroups: Autonomy & Site Planning, Site Prep, Horizontal & Vertical Construction, Additive Manufacturing & Raw Materials, and Outfitting & Maintenance. Their pages on Confluence are linked here for your convenience.

Further, E&C welcomes a transition in our leadership. Sarah Hasnain and Jibu Abraham of APL are stepping up as the new LSIC E&C Leads. We thank Dr. Athonu Chatterjee for his leadership in this role up to this point, and are excited to engage with the community in this capacity.

Extreme Access

November was a busy month in Extreme Access. With AIAA ASCEND at the end of October immediately followed by the LSIC fall meeting at the beginning of November, we did not hold our monthly telecon. However, we have begun booking speakers for the joint telecon on open source and open standards to be held January 24. The Communications subgroup had a presentation from Dan Adams of KSAT on their lunar ground station service offerings, and the PNT subgroup held the second meeting of its paper reading group on November 28. The mobility subgroup moved their November meeting to December, due to a conflict with the Thanksgiving holiday.

Extreme Environments

Extreme Environments (EE) is about to dive into NASA SBIR/ STTR solicitations! What are they? What are they looking for? We hope to count on community discussions as we present an overview of these funding calls and their five-year (2018-2022) evolution. Plan on some interesting breakout rooms for our December and January meetings so we can jump in! We canceled our November meeting due to the LSIC Fall Meeting, but our subgroups kicked off two new teams. Dr. Milena Graziano introduced our External Hazards subgroup with a talk by Dr. Clive Neal on lunar seismicity. Dr. Michael Zimmerman will restart Space Weather and Plasma subgroup on November 28 with a brief introduction and discussion on subgroup goals. As always, if community members have ideas for what they would like to see or discuss, please reach out to any members of EE leadership.

ISRU

The ISRU Focus Group hosted its November monthly meeting just a couple weeks after the LSIC Fall Meeting, as excitement for Lunar Proving Grounds was at an all-time high! Phil Sadler (University of Arizona) gave a talk on how McMurdo Station (Antarctica) can be used as a lunar South Pole ISRU analog proving ground, and Trevor Graff (Jacobs/NASA JSC) presented on several terrestrial field locations for ISRU in support of Artemis. This sparked an exciting discussion during the “Coffee & Donuts” portion of our meeting on our next steps for lunar proving grounds, including thoughts and lessons learned from the LSIC Fall Meeting. The December monthly meeting will be canceled as we all take some time off and spend quality time with loved ones over the holidays, but we’ll be back in full swing in January 2023 with a telecon focused on detecting and finding water at the lunar South Pole!

Surface Power

In November, the Surface Power team participated in the LSIC Fall Meeting in El Paso and NASA GRC’s Prometheus/Constellation Nuclear System’s workshop. At the LSIC Fall meeting, members of the surface power team attended both in-person and virtually, served as moderators for break-out sessions, and assisted with planning and in-person logistics. The Nuclear Systems workshop was a great opportunity to meet with some of our nuclear colleagues in the Surface Power FG. The workshop reviewed NASA’s past space nuclear power technology development initiatives. The Surface Power FG is holding a combined November/December telecon, which will be held at 11:00 AM EST on December 1st. At the meeting, the APL Surface Power facilitators will provide a broad summary of the past year of activities and events within the FG, and provide a forum and survey to solicit feedback and input from the community to guide 2023 activities.

Working Group – Modular Open Systems Approach (MOSA)

The MOSA working group will host a telecon on Wednesday, December 14 at 10 AM Eastern. **Wesley Powell**, NASA's Principal Technologist for Avionics of the Space Technology Mission Directorate, will be giving a presentation on a study NASA has recently completed that provides **recommendations to enhance interoperability within the SpaceVPX-based avionics systems** (https://ntrs.nasa.gov/citations/20220013983). This applies to several of the technologies listed in the STMD Advanced Avionics Envisioned Future Priorities (https://techport.nasa.gov/file/144877) and is applicable to lunar exploration. We hope to see you on the telecon.

In November, the White House released a US National Cislunar Science and Technology Strategy (https://www.whitehouse.gov/wp-content/uploads/2022/11/11-2022-NSTC-National-Cislunar-ST-Strategy.pdf). Interoperability is included in, '*Objective 4: Implement Cislunar communications and positioning, navigation, and timing capabilities with scalable and interoperable approaches.*'

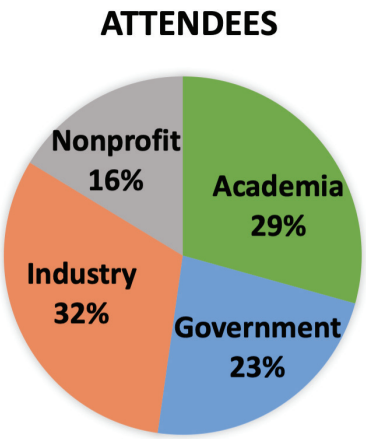
Working Group – Simulants

The month of November 2022 began with Dr. Karen Stockstill-Cahill attending and presenting at the Fall Meeting, which brought many positive interactions and increased awareness regarding the LSIC Lunar Simulants Survey. This survey is designed to fully understand the simulant needs of NASA and our broader community to direct our future activities. In addition, we completed the final geotechnical tests on the eight lunar regolith simulants for the 2022 Assessment and began analyzing all the data with Dr. Lucas de Melo (JHU). The team has begun preparing the assessment manuscript as well. Dr. Stockstill-Cahill also met with the NASA LSII Simulants Team to coordinate our support for their activities and projects. In particular, she presented a summary of the responses to the Lunar Simulants Survey through August 2021. If you are interested in learning more about simulants, please visit the confluence page for the Lunar Simulants Working Group on the LSIC wiki.

Feature Article

LSIC 2022 Fall Meeting Overview

The Lunar Surface Innovation Consortium (LSIC) 2022 Fall Meeting was held on November 2-3, 2022 at The University of Texas at El Paso (UTEP). The objective of this meeting was to provide a forum for NASA and the space technology community to discuss technology development for establishing a sustained presence on the lunar surface, focusing in particular on investments, needs, and concerns associated with excavation and construction. Attendance included 443 people representing over 170 institutions that met over the course of two days. Just under half (49%) of those who attended the meeting had not previously worked with NASA's Space Technology Mission Directorate (Space Tech). The meeting was run in a hybrid format, with questions being taken only via a digital tool in an effort to provide a more equitable experience for online attendees.



The University of Texas at El Paso is a minority serving institution with >80% Hispanic enrollment and a majority of students are the first in their families to attend college. The Aerospace Center at UTEP, who hosted the meeting, explores new technologies and challenges in space, aeronautics, defense, and energy using digital tools and skills that are transforming the way we design, build and test. The Aerospace Center's mission is to educate and prepare a diverse, future-ready workforce for high-paying, in-demand careers through project-based learning in applied, cutting-edge research in aerospace, defense, and energy. Beginning with grants from NASA's Minority Undergraduate Research and Education Project (MUREP) and continuing with sustained engagement of the aerospace industry, the Aerospace Center has grown from a 3,000 square foot lab employing 30 students as research assistants to an over 35,000 square foot laboratory with an additional 8,000 acres of test facilities employing >200 students today and still growing. Students from the University presented research, co-chaired sessions, and guided UTEP facility tours for meeting attendees. Jim Reuter and Niki Werkheiser, of NASA's Space Tech, met in a special breakout session with all interested student attendees (including those from UTEP as well as those who traveled to attend the meeting) to discuss NASA and Space Tech.

Congresswoman Veronica Escobar welcomed the group to El Paso and introduced a keynote address presented by Jim Reuter, NASA Associate Administrator for Space Tech, who provided an update on the Space Tech and their Envisioned Futures. Another key note address was presented by former astronaut and current professor at UC Davis, Dr. Steve Robinson, detailing the Space Technology Research Institute (STRI) Habitats Optimized for Missions of Exploration (HOME). Technical sessions throughout the rest of the meeting sought to explore (1) how we can adapt and/or learn from terrestrial excavation and construction experiences to plan for and design technology for the Moon; (2) what testing facilities or large proving grounds exist for maturing lunar systems; (3) what early infrastructure is in development for the Moon; and (4) what is needed and planned with respect to locating and using lunar resources. Other high-level presentations included a deeper dive into NASA's Excavation, Construction, and Outfitting Envisioned Future, as well as a presentation about Emerging Technology and Space Law.

Videos of the event can be accessed at: https://lsic.jhuapl.edu/Events/Agenda/index.php?id=350

In addition to the plenary sessions, virtual and in-person poster sessions provided an opportunity for attendees to present their own research. Virtual and in-person breakout sessions also provided a forum for the community to discuss some of the biggest challenges for establishing a sustained presence on the lunar surface. Peripheral tours included ICON's 3D printed barracks at the Fort Bliss military installation and potential lunar proving grounds for instrumentation and technologies at White Sands, who claimed at the meeting to be prepared to go as far as reshaping parts of the installation landscapes to be more lunar analogous specifically to support Artemis technology testing.

Member Spotlight

Aerospace Center, the University of Texas at El Paso

Ahsan Choudhuri (Associate Vice President and Founder of the Aerospace Center), Joel Quintana (Director of the Aeronautics and Defense Division), Md Mahamudur Rahman (Director of the Space Division), and Susie Byrd (Director of the Economic Development and Workforce Excellence Division)

In 2003, a dream started to take shape at the University of Texas at El Paso (UTEP). Ahsan Choudhuri, then a professor of Mechanical Engineering at UTEP, set up the Combustion and Propulsion Research Lab (CPRL) with his students in the College of Engineering building on campus. Their first proposal was for running a combustion experiment on NASA's KC-135 Microgravity Aircraft. It was accepted but not funded, and the students of the CPRL rose to the challenge and raised the money themselves to power the proposal. They went on to pass the required flight safety review and successfully executed the experiment themselves. That initial success continued, and in 2009 the CPRL became the Center for Space Exploration and Technology Research after receiving a grant of $5 million from NASA to convert the lab into a research center. Their portfolio kept on growing, and in 2019 they expanded again to become a University Affiliated Research Center (UARC), and began doing more work with the Department of Defense and the Department of Energy. The organization's name was simplified to the Aerospace Center, as it stands today. "What never changed is what we do – creating success and opportunities for our students," stated Choudhuri proudly. He is now the Associate Vice President and Founder of the Aerospace Center, and continues what he describes as the work of his entire career with UTEP's students.

One of the goals of the Aerospace Center is to build opportunities in the El Paso region so young people growing up in the area have direct access to the aerospace and defense industries without leaving home. And those opportunities have abounded – their initial grant was for $20,000, and their latest was for $81.5 million dollars. The Center's overarching objective is to create the next generation of talent while doing cutting edge research on defense and aerospace technology, all while creating new chances for student success. "What we mean by student success is really working on the talent pool," explained Choudhuri. "There were a lot of barriers to getting into aerospace. We removed them by building this research infrastructure that allows minority students from our community, many from economically disadvantaged backgrounds, to directly engage in this work."

A feature that sets the Aerospace Center apart is their Economic Development and Workforce Excellence initiative, which provides services and resources to help El Paso manufacturers grow and meet new customers in aerospace and defense markets. Their work seeks to actually create opportunities for long-term career growth and job opportunities for their students, building local industry that strengthen the El Paso community while also launching new graduates from UTEP onto a path towards success in their chosen fields. Susie Byrd serves as the Director for Economic Development at the Center. "We work with startups as well as small and medium manufacturers to help them become more competitive in their current markets, while also supporting their efforts to compete in the aerospace and defense markets," shared Byrd. Her time with the Aerospace Center is often spent with the local Chamber of Business, county and city government, as well as area manufacturers to understand both where they are and what they need to continue to grow.

The Center itself is divided into three divisions in addition to their economic development initiative:

- Space (supports NASA's Artemis program and Moon to Mars initiative by focusing on strategic capabilities in propulsion and robotic landers, lunar surface habitation and exploration, and small spacecraft technologies)
- Aeronautics and Defense (supports the research and development of hypersonic, missile, and unmanned aerial systems technologies)
- Energy (provides capabilities in sub-pilot scale to commercial scale fossil, nuclear, and renewable energy technology development)

The Center itself encompasses over 35,000 square feet of laboratory space and another 8,000 acres of test facilities. It also houses three Digital Engineering Aerospace and Defense Systems Design Centers (DECD), with one location at El Paso, another in Huntsville Alabama, and a third in Youngstown, Ohio. Two hundred students are currently employed throughout the Aerospace Center as research assistants, both at graduate and undergraduate levels. While the Aerospace Center itself is academic, it does have structured operational processes, both in terms of management and mentoring students. The faculty oversee the research program, and right underneath them are postdocs working independently as research associates. They're supported by research engineering and research technician teams, both of which are in turn buoyed by the research management team. There is also a large business operations team to keep the whole system running smoothly. "Students learn not only from the faculty, but also get a lot of practical training from research machinists, technicians, and engineers," explained Choudhuri. "We treat it like an industry within a university."

And providing opportunities to students doesn't just mean working at UTEP or within the local community. There's a concerted effort to place students at internships both with other universities and industry itself. The last two fiscal years saw 220 students placed in internships outside of UTEP, with government agencies (primarily NASA), private companies, and other universities. "We used to only send our students out," explained Choudhuri, "but now we hire interns as well from throughout the country to come and work in our facility." Beyond this even is the Center's work to build partnerships, not only with companies throughout the industry but also with Historically Black Colleges and Universities (HBCUs) and other minority-supporting institutions. Almost every week sees a new guest visiting the Center, with students providing tours and up-close demonstrations of their work.

The work being done at the Aerospace Center is mostly applied engineering, with some technology development and fundamental research as well. Their customers include not only federal agencies, but also companies. Joel Quintana is an assistant professor in aerospace and mechanical engineering, and leads the Aerospace Center's Aeronautics and Defense division. "On a daily basis I manage a 60-student team to develop satellite technology for in-space servicing, assembly, and manufacturing," Quintana shared. The teams essentially run themselves, he went on to explain, "I meet with our engineering staff to keep them on track. Our main purpose is guiding the development of these technologies and how they need to be applied – and more importantly, identifying the skill sets students need to be able to carry out such difficult tasks."

Another exciting area of development for the Center are their ISRU efforts, which only started in 2019. “We started ISRU with thermal mining of water from the Moon,” explained Md Rahman, another assistant professor at UTEP who services as the Space Division Director at the Aerospace Center. “LSIC has given us huge exposure to a lot of different areas – on one platform you could see many industries and schools that are involved, where there are gaps and where we are learning more.” Finding that sort of information and support, not only about ISRU but on topics like how to survive on the Moon in the dark polar region, continues to be important for Rahman’s team and the wider Aerospace Center community.

NASA and Community News

Artemis I Flight Day 14: Deep Space Testing Continues

NASA News \\ 29 November 2022

https://blogs.nasa.gov/artemis/2022/11/29/artemis-i-flight-day-14-deep-space-testing-continues/

NASA's Going Back To The Moon And Must Confront A Familiar Enemy: Dust

Los Angeles Times \\ 21 November 2022 \\ Samantha Masunaga

https://www.latimes.com/business/story/2022-11-21/nasa-moon-artemis-dust

CAPSTONE Forges New Path For NASA's Future Artemis Moon Missions

NASA News \\ 21 November 2022

https://www.nasa.gov/press-release/capstone-forges-new-path-for-nasa-s-future-artemis-moon-missions

Astronauts To Live And Work On The Moon By 2030, NASA Official Says

The Guardian \\ 20 November 2022 \\ Ian Sample

https://amp-theguardian-com.cdn.ampproject.org/c/s/amp.theguardian.com/science/2022/nov/20/astronauts-moon-nasa-artemis-mission-space

PickNik Robotics And CisLunar Industries To Develop Metal Processing Facility In Space

Robotics & Automation \\ 18 November 2022 \\ Mark Allinson

https://roboticsandautomationnews.com/2022/11/18/picknik-robotics-and-cislunar-industries-to-develop-metal-processing-facility-in-space/58149/

First Canadian Lunar Rover To Set Wheels On The Moon In Development

Journal of Space Commerce \\ 18 November 2022 \\ Tom Patton

https://exterrajsc.com/first-canadian-lunar-rover-to-set-wheels-on-the-moon-in-development/2022/11/18/

NASA Awards Foster Small Business Tech With Market Potential

NASA News \\ 17 November 2022

https://www.nasa.gov/directorates/spacetech/sbir_sttr/NASA_Awards_Foster_Small_Business_Tech_with_Market_Potential

Artemis I Mission Shares Spectacular View Of Earth After A Historic Launch

CNN \\ 17 November 2022 \\ Jackie Wattles

https://www.cnn.com/2022/11/16/world/artemis-1-launch-nasa-scn/index.html

Liftoff! NASA's Artemis I Mega Rocket Launches Orion To Moon

NASA News \\ 16 November 2022

https://www.nasa.gov/press-release/liftoff-nasa-s-artemis-i-mega-rocket-launches-orion-to-moon

NASA Awards SpaceX Second Contract Option for Artemis Moon Landing

NASA News \\ 15 November 2022

https://www.nasa.gov/press-release/nasa-awards-spacex-second-contract-option-for-artemis-moon-landing-0

Moon Enthusiasts In California Remotely Operate 700-pound Planetary Rover In Kailua-Kona

Big Island Now \\ 12 November 2022

https://bigislandnow.com/2022/11/12/moon-enthusiasts-in-california-remotely-operate-700-pound-planetary-rover-in-kailua-kona/

MIT Will Return To The Moon For The First Time Since Apollo, Thanks To This Space Startup

Forbes \\ 09 November 2022 \\ Arianna Johnson

https://www.forbes.com/sites/ariannajohnson/2022/11/09/mit-will-return-to-the-moon-for-the-first-time-since-apollo-thanks-to-this-space-startup/?sh=27d983e76d72

ispace Receives License To Conduct Business Activity On The Moon

SpaceWatch Asia Pacific \\ 08 November 2022

https://spacewatch.global/2022/11/ispace-receives-license-to-conduct-business-activity-on-the-moon/

FCC To Open 'Space Bureau' To Keep Up With Satellite Boom In New, Commercial 'Space Age'

Breaking Defense \\ 03 November 2022 \\ Lee Ferran

https://breakingdefense.com/2022/11/fcc-to-open-space-bureau-to-keep-up-with-satellite-boom-in-new-commercial-space-age/

NASA's Lunar Flashlight Ready To Search For The Moon's Water Ice

The Journal of Space Commerce \\ 02 November 2022 \\ Tom Patton

https://exterrajsc.com/nasas-lunar-flashlight-ready-to-search-for-the-moons-water-ice/2022/11/02/

NASA Announces Second Collaborations For Commercial Space Capabilities Opportunities

NASA News \\ 02 November 2022

https://www.nasa.gov/leo-economy/nasa-announces-second-collaborations-for-commercial-space-capabilities

Firefly Prepares For Production Ramp; Names Permanent COO

Payload \\ 02 November 2022 \\ Jacqueline Feldscher

https://payloadspace.com/firefly-production-ramp/

NASA Makes Progress With New Lunar Terrain Vehicle Moon Rover Services

NASA News \\ 02 November 2022

https://www.nasa.gov/feature/nasa-makes-progress-with-new-lunar-terrain-vehicle-moon-rover-services

Funding Opportunities

Tech Development

- NASA Innovation Corps Pilot
  https://nspires.nasaprs.com/external/solicitations/summary.do?solId=%7b1B42E782-61BB-9834-F20F-44CBEF13C0A6%7d&path=&method=init

  Proposals may be submitted at any time through March 29, 2023, but applications will be reviewed in intervals on the following dates: July 22, 2022; Sept. 16, 2022; Nov. 17, 2022; and Jan 20, 2023

- NASA Innovative Advanced Concepts (NIAC) Phase II Call for Proposals
  https://nspires.nasaprs.com/external/solicitations/summary.do?solId={0DD3E590-F13D-B4D4-0D48-56D01BE377B9}&path=&method=init

  Proposals Due: 15 December 2022

Request for Information

- Sustainability of Microgravity R&D During and Beyond ISS Transition
  https://www.federalregister.gov/documents/2022/11/22/2022-25438/request-for-information-sustainability-of-microgravity-randd-during-and-beyond-iss-transition

  Responses Due: 31 December 2022

For more funding opportunities, please visit LSIC's website here: http://lsic.jhuapl.edu/Resources/Funding-Opportunities.php