FINAL REPORT

California Advanced Defense Ecosystems and National Consortia Effort (CADENCE)

Project 11: Space Commercialization and Manufacturing Support

01 December 2023

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Executive Summary

As Vice President Kamala Harris noted recently, "From the very beginning, the innovation, the creativity, and the drive of commercial space companies, combined with the resources and the vision of the United States government, has powered America's progress in space and our leadership of progress in space."[1] Currently, the commercial space economy employs 354,000 people and includes $200 billion a year in economic activity nationally, with expectations of significant growth in the next two decades.[2] Moreover, there is broad consensus within the defense community that "The U.S. can retain its leadership position in space by accelerating the adoption of commercially-sourced solutions for both civil and national security space applications."[3] To put it simply, the Defense Industrial Base and the Space Industrial Base are one and the same. Workforce development in the Space Industrial Base is essential to retain strategic and tactical advantages against the United States' competitors and secure the United States' future.

Under this CADENCE grant, the California Cybersecurity Initiative (CCI), the Digital Transformation Hub (DxHub), and the Cal Poly CubeSat Lab—all part of the California Polytechnic State University San Luis Obispo (Cal Poly)— pursued four intertwined campaigns to enhance economic competitiveness and national security. By leveraging public-private-academic partnerships supported by this grant, Cal Poly worked:

1) **To pursue innovative workforce development activities** in coordination with the private sector, government, and educational institutions to support California's defense manufacturers engaged in the commercialization of space;

2) **To provide direct advice and technical assistance to defense manufacturers** working in the Space sector;

3) **To promote interventions at all relevant points of the workforce development pipeline**: from educating students to attracting new workers to the commercial space sector, from upskilling existing workers to enhancing knowledge and threat preparation skills in the C-suite;

4) To support California workers to **utilize cloud computing technology while embracing the fundamental necessities of best practice in cybersecurity**; and

5) **To coordinate communications strategies** to provide California defense manufacturers with better situational awareness of what the CADENCE program could provide to them—through seminars, newsletters, marketing materials, and capabilities documents.

All of these efforts focused specifically on assistance, information, support, and aid to small and medium Department of Defense manufacturers (and potential defense manufacturers) to create a resilient and reliable supply chain across the Space sector.

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[1] Vice President Kamala Harris, "Remarks by Vice President Harris on Supporting the Commercial Space Sector," Chabbot Space and Science Center, Oakland, CA, August 12, 2022. (https://www.whitehouse.gov/briefing-room/speeches-remarks/2022/08/12/remarks-by-vice-president-harris-on-supporting-the-commercial-space-sector/)

[2] Ibid.

[3] J. Olson, S. Butow, E. Felt, & T. Cooley, "State of the Space Industrial Base 2022," dated August 2022 (https://assets.ctfassets.net/3nanhbfkr0pc/3wpHArrpttx99gFk5vfymS/873bf925beb44e0cf30a07170927acf5/State_of_the_Space_Industrial_Base_2022_Report.pdf)

Project 11 Overview

Space Commercialization and Manufacturing Support

Speaking at a space education center in Oakland, CA, Vice President Kamala Harris, who chairs the National Space Commission, noted, "From the very beginning, the innovation, the creativity, and the drive of commercial space companies, combined with the resources and the vision of the United States government, has powered America's progress in space and our leadership of progress in space." Space has always been a public-private partnership.

Currently the global Space economy is valued at over $415 billion. On California's Central Coast (including Santa Barbara and San Luis Obispo counties) the aerospace and Space commercialization industry has already grown and attracted 100 companies, supporting over 3,700 well-paid jobs.[4] Globally expectations are that the Space commercialization industry will grow to be a $1 to $3 trillion market in the next 20 years.[5] This exponential growth creates both an exceptional opportunity and an exceptional need for skilled workers.

As noted in the Biden Administration's December 2021 United States Space Priorities Framework, "Developing space technologies spurs innovation." As this national framework explains:

> New space goods and services create new industries and jobs, such as in clean energy technology and broadband access, providing increased opportunities for equitable economic growth and development in historically underserved or disadvantaged communities. Furthermore, space activities fuel cutting-edge research and technology development, yielding new discoveries that improve the quality of life for people on Earth.

But again, this opportunity cannot be separated from concerns about finding the right workers for these positions. As noted by the Biden White House, "Investing in STEM education is critical to continuing U.S. leadership into the next generation and preparing the nation's STEM workforce to fuel the economy of the future."[6]

This CADENCE grant is focused on supporting workforce development—in education, in reskilling, and in upskilling—to maintain American prowess and predominance in Space.

The Space Industrial Base is the Defense Industrial Base

Growing the skilled workforce to address needs in commercial Space operations will simultaneously improve America's Defense Industrial Base. As explained in the State of the Space Industrial Base 2022 report, jointly written by experts from the Defense Innovation Unit, the United States Space Force (USSF), and the U.S. Air Force Research Lab, "The U.S. can retain its leadership position in space by accelerating the adoption of commercially-sourced solutions for both civil and national security space applications while reducing the bureaucratic 'roadblocks' that tie innovation and slow the pace of technological advancement."[7] Or, as the House Armed Services Committee,

[4] REACH website (https://reachcentralcoast.org/aerospace/).

[5] Space Foundation, Executive Summary, accessed August 2022 (https://www.spacefoundation.org/wp-content/uploads/2020/08/CIE_Executive-Summary_LINKS_5-20-20.213.pdf). For an analysis in 2020 see Morgan Stanley Research, "Space: Investing in the Final Frontier" (https://www.morganstanley.com/ideas/investing-in-space) which puts investment in 2020 at $350 billion with expectations of a $1 trillion industry by 2040.

[6] United States Space Priorities Framework, December 2021 (https://www.whitehouse.gov/wp-content/uploads/2021/12/united-states-space-priorities-framework-_-december-1-2021.pdf).

[7] J. Olson, S Butow, E. Felt, & T. Cooley, "State of the Space Industrial Base 2022" (August 2022) : (https://assets.ctfassets.net/3nanhbfkr0pc/3wpHArrpttx99gFk5vfymS/873bf925beb44e0cf30a07170927acf5/

Subcommittee on Strategic Forces explained during a June 2022 budget mark-up session, "The military would benefit from greater use of commercial space technologies." As explained further by the Subcommittee Chairman Rep. Jim Cooper, "We must continue to buy the best off-the-shelf technology and partner with the best firms to invent new technology. We must also demand that the U.S. have capabilities that vastly exceed anything in the private sector."[8]

The overlap of the Space Industrial Base and the Defense Industrial Base creates a symbiotic and essential relationship. As explained by the USSF:

> A robust/competitive U.S. Space Industrial Base is essential to maintaining the U.S. as a preeminent space power, but its competitive advantage is threatened. . . . To meet these challenges, the USSF must lead and develop an all-of-government strategy to partner with the U.S. Space Industrial Base, taking advantage of present, commercial capabilities while stimulating future commercial capability development for U.S. space military needs.[9]

Improving the workforce pipeline for commercial Space development, therefore, moves in lockstep with improving the defense manufacturing workforce.

Currently, one of the most dynamic spaces for collaborations between commercial Space operations and the defense sector is in the burgeoning area of small satellites. As a RAND report notes, recent growth in the Space Industrial Base have been driven "by small satellite technologies and the proliferated constellation model, advanced manufacturing, use of AI/ML, and venture-capital investments."[10]

The Department of Defense has responded to these shifts and has invested in these new small satellite technologies. As a single example, in March 2022 SpaceNews reported that "The Pentagon's [Space Development Agency] is buying 126 small satellites for $1.8 billion to build a communications network in low Earth orbit known as the Transport Layer." It is notable that one of the recipients of this contract is York Space Systems, "a commercial satellite manufacturer that has never won a large defense contract." The DoD is also supporting a program to use small satellites for weather imaging.[11]

As the birthplace of the CubeSat standard, Cal Poly is uniquely positioned to respond to and lead the movement toward embracing small satellites. Specifically, Ryan Nugent and the CubeSat Lab's expertise is an essential contact point for providing technical assistance and to inform about best practices in workforce development. The CubeSat Lab's reputation and role in the small satellite community also make it an excellent partner for reaching out to new and growing companies in the small satellite ecosystem.

State_of_the_Space_Industrial_Base_2022_Report.pdf)

[8] Sandra Erwin, "House Armed Services Panel Calls on DoD to Buy Commercial Space Technology and Data," SpaceNews, June 8, 2022 (https://spacenews.com/house-armed-services-panel-calls-on-dod-to-buy-commercial-space-technology-and-data/).

[9] United States Space Force Space Futures Workshop Report (2021), as quoted in J. Olson, S. Butow, E. Felt, T. Cooley, and J. Mozer, State of the Space Industrial Base 2021, dated November 2021 (https://assets.ctfassets.net/3nanhbfkr0pc/43TeQTAmdYrym5DTDrhjd3/1218bd749befdde511ac2c900db3a43b/Space_Industrial_Base_Workshop_2021_Summary_Report_-_Final_15_Nov_2021.pdf).

[10] Emmi Yanekura, Brian Dolan, Moon Kim, Krista Romita Grocholski, Reza Khan, and Yool Kim. "Commercial Space Capabilities and Market Overview: The Relationship between Commercial Space Developments and the U.S. Department of Defense," Rand Research Report (2022) (https://www.rand.org/pubs/research_reports/RRA578-2.html).

11 Sandra Erwin, "On National Security: DoD's internet in space a win for commercial space," SpaceNews, March 22, 2022 (https://spacenews.com/on-national-security-dods-internet-in-space-a-win-for-commercial-space/)

Space is Critical Infrastructure

Finally, Space is also a terrestrial concern critical to economic and national security. As explained by the Biden White House, "Space systems are an essential component of U.S. critical infrastructure – by directly providing important services and by enabling other critical infrastructure sectors and industries."[12] This includes satellite communications, navigation systems like GPS, remote sensing, environmental monitoring, and data transmission.

Moreover, the Space commercialization sector is a target for foreign competitors, both economic and strategic. In part, because it is intertwined with the Defense Industrial Base, the Space Industrial Base is undoubtedly a target for "espionage efforts intended to undermine both U.S. Military capability" as well as a target for "intellectual property theft that hinders long-term growth and prosperity and jeopardizes U.S. leadership in key technologies."[13]

Combining these two factors—its status as critical infrastructure and its role in the defense manufacturing ecosystem—clarifies that the Space sector needs to maintain a robust cybersecurity defense. As addressed in the *United States Space Priorities Framework*:

> The United States will protect space-related critical infrastructure and strengthen the security of the U.S. space industrial base. . . . The United States will enhance the security and resilience of space systems that provide or support U.S. critical infrastructure from malicious activities and natural hazards. In particular, the United States will work with the commercial space industry and other non-governmental space developers and operators to improve the cybersecurity of space systems, ensure efficient spectrum access, and strengthen the resilience of supply chains across the nation's space industrial base.[14]

As a testament to the threats posed by potential cyberattacks, the Cybersecurity and Infrastructure Security Agency (CISA) has a Space Systems Critical Infrastructure Working Group, because "secure and resilient space-based assets are critical to our economy, prosperity, and our national security."[15]

Here, again, Cal Poly has the knowledge, skills, and reputation to lead. Supported by a CASCADE II grant, the DxHub and the California Cybersecurity Institute spent over two years understanding, responding to, and educating the public about the connections between Space and proper cybersecurity. More importantly, together these two groups have the experience to help more manufacturers transition to the efficiencies of cloud-based computing systems *while simultaneously protecting their IP and the national security from recognized cybersecurity threats.*

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[12] United States Space Priorities Framework.

[13] CyberSpace Solarium Commission Report, dated March 2020 (https://www.solarium.gov/report).

[14] United States Space Priorities Framework.

[15] Press Release, "CISA Launches a Space Systems Critical Infrastructure Working Group," May 13, 2021 (https://www.cisa.gov/news/2021/05/13/cisa-launches-space-systems-critical-infrastructure-working-group)

As a comprehensive, public polytechnic university with nationally ranked programs in computer science, software engineering, and aerospace, Cal Poly brings wide expertise, community trust/social capital, and a deep reserve of knowledge to the issues at hand. Efforts in this grant were pursued specifically by combining the resources of three internal organizations:

- Cal Poly's Digital Transformation Hub (DxHub) powered by AWS located at U.S Economic Developing Administration-funded on-campus Tech Park;

- Cal Poly's Cube Satellite (CubeSat) Program, a leader in small satellite development; and

- the California Cybersecurity Institute (CCI).

Given its location on California's Central Coast, the CCI also leveraged its existing relationship with Vandenberg Space Force Base (SFB) in each of the project foci. Buoyed by its reputation among potential students, California's educational and thought leaders, and the state's business community, Cal Poly has the unique qualifications needed to engage with public, private, and academic organizations to innovate in response to shifting challenges for workforce development in various ecosystems: space, defense, cybersecurity, cloud computing, as well as the areas where all of these ecosystems overlap.

Cal Poly is a lynchpin for the public-private partnerships that will grow the Space sector and provide the pipeline of needed workers. CCI, the DxHub, and the CubeSat Lab form the bridge that allow government and private industry to connect more easily with each other. In some tasks Cal Poly leverages its credibility with the public to host events and share information that teach the public about the nature of the economic opportunities and the national security threats that America faces. In some tasks listed below Cal Poly provides the deep bench of academic and research expertise to advise companies on how to solve real world problems. In workforce development, Cal Poly utilizes its strengths as a teaching university to foster the necessary learning—in government, in industry, and in the workforce of tomorrow—to assist the government sector and the private sector to build the workforce they need. Through these actions, Cal Poly is helping to maintain America's national and economic security as the country adjusts to an ever-shifting strategic environment in Space and on Earth.

Scope of Work

Under this CADENCE grant, the California Cybersecurity Initiative (CCI), the Digital Transformation Hub (DxHub), and the Cal Poly CubeSat Lab—all part of the California Polytechnic State University San Luis Obispo (Cal Poly)—pursued four intertwined campaigns to enhance economic competitiveness and national security. By leveraging public-private-academic partnerships supported by this grant, Cal Poly worked:

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All of these efforts focused specifically on assistance, information, support, and aid to small and medium Department of Defense manufacturers (and potential defense manufacturers) to create a resilient and reliable supply chain across the Space sector.

As laid out in the original grant agreement Cal Poly was assigned four key tasks connected to the scope of work:

1) Task 11.3: Engage and Define CADENCE Consortium Partner Capabilities, Resources, and Objectives

2) Task 11.4: Engage with Firms in the Defense Innovation and Manufacturing Base

3) Task 11.5: Deliver a 10-hour Pilot Digital Literacy and Security Curriculum to Support Space Commercialization and Manufacturing

4) Task 11.6: Design and Implement Communications Strategies Activities

Task 11.3 and 11.6 required the Cal Poly team to primarily engage with the public sector. To fulfill Task 11.3 Cal Poly created a series of marketing and communications packets to inform the public—including companies in the defense manufacturing sector and workers either looking to join the field or already employed in the field—about the services the CADENCE consortium members could offer. This included a one-page marketing flyer, a CADENCE guidebook, as well as graphics and backgrounds to use for social media and virtual meetings. Cal Poly also hosted a CADENCE partner workshop which came together during a DoD/OLDCC visit to the Central Coast of California on April 28, 2022.

Task 11.6 focused almost entirely on public outreach regarding workforce development in those spaced where thee Space Industrial Base, the Defense Industrial Base, cloud computing, and cybersecurity overlap. For this task, CCI created four podcasts and substantially supported the development of three others. CCI also published 21 issues of its *Space & Cybersecurity Newsletter* reaching inboxes over 11,000 times. Cal Poly also hosted two CADENCE consortium support events—one for the Employment Training Panel (ETP) and one for the DxHub—at the 16th Annual CubeSat Developers Conference. Finally, CCI spearheaded the effort to host a CADENCE Showcase at the CubeSat Developers Conference that provided a forum for CADENCE Consortium partners CMTC, East County Economic Development Council, El Camino College, ETP, California Community Colleges, NextFlex, CCI, DxHub, and the Cybersecurity Center of Excellence to explain the services they could provide to nearly two dozen companies involved in Space commercialization.

To complete Task 11. 5, CCI put in place a dynamic team and created a free, interactive educational course titled, "Cybersecurity Incident Reporting for Executives." The course is designed to address the specific needs and concerns of the discrete business vertical of CEOs and executives at small- and medium-sized companies in the Department of Defense supply chain.

Task 11.4 involved a number of different initiatives and efforts in the overlapping fields of Space commercialization, defense manufacturing, and workforce development. To complete this task, the Cal Poly team pursued an

innovative AWS-ETP-UpSkill California collaboration to train defense workers through California's community colleges, and it hosted Amazon Discovery Days to introduce workers to training opportunities in cloud computing. Led by the CubeSat Lab and the DxHub, Cal Poly also provided direct technical advice to Space commercialization firms in California and beyond. Both entities also engaged directly with private companies and business groups to develop resources for workforce development in the Space and Defense sectors. CCI team members also met and collaborated with DoD representatives and California State government officials. The team provided exciting educational opportunities for K-12 students interested in Space, and advised a program by the Paso Robles City government to transform its regional airport into a Space Port.

The complexity and effectiveness of each of these individual efforts to fulfill the overall mission to "Engage with Firms in the Defense Innovation and Manufacturing Base" is further evidence of Cal Poly's important role as the connective tissue in public-private initiatives enhancing workforce development, defense manufacturing, Space commercialization, cloud computing, and cybersecurity.

Each of the key tasks included in this grant are addressed below. Each section discusses the purpose, successes, and limitations of each of these tasks, and each section includes a separate list of key lessons to take away from CCI, the CubeSat Lab, and the DxHub's experiences completing the work in this grant.

Scope and Structure of Completed Tasks

Task 11.3 Engage and Define CADENCE Consortium Partner Capabilities, Resources, and Objectives

Summary

Working in close collaboration with CADENCE partners, CCI spearheaded the effort to create a consistently branded marketing and communications (MarCom) guidebook to highlight CADENCE capabilities to the California defense ecosystem, while also planning and hosting a CADENCE partner workshop to present the program's strengths and accomplishments for a DoD/OLDCC visit to Cal Poly.

Work Completed

The work in this task focused primarily on defining CADENCE consortium partners' capabilities and presenting this information to the public in a consistently branded product. The first phase of the task focused on creating a consistently branded marketing and communications guidebook. The second phase of the task focused on a CADENCE partner workshop which came together during a DoD/OLDCC visit to the Central Coast of California on April 28, 2022.

Recognizing the need to create a cohesive campaign focused on the details of the CADENCE program initiatives, it was essential for the CADENCE teams to work together to develop consistently branded program outreach content to maximize the program's impact. Care was also needed to ensure that these publicly distributed materials were consistent with CADENCE grant requirements and information guidelines. Actions on the first phase began in earnest in June 2021, when CCI's Makenna Davis began meeting at least bi-monthly and often as much as weekly with Lindsey Silvia, from the San Diego East County Economic Development Council. CCI recognized that its team has an abundance of skill in content creation, but CCI lacked overall program awareness which Silvia was able to provide. Eileen Sanchez from OPR was also regularly brought in for briefings as the team created a draft marketing and communications kit (MarCom kit) for the entire CADENCE partner network. Care was taken to ensure that all materials were consistent with DoD information guidelines.

A draft MarCom Kit was presented to CADENCE partners at the end of September 2021. Recommendations for improvements and tweaks where collected from each partner. Suggestions and revisions were integrated into the MarCom and the final package was provided to CADENCE partnership members for individual program use in December 2021.

In its final form, the MarCom kit included marketing assets and messaging that allow CADENCE members to focus their marketing and outreach efforts on a variety of strategies and tactics, in order to reach different audiences statewide. Thus, the MarCom simultaneously furthers the program's collaborative goals and supports projects related to workforce development, research, and innovation across California.

The key pieces of the MarCom kit included:

- a succinct, one-page **Marketing Flyer** explaining the overall scope of the CADENCE program and providing short details about each constituent project;

- a **Partner Guidebook** providing background information on the entire CADENCE program as well as more specific information about each of the program's 14 individual initiatives;

- 11 **social media graphics and captions** to be used on different social media platforms to share details about the projects, including branded images which visually draw in an audience while specific language helps inform social media audiences about the projects; and

- 10 **Zoom backgrounds** for CADENCE consortium members to use in their virtual meetings, to inform their contacts and audiences about CADENCE and to make CADENCE projects a topic of focus in their virtual engagements.

After the MarCom kit was completed and distributed the CCI turned its focus toward the second piece of this task: to deliver a CADENCE partner workshop. From the outset, CCI was committed to hosting an event in person to both combat "Zoom fatigue" and provide meaningful team-building opportunities for CADENCE consortium members. CCI first attempted to hold a workshop at Vandenberg SFB, but this

CADENCE Marketing Flyer
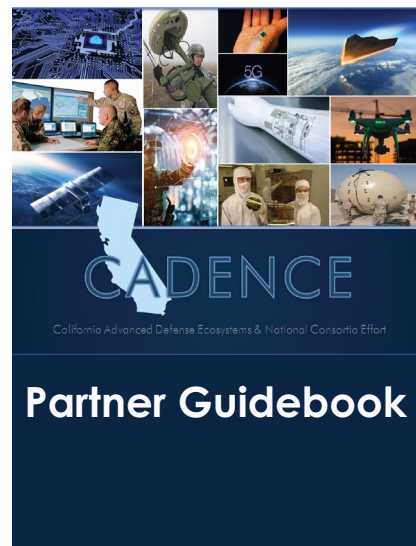
CADENCE Partner Guidebook

One of the CADENCE Zoom backgrounds

A few of the CADENCE social media graphics

proved far too difficult due the recent leadership changes at Vandenberg SFB combined with the ongoing administrative reorganization, connected to Vandenberg's broader transition from an Air Force base to a Space Force base and the reorganization of the Space Force. Ultimately, CCI hosted an event for a visiting delegation from DoD/OLDCC at the end of April 2022.

Seth Y. Isenberg and Louis C. Littleton arrived in San Luis Obispo on April 27 for a full-day event the next day. On April 28 events began at the Cal Poly Technology Park, with a presentation by CCI and the DxHub about its ongoing projects to support innovation, digital transformation, and workforce development in the space sector through collaboration with Vandenberg SFB. Steve Rogers, Range Technical Director at Vandenberg SFB joined the opening session virtually providing insights into CCI, the DxHub, and CADENCE's impact on the Central Coast of California.

This opening session was then followed by presentations by and discussions with CMTC, El Camino Community College, Cyber Center of Excellence, California ETP, San Diego East County Economic Development Council, NextFlex DoD Manufacturing Innovation Institute, and the California Community Colleges Centers for Applied Competitive Technologies (CACT) and Business & Entrepreneurship (BES). Overall, the day's events provided an opportunity for CADENCE consortium partners to highlight their objectives, resources, and capabilities providing specific examples of the impact the CADENCE program is having on defense manufacturing and the defense industrial base, located in California but in service of national priorities.

To maximize efficiency and minimize extraneous costs, the DoD/OLDCC visit was timed to correspond with other CADENCE outreach activities connected to Cal Poly's CubeSat Developers Conference, also held at the end of April. (See task 11.6 for details.)

DoD/OLDCC visit itinerary

Lessons Learned

Due to the wide use of social media by the business development community, for recruiting workers to the defense manufacturing sector, and across workforce development campaigns, it was essential for the CADENCE teams to work together to develop consistently branded program outreach content to create maximize impact.

Developing marketing and communications materials for the entire consortium (rather than each individual project team member creating materials) increased synergy, insured compliance with DoD and CADENCE information guidelines, and enhanced cost savings.

Combining regular virtual meetings with occasional in-person events can strengthen team building and engagement, evidence of the positive impacts of a hybrid structure for collaboration.

Task 11.4: Engage with Firms in the Defense Innovation and Manufacturing Base

Summary

In this task, CCI, the DxHub, and the CubeSat Lab demonstrated its versatility as an innovator for public-private-academic partnerships in the overlapping fields of Space commercialization, defense manufacturing, and workforce development by pursuing an innovative AWS-ETP-UpSkill California collaboration to train defense workers through California's community colleges, by hosting Amazon Discovery Days to introduce workers to training opportunities in cloud computing, by providing direct technical advice to Space commercialization firms in California and beyond, by engaging directly with private companies and associations to develop resources for workforce development in the Space and Defense sectors, by meeting and collaborating with DoD representatives and California State government officials, by providing exciting educational opportunities for K-12 students interested in Space, and by advising a program by the Paso Robles City government to transform its regional airport into a Space Port.

93 California workers trained in essential cloud computing skills through an innovative AWS-ETP-UpSkill California relationships facilitated by Cal Poly

365+ individuals introduced to cloud computing basics and training opportunities through 7 Amazon Discovery Days

2 SBBR projects supported

1 STTR project supported

18 Commercial Space companies received technical assistance from Cal Poly's CubeSat lab

14 California Commercial Space companies received technical assistance from Cal Poly's CubeSat Lab

16 Space commercialization and defense manufacturing workforce development events and advisory meetings

26+ Engagements with DoD and State Government Authorities related to Space Commercialization, Defense Manufacturing, and Workforce Development

1 NSF EAGER Grant submitted

1 Letter of Intent signed by Cal Poly President Jeffrey Armstrong and Paso Robles Mayor Steve Martin in support of Paso Robles' ongoing work to transform its municipal airport into a Space Port

Work Completed

AWS ATP-ETP-UpSkill California Partnership

One sustained subtask for the workforce development goals of this task was to leverage Amazon Web Services' Authorized Training Partnership (AWS ATP) with Cal Poly against Cal Poly's existing connections to the California Employment Training Panel (ETP) and UpSkill California to create innovative training solutions for Department of Defense manufacturers in the space sector. Connected to the CASCADE II grant previously completed by CCI, Amazon Web Services signed an Authorized Training Partnership with Cal Poly, so that the university can provide training on various aspects of AWS's cloud computing capabilities. Specifically, AWS, the DxHub, and CCI worked to provide educational programming designed for California's defense contractors to create a more resilient, secure, and reliable supply chain process by supporting the defense sector's transition to cloud computing. UpSkill California (previously known as the California Community College Contract Education Consortium), which assists California's community colleges to contract with public or private entities for the purposes of providing instruction or services or both, was also brought in to provide support to make these courses available to workers in the defense sector.

In addition, California's community colleges are an essential piece of getting needed training to California's workforce. As a comprehensive polytechnic with top-ranked engineering programs and the largest undergraduate aerospace program in the state, Cal Poly is a recognized tech and innovation leader. As a piece of the California State University system, Cal Poly is known for providing four-year and master's degrees and feeding knowledgeable workers into the workforce. While Cal Poly has the reputation, technical expertise, elevated domain knowledge, and relationship with AWS to provide the training, as a four-year college focused on granting degrees, the university just does not have the close contacts with local manufacturers who are looking to upskill their labor force with shorter, more focused trainings. This is why community colleges were brought into this subtask. Community colleges have existing contacts and relationships with the manufacturing community in their local areas; these are the institutions that manufacturers already turn to for targeted trainings. In this force multiplying relationship Cal Poly provides content and expertise, ETP leverages its existing skills and programs to get training to workers, and community colleges provide penetration with and access to manufacturing firms and their workforce.

The seeds of this program were planted during Cal Poly's CASCADE II grant, but drafting and finalizing the arrangements required to implement this training system meant that the CCI had to pursue direct relationships with community colleges from the Spring through Fall 2021. By March 2021, Cal Poly had drafted four contracts necessary to finalize this UpSkill California project, including MOUs between Cal Poly's division of Extended Education with both El Camino College in Torrance and College of the Canyons in Santa Clarita to offer the AWS courses, as well as agreements between CCI and El Camino College and College of the Canyons to reimburse the community colleges for recruiting costs.

As complex state entities, review and negotiations with the Community Colleges about the specific language in the MOUs took significant time. On August 2, 2021, Cal Poly signed a Professional Services Agreement with the College of the Canyons (also known as the Santa Clarita Community Colleges District) to provide delivery and execution of Amazon Web Services Training Programs. On October 20, Cal Poly signed a second Professional Services Agreement to provide delivery and execution of Amazon Web Services Training Programs with El Camino College. Both of these contracts were the culmination of more than 18 months of coordination and effort. In October, Cal Poly, College of the Canyons, and El Camino College also began negotiating an amendment to the professional services agreements, to simplify billing procedures and improve efficiency. Working through ETP reduces the costs of AWS training for California employers.

After contracts were completed with College of the Canyons and El Camino College, CCI's Martin Minnich began plans to meet with representatives from other California Community Colleges, to brief all of them on the opportunity to aid their local communities through this AWS-ETP-UpSkill California training provided by Cal Poly. On November 10, 2021, Minnich hosted a meeting—led by Eric Robertson and Gabrielle Lyles (AWS) and including Robert Meyer (ETP) and Eldon Davidson (UpSkill California)—about Amazon Web Services training courses for cloud computing and cyber security. In total representatives from 23 community colleges took part in the meeting, including: American River College, Butte Community College, Cerritos College, Chaffey College, College of the Canyons, College of the Dessert, College of the Sequoias, El Camino College, Gavilan College, Kern Community College District, Los Rios Community College District, Mendocino College, Mira Costa College, Mt. San Antonio College, Mt. San Jacinto College, Pasadena City College, Riverside Community College District, San Bernardino Community College District, San Diego Community College District, San Mateo College, Santa Monica College, Shasta College, and Yosemite Community College District. College of the Canyons is recognized across the community college system for its rigorous contracting process, and as such CCI expects more community colleges to sign on to the AWS-ETP-UpSkill California program in what should be a streamlined process. This wide variety of community college partners creates the potential to influence workforce training in the defense sector across the entire state.

While contracts were being negotiated and finalized with El Camino and College of the Canyons, CCI coordinated with ETP and the community colleges on marketing materials to inform employers in the defense manufacturing sector about the upskilling opportunities. In February 2021 CCI finalized the marketing materials for the AWS cloud training and cybersecurity courses to be offered through ETP and UpSkill California to various community colleges. They also issued a press release on February 18 regarding these courses and began promoting the cybersecurity and cloud computing courses for the

defense sector and other California employers. When price negotiations concluded new marketing materials were created to reflect that change in information. Martin Minnich at CCI also coordinated with AWS and Strategies 360, a full-service research, public affairs, and communications, to help increase the impact of marketing the AWS training program through the community colleges and UpSkill California. CCI also coordinated throughout with ETP to connect with companies who would either benefit from the AWS training or who could help promote the program. El Camino College and College of the Canyons also sent out multiple email blasts to inform their existing contacts of this exciting and important new program. All of these efforts were made in order to ensure that the desired small- and medium sized defense manufacturing firms became aware of this upskilling and reskilling opportunity necessary to both increase efficiency and productivity, while simultaneously ensuring robust cybersecurity measures are taken against the United States' competitors.

El Camino College AWS Training Marketing Flyer

In an important return on the effort to offer AWS Cloud computing training through ETP and community colleges, CCI team members led a series of trainings with employees of Robert Half, a management consulting company that serves the defense industry, among other clients. Robert Half has offices in 41 cities across California serving the Fresno-Visalia area, the Great Los Angeles Area, Orange County, the Sacramento-Stockton-Modesto area, San Diego, and the San Francisco Bay Area. Each of the trainings were taught by Ryan Matteson, deputy CIO at Cal Poly.

At an initial training on May 27, 2022, over 30 employees progressed through the first 3-hour training session titled, "Fundamentals: Concepts Discovery Day." Feedback was very positive from participants. A selection of remarks from participants includes:

- "This training session from CalPoly is awesome. I have attended a free course a very long time ago and it was waste of time… no comparison to Cal Poly's today session. Thank you so much for all your help."

- "This was fantastic! Thank you!"

- "Thank you!!! Very informative - looking forward to more"

- "Thank You very well done! I learned much!"

- "Looking forward to the future classes, thank you Ryan and Cal Poly team"

This first session was then followed by subsequent trainings again offered by Matteson. On June 3, Matteson led the class "Technical Essentials" with 19 participants. From June 8 to 10, he hosted a three-day session on "Architecting on AWS" with 18 participants. From June 30 to July 1, Matteson completed a multi-day training on "Cloud Financial Management" with 9 attendees. Matteson then led 17 Robert Half employees through a 3-day training from July 6 to July 8 covering "Security Engineering." Feedback from participants was uniformly enthusiastic, including comments such as:

- "Thank you! This was indeed an awesome training."

- "Thank you, Ryan! Its was a fantastic course. Enjoyed the 3-day training."

- "Thanks so much Ryan. It was a great 3-day course."

Overall this series of engagements provided 93 training and upskilling opportunities to Robert Half employees.

AWS Discovery Days

As a secondary effort to both market AWS courses that Cal Poly can offer to employers across the state and to provide insight into upskilling and reskilling opportunities for workers looking to embrace new positions in cloud computing, CCI and Cal Poly offered a series of what are known as "AWS Discovery Days" throughout 2021. This effort was led by Mckenna Downing. AWS Discovery Days are complimentary (free) training events that introduce cloud computing concepts and AWS topics. These training sessions provide an opportunity to learn about AWS cloud fundamentals for free, gaining valuable insight from Cal Poly's AWS-certified instructors and learning more about the Cal Poly AWS Training program. Each Discovery Day session is designed to teach business leaders and technical professionals the benefits of computing in AWS cloud and how to improve business processes and benefit from AWS security and compliance services. In part, these free introductions are meant to provide insight into why manufacturers might want to embrace cloud computing and the efficiency, compliance, and security advantages that come with it, a clear necessity for those working in defense manufacturing and Space commercialization.

In total Downing planned and executed seven Amazon Discovery Days during 2021: on April 21, May 27, June 30, July 21, July 26, August 25, and September 22. In total 550 people registered for these events. Although precise records were not kept of who attended these virtual events, based on peak attendance numbers for each session, over 365 people attended the events for at least part of the time.

AWS Discovery Days Marketing Flyer

While these AWS Discovery Days events were not specifically focused on defense manufacturers or the space sector, these brief introductions to AWS capabilities are a wat to inform about Cal Poly's capabilities for workforce training. They also act as a form of outreach to defense and space firms that might then pursue the training opportunities offered through UpSkill, ETP, El Camino College, and College of the Canyons.

Technical Advice and Support for Commercial Space Companies

As a bachelors and masters' degree granting academic institution with nationally recognized programs in STEM and engineering and the state's largest undergraduate aerospace program, Cal Poly holds immense expertise for companies moving into the dynamic Space

commercialization environment. As an original founder of the CubeSat small satellite design specification and the home of the Cal Poly CubeSat Lab, the university can also provide important technical advantages to local and national companies who need advice or help preparing to send their small satellites into orbit, particularly with testing small satellites for launch and operation in the space environment.

Company	CA Company?
Exquadram	🐻
Maverick Space	🐻
NanoRacks	
Orbotic Systems	🐻
Phase 4	🐻
Microsoft	
Rocket Lab	🐻
Fluid Flux Technologies	🐻
Planet	🐻
Orbital Effects	
Booz Allen Hamilton	🐻
Pumpkin, Inc	🐻
CesiumAstro	
Hypercubes	🐻
Firefly	🐻
Relativity Space	🐻
Apogee Technology Solutions, Inc.	🐻
Future Engineers	

As part of this grant, the CubeSat lab has provided support and technical expertise to 18 commercial space companies, 14 of which are based or have significant assets in California. Below are brief synopses of the technical support provided:

- February 2021: Dave Pignatelli of the Cal Poly CubeSat Lab staff completed a SBIR with Exquadram, a California-based company, which provides engineering consulting to overcome the most demanding technical challenges in order to design, build, and test highly effective systems in commercial and defense aerospace communities. The SBIR was titled, "Solid Propulsion Engineered for CubeSat Kinetic Operations (SPECK-Ops).

- March 2021: CubeSat Lab employees have assisted Maverick Space (a California-based company focused on mission engineering and launch support) with vibration testing on a CubeSat dispenser for launch vehicles, so that the new piece of equipment can be flight certified for launch. Dispensers are the adaptors that "attach" CubeSats to the launch vehicle and then release them once in orbit. Testing has been ongoing since December 2020.

- May 2021: Ryan Nugent consuled with NanoRacks (TX based) to help the company receive FCC licenses to be allocated radio frequencies for communicating with low-Earth orbit satellites. NanoRacks was founded in 2009 to provide commercial access to low-Earth orbit. Since then, the company has brought over 1,000 research payloads and small satellites to the International Space Station.

- August 2021: Dr. Pauline Faure worked with Maverick Space on a stage 1 STTR, "STTR Phase I: Advanced Reaction Control System (RCS) for CubeSat and Microsatellite Platforms," which began in August 2020 and will continue through August 2021.

- February 2021 to May 2021: Ryan Nugent and CubeSat staff have been consulting with Orbotic Systems, a Wyoming-based company with a California presence that focuses on CubeSat services, space debris remediation, and satellite propulsion and energy. Specifically, consultations have focused on testing and certification processes for launch and operating in space regarding a de-orbit device to bring non-functioning satellites back to earth and decrease the amount of space debris.

- March 2021: Ryan Nugent and CubeSat Lab staff held initial consultations with Phase 4, a California-based company working on propulsion systems for small satellites, regarding using CubeSat Lab facilities for long-term thermal vacuum testing. The head test engineer from Phase 4 visited Cal Poly on March 2.

- June 14-15, 2021: CubeSat lab conducted a virtual CubeSat Training course. Relevant attendees included: Harmanjot Singh Kharoud from Microsoft, Juan Cepada-Rizo from Rocket Lab as well as Fluid Flux Technologies (both CA companies), Nathan Johnson from Planet (a CA company), and Serenity Monroe, Orbital Effects (a Michigan company).

- June 2021: The CubeSat lab conducted vibration testing on two flight satellites which will be launched as secondary payloads on the LandSat-9 mission from Vandenberg SFB in mid-September. The satellites we two 6U CubeSats built by Pumpkin, Inc. (a CA company) for their customer CesiumAstro (a TX company).

- October 6, 11, 13, & 18, 2021: The CubeSat lab performed vibration testing for Maverick Space Systems on a CubeSat dispenser for flight.

- October 20 & 26, 2021: The CubeSat Lab held calls with managers and engineers from Firefly Aerospace, to provide technical insight of how different analyses are performed for CubeSats. They also discussed potential of performing launch environments tests on hardware they are developing. Firefly is based in Austin, TX, but launches out of Vandenberg SFB.

- October 25 & 29, 2021: The CubeSat Lab loaned a CubeSat dispenser to Relativity Space, located in Long Beach, CA, so that they could perform "hardware in the loop" testing for an upcoming launch. The lab routinely gets requests like this because the industry is so young, organizations typically don't know all of what they need to properly test their hardware/products. This leads many start-ups having to procure specific hardware very late. Also, many types of hardware have long lead times—typically 3-6+ months even before the pandemic and the pandemic related shortages have made lead times even longer—so loaning hardware is an important support the CubeSat Lab provides to defense contractors and potential defense contractors.

- December 17, 2021: The CubeSat lab ran vacuum testing of light hardware for Maverick Space.

- February 11, 2022: Nugent met with Firefly Aerospace, a Texas based company that launches out of Vandenberg SFB, to clarify requirements for launching CubeSats for their NASA customer.

- February 23 & 25, 2022: Nugent participated in meetings regarding a NASA SBIR Proposal with Apogee Technology Solution, Inc. This company was recently started by two of the CubeSat Lab's current students, Mark Wu and Jered Bell. The technology being developed is to put small satellite electronics/harnessing with optical wireless communication in additively manufactured structures.

- February 24: The CubeSat lab preformed another set of vibration tests for Maverick Space Systems on a dispenser for flight.

- March 9, 23, & 25, 2022: The CubeSat lab performed vibration testing and vacuum testing for a company called Future Engineers. They are developing hardware for 57 student teams (grades 6-12) to fly experiments on sub orbital and high-altitude balloon flights.

Space Commercialization and Defense Manufacturing Workforce Development Events and Advisory Meetings

To fulfill the goals of this task, members of the Cal Poly team—most notably Paul Jurasin from the DxHub and Martin Minnich from CCI—met regularly with members of the public, business and advocacy associations, and individual companies to discuss workforce development challenges and opportunities particularly as they relate to the overlapping concerns of Space commercialization, defense manufacturing, cloud computing, and cybersecurity. These meetings and events allow Cal Poly to share their insights and experiences responding to the opportunities and challenges presented in these rapidly developing fields, while also gaining insight into the public's and employers' current needs and concerns. These meetings and events highlight Cal Poly's important role as an interlocutor between academia and private employers.

A chronologically ordered list of these events and meetings follows:

- June 16, 2021: Martin Minnich, CCI team members, and Cal Poly faculty delivered a training and workforce development presentation focused on a 1-year pathway to cybersecurity jobs for workers at PG&E's Diablo Canyon Nuclear Plant. The pathway is mean to use Cal Poly's Learn by Doing pedagogy to transition interested employees into the tech field, as the power plant may be decommissioned in the coming years.

- July 13, July 20, and August 3, 2021: Jurasin took part in National Security Innovation Network (NSIN) meetings to discuss workforce development and innovation processes. NSIN is tasked with developing a new alliance between defense, academia, and venture communities whose collaboration is imperative in the service of our national security, to build networks of innovators that generate new solutions to national security problems.

- August 11, 2021: Jurasin presented information about the DxHub's innovation processes and workforce development projects at a "Conversation for the Future" event hosted by the Foundation for the Future.

The two-day meeting was focused on promoting the Space Workforce and Industrial Base. The Foundation for the Future (F4F) is an education and advocacy non-profit dedicated to advancing the space economy by developing critical infrastructure to enable it, investment tools to finance it, and the workforce to power it.

- October 28, 2021: Bill Britton, Cal Poly's Vice President of Information Technology Services and Chief Information Officer, spoke at a session of the Educause Annual Conference 2021 on "The Cloud Tipping Point." Elisa Horta, a Cal Poly student and employee of the DxHub, spoke at the same conference on a session focused on "Engaging students in Digital Transformation."

- January 5 & 12, 2022: Jurasin met with Tim Chrisman, executive director of the Foundation for the Future, to discuss space workforce development.

- January 20-21, 2022: Jurasin also made a presentation about the overlapping concerns about space and cybersecurity at the Foundation for the Future's "Conversations for the Future" workshop series for its members. Jurasin was joined during his talk Cal Poly undergraduate student Luis Placencia. There were 200 attendees to this talk "in the room" with another 5.2k watching over the live-stream. About 25% of the 200 "in the room" attendees came from government/military, with 45% from the aerospace industry, and 20% education. The audience also included individuals from 11 Congressional offices.

- January 25, 2022: Jurasin discussed space infrastructure and workforce development with John Weathersby, CEO of the Stellar Modal Transportation Association.

- February 17, 2022: Jurasin met with Lisa Easterly of the San Diego Cyber Center of Excellence, regarding workforce development in cybersecurity for the Space realm.

- May 12, 2022: Jurasin met with Eddie Zervigon, CEO of Quantum Xchange—a company of seasoned enterprise-security professionals who are the creators of a completely reimagined approach to data encryption that delivers an unsurpassed level of security today and quantum-safe protection from future threats—about cybersecurity and the Space supply chain. Zervigon is also a member of the Board of Directors for Maxar, a Space technology and intelligence firm with offices throughout California.

- May 12, 2022: Jurasin consulted with General Brett Williams (Ret. USAF) the founder of IronNet—a cyber-security company that utilizes Collective Defense to defend companies, sectors, and nations—to discuss issues and opportunities regarding cybersecurity and the Space supply chain.

- May 12, 2022: Jurasin spoke with Evan Glick, Director of cyber defense solutions for Aerospace Corporation—the only federally funded research and development center for the Space enterprise–about the opportunities and challenges regarding cybersecurity and the Space supply chain.

- May 25, 2022: Jurasin met with Steve Jacques, CEO of the National Security Space Association—a non-profit support association dedicated to the National Security Space enterprise working to foster long-term cooperation among industry and government officials—to pursue possibilities for a future collaboration with the DxHub focused on Space commercialization.

- May 26, 2022: Jurasin met with Alicia Stump, the head of marketing and communications for Kepler Space—a company that provides real-time, continuous connectivity for space, abolishing barriers to make space-generated data universally accessible by creating the infrastructure needed to support the current and future needs of the space industry—to discuss the development of Space commercialization and cloud computing, as well as the possibility of future collaboration with the DxHub.

- May 26, 2022: Jurasin also met with Scott Carl, the CIO of SecureStrux—a firm with extensive Department of Defense expertise that provides specialized services in the areas of compliance, vulnerability management, cybersecurity strategies, and engineering—about cybersecurity and the Space supply chain.

- June 7, 2022: Martin Minnich participated in a CASCADE-focused panel at the National Initiative for Cybersecurity Education (NICE) Conference and Expo in Atlanta. The panel highlighted the work completed during this CADENCE grant as well as a previous CASCADE grant, regarding workforce development with a particular focus on Space commercialization.

- June 13, 2022: Jurasin met with Nathan Beach, Cyber Defense Lead at Amazon Web Services, to discuss secure enclave partnerships.

- May 24, 2023: DeBrum and St. John, delivered a compelling presentation to the California Governors Military Council around Cal Poly's workforce and innovation support for Central Coast spaceports. The presentation, coordinated by OPR highlighted the Cal Poly DxHub's digital transformation support for Vandenberg, work on the Paso Robles Spaceport project, and development of the Cleared for Success, public sector clearance education program.

- June 5-8, 2023: DeBrum participated in a focused panel at the NICE Conference in Seattle, WA with, to discuss Cal Poly DxHub work with CADENE partner CCOE.

- July 10-13, 2023: DeBrum attended the annual AWS Imagine conference in Sacramento, CA, presenting on Cal Poly DxHub's project work leveraging Machine Learning platforms.

- July 13, 2023: DeBrum, Britton, and Chinichian, conducted several in person meetings in the Sacramento area to discuss current and future partnerships related to both CCI and DxHub operations related to CADENCE work. A meeting with the California Aerospace Museum discussed continued partnership with Cal Poly's cyber education initiatives, Cal Poly's efforts supporting the Paso Robles Spaceport, and potential future STEM engagements in the Sacramento region. A meeting with the California Department of Technology focused on continuing support for cyber education and training for state employees. A conversation with CADENCE partner ETP, discussed future training needs around space commercialization on the Central Coast. And finally, the Cal Poly team met with the new commander for the California National Guard's cyber division to discuss future training programs and partnerships around Cal Poly's game-based cyber training platform and the future security clearance training program, Cleared for Success

- August 28, 2023: DeBrum and Britton met with the new base commander and LT Commander for California National Guard Bases Camp Roberts and Camp San Luis Obispo to review Cal Poly's Cleared for Success security training program.

Understanding "Customer" Requirements at Vandenberg SFB

At the beginning of the grant process CCI and the DxHub began inquiring with individuals at Vandenberg SFB about the possibility of creating a "Voice of the Customer Coalition." Conceptually, the purpose of this initiative was to provide the California community (defense contractors, manufacturers, and their advocates including CADENCE group members) with direct contacts to Vandenberg SFB staff and leadership. The goal was to improve communication and provide a mechanism for Vandenberg to better communicate its needs, resources, and opportunities in the space and defense fields. Key contacts at Vandenberg SFB on this initiative included Steve Rogers, Range Technical Advisor, who would be the executive sponsor on the project and Lt. Anthony Leogrande who would work as the action officer. The initial goal was to host a CADENCE-focused workshop with Vandenberg, face-to-face and on base.

Unfortunately, it became increasingly clear that any decisions regarding the Voice of the Customer initiative would have to go thorough leadership at Cape Canaveral SFB. Members of the DxHub and CCI met with Cape Canaveral leadership and decisions were made to pursue cloud computing initiatives within the Space Force, outside of the

purview of this grant. At this point, it became clear that (despite interest in the project) Vandenberg SFB did not have the bandwidth to take on large projects, like the Voice of the Customer Coalition. Moreover, Vandenberg SFB did not then have the political weight to make organizational and directional shifts; those need to be pursued in tandem with the more senior leadership at Cape Canaveral SFB. The "Voice of the Customer Coalition" had hit an insurmountable block, but conversations with Vandenberg and Cape Canaveral continued on other possible paths forward.

As part of the engagements with Vandenberg SFB, the CCI team, including Dr. Kurt Colvin became aware of staffing issues being experienced by Range Generation Next, LLC (RGNext). RGNext is jointly owned by Raytheon Company and General Dynamics Information Technology and is responsible for operations and range and technical services at Vandenberg SFB, as well as other major U.S. military bases around the country. At Vandenberg SFB, RGNext's workforce provides expertise in technical services, engineering, communications, meteorological services, systems operations, maintenance and sustainment, ballistic missile, guided weapon and aeronautical tests and evaluations, cybersecurity, information technology, logistics and many other strategic and specialized business functions. In August, Dr. Colvin began conversations with RGNext about the possibility of allowing Cal Poly students to complete Learn by Doing internships working at Vandenberg SFB.

Throughout September and October CCI's Martin Minnich took part in multiple meetings with RGNext leadership including Nick Peltser (RGNext lead at Vandenberg) and Charles Womack (RGNext cybersecurity lead). Minnich began meeting simultaneously with Cal Poly College of Engineering Dean Amy Fleischer, Bruce DeBruehl (Associate Professor of Computer Science and Software Engineering), and Dean Arakaki (Associate Professor of Electrical Engineering) to discuss possible collaborations with RGNext. Minnich also began meeting with Professor Chris Lupo, Chair of the Computer Science and Software Engineering Department. By the end of September Cal Poly was drafting an agreement with RGNext to create two, six-month faculty exchanges/externships at Vandenberg SFB to allow Cal Poly faculty to gain full awareness of RGNext's operations and better understand RGNext's requirements and technical needs. Because RGNext has a significant number of job vacancies at Vandenberg SFB, the expectation was that by combining faculty oversight with Learn by Doing opportunities for Cal Poly students, the project would both prepare students to work in the defense field at the nexus of space, cybersecurity, and national security, and knock out the tech deficit at Vandenberg SFB.

Coordination continued through October focused on initiating a faculty exchange at Vandenberg SFB followed by a series of student externships with RGNext. Significant follow-on conversations continued with Lupo, chair of Computer Science and Software Engineering. On October 25, a faculty delegation led by Dr. Steven Beard (Computer Engineering) and including Dr. Bruce DeBruhl (Computer Engineering) and Dr. Zachary Peterson (Computer Science and Software Engineering) visited RGNext at Vandenberg SFB.

Meetings and discussions continued on all fronts through November and on December 3, 2021, Nicholas Pelster and RGNext posted two job requisitions: one for Casual Software Engineer Senior Principal, and one for a Casual Network Engineer Senior Principal. Working together with Chris Lupo and RGNext, CCI identified Cal Poly faculty best suited for these positions, which would serve as the advance team to study and understand RGNext's needs. By design, these faculty positions would determine potential projects and problems at Vandenberg SFB that teams of Cal Poly students and faculty could address. In January, Steven Beard, assistant professor of Computer Engineering, and Zach Peterson, associate professor of Computer Science (both from Cal Poly's College of Engineering) applied for the job opportunities posted by RGNext. Negotiations over salary and responsibilities continued throughout February at all levels, facilitated throughout by Minnich.
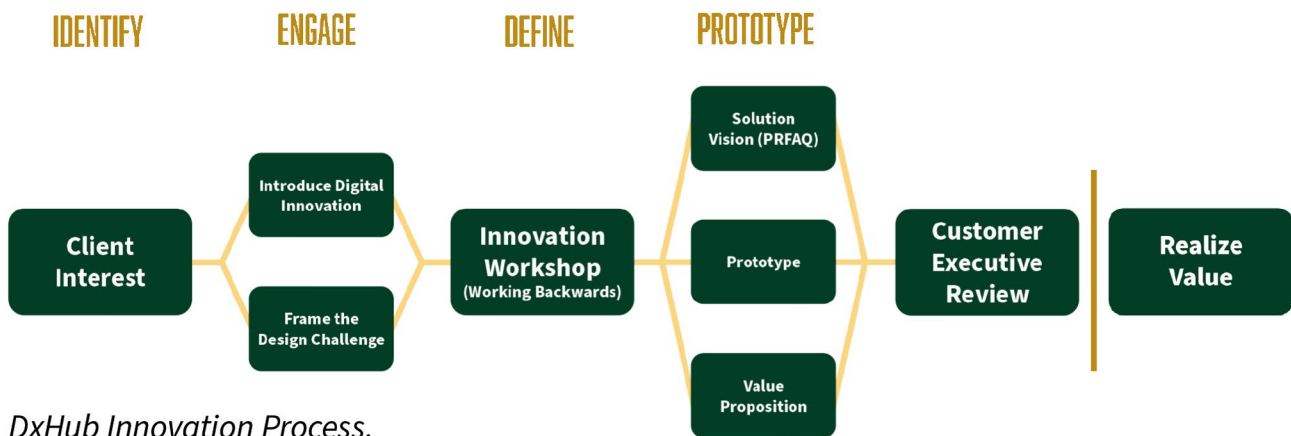
Unfortunately in March, the collaboration with RGNext hit an insurmountable obstacle caused by budget restrictions and the initiative was put on hold. As highly trained and exceptionally skilled specialists, the Cal Poly

faculty identified to be part of this pilot project required and deserved compensation commensurate to their experience. With 18 months left in their contract with Vandenberg SFB and their funds already allocated to existing efforts, RGNext was not able to offer support at the necessary levels to make this effort tenable for all parties involved. Steve Rogers (Vandenberg SFB) is currently seeking potential ways to have the base directly support this effort, but that financial support will also take significant time to acquire.

One big lesson of this subtask is that the rigidity of budgets and the pace of the budgeting process significantly hinder the flexibility needed to pursue innovative responses in a swift manner. Nonetheless, CCI, Cal Poly, RGNext, and Vandenberg SFB have created a meaningful foundation on which to engage in future conversations and, potentially, new avenues to create similar programs through collaboration.

After both the "Voice of the Customer Coalition" and the collaboration with RGNext were put on hold, the DxHub continued conversations with Steve Rogers on potential points of collaboration. In March, the DxHub identified a "challenge" to be completed with the base leadership at Vandenberg SFB. The DxHub will be determining the output of data that the base commander needs to make decisions regarding resource allocations. The DxHub team will reverse engineer a data intake process that collects and aggregates necessary data streams to meet the leadership's future planning needs.

The "challenge" procedure is a framework for solving real-world problems. It is based on a model created by Cal Poly's Digital Transformation Hub (DxHub), which itself draws from the experience, in part, of Amazon Web Service's (AWS) "working backwards" product development strategy.

IDENTIFY   ENGAGE   DEFINE   PROTOTYPE

Client Interest → Introduce Digital Innovation / Frame the Design Challenge → Innovation Workshop (Working Backwards) → Solution Vision (PRFAQ) / Prototype / Value Proposition → Customer Executive Review → Realize Value

DxHub Innovation Process.

As a process framework, these challenges are not single events, like a conference or a symposium. Rather, challenges involve a series of engagements with clients across a number of stages, including:

- First, an intake form is created when the challenge is accepted by the DxHub and its Cal Poly partners like the California Cybersecurity Institute (CCI).

- Next, the DxHub and its partners host a one or two day workshop event in which the client meets with subject/domain experts to define the problem that they want to solve. This results in the 5 Questions document, illustrating the core problems that need to be solved through the engagement process.

- The third step is for the DxHub and its partners to create a Public Relations Frequently Asked Questions (PR FAQ) document. The press release contains information about the problem, how current solutions are failing, and why the new product will solve this problem. The PR FAQ document is then revised in consultation with the client.

- As a next step, the client and domain experts meet in another workshop to brainstorm a number of possible solutions to the problem set identified and explained in the previous stages.

- The DxHub and its partners (including domain experts) then devise a prototype solution to the identified and analyzed problem or problem set.

- Finally, meetings between and communications among the DxHub team and the client continue with critiques shared of the prototype so that it can be further refined. The process is complete when a functioning prototype has been created.

During the first half of 2022, the DxHub and Vandenberg SFB continue to coordinate and plan for the upcoming challenge. Paul Jurasin met regularly with Steve Rogers, Range Technical Director, to determine the best path forward and to secure support from the command deck to receive approval from the installation commander to move forward with the challenge process. The defined focus of the challenge was to support Vanderberg with establishing its own Digital Transformation Office to support enterprise level transformation efforts. In December of 2022, the DxHub team conducted a half-day workshop session with Vandenberg SFB transformation leadership focused on the techniques used for developing innovative solutions to challenges. Topics during the workshop included the submission of challenge requests, the structure of the innovation process, ideation techniques, empathy mapping, PRFAQ development and documentation, prototyping and executive reviews. Each of the topics were described and enhanced with examples. Documentation including an innovation playbook were provided to the team for their reference in standing up a new digital transformation office at Vandenberg.

Engagements with State and Federal Government Authorities, Especially Vandenberg Space Force Base

To fulfill the goals of this task, members of the Cal Poly team—most notably Ryan Nugent from the CubeSat Lab, Paul Jurasin from the DxHub, and Martin Minnich from CCI, but also Cal Poly faculty—met regularly with representatives from the Department of Defense and California State government. Some of these meetings provided opportunities for Cal Poly to provide technical advice on small satellite programs in particular. More generally, Cal Poly team members met regularly with military personnel and state officials to better understand the challenges and opportunities for innovative workforce development programs at the confluence of defense manufacturing, Space commercialization, cloud computing, and cybersecurity.

Many of these events reflect the dynamic relationship between Cal Poly and Vandenberg SFB. This special relationship was at the core of an attempt to create an exceptionally innovative program to hire Cal Poly faculty and students to advise and work with RGNext—the main defense contractor at Vandenberg SFB—to solve technical and innovation problems across their work. While this effort was not ultimately successful, it provides important insights into the potential for new workforce development and training opportunities between academia and the Department of Defense.

These meetings and events with military personnel allow Cal Poly to share their insights and experiences responding to the opportunities and challenges presented in these rapidly developing fields of Space commercialization and workforce development, while also gaining insight into the national security community's

current needs and concerns. The team views engagement with these individuals and agencies as an essential means of communication to ensure that the national security community has the products and workers it requires. These meetings and events highlight Cal Poly's important role as an interlocutor in public-private-academic initiatives.

A chronologically ordered list of these events and meetings follows:

- June 25, 2021: Dr. Pauline Faure (Cal Poly CubeSat Lab and Aerospace Department) and Ryan Nugent met with Jennifer Callaro (U.S. Space Force Strategic Engagements Branch Chief), Stephen Serniak (Space Delta 5 Technical Director), and Jessica Gover and Ed Quinonez (Booz Allen Hamilton) to discuss the CubeSat lab's CRADA.

- September 2021: Nugent served as a judge for a NASA contest for small satellite observation technologies that can autonomously detect, locate, track, and collect data on transient events. In the TechLeap Autonomous Observation challenge No. 1, NASA seeks to advance observation capabilities using adaptive, distributed, heterogeneous networks of spacecraft, suborbital, and ground-based sensors working cooperatively. At the end of the challenge, up to 4 teams could win $500,000 to build their payloads and receive a free suborbital flight to test them.

- September 29, 2021: Jurasin met with Christin Helberson (director of solutions acceleration at AWS) about potential work with Vandenberg SFB.

- October 8 & 22, 2021: Nugent spoke with engineers at NASA Ames Research Center about having, at least, 1 student do a virtual paid internship to help develop and test software they are developing for Space Traffic Management.

- October 19, 2021: Nugent attended the Central Coast National Security Collaboration meeting, which is organized by the local FBI office and includes local businesses (mainly small businesses) and researchers that support DoD. The attending members were briefed on current threats relating to cybersecurity and, in response, members provided insights on threats they had been defending against.

- October 20, 2021: Jurasin met with Dimitrious Louloudis, Provost of the National Intelligence University, to discuss a potential collaboration to create a pathway for intelligence community staff to improve their digital literacy.

- October 28, 2021: Nugent spoke with faculty and students from the Naval Postgraduate School located in Monterey, CA, to discuss ground station architectures for an educational ground station network.

- November 2021: Nugent began advising and supporting an effort driven by the U.S. Space Force to create a "Multi-manifest Design Specification (MMDS)." The goal of the MMDS is to create a standard/spec (similar to the role Cal Poly played for creating the CubeSat standard) for small satellites that are larger than CubeSats. The group is made up of USSF officers, NASA experts, small satellite developers, launch providers, and launch integrators.

- December 1, 2021: A Cal Poly team led by Philosophy Professor Patrick Lin submitted an NSF EAGER grant to develop a broad set of scenarios and taxonomy on how cyberattacks could occur with space technologies, as well as their associated ethical, legal, and policy issues. These will help to better conceptualize the cyber vulnerabilities, which will help toward mitigating them, both from technical and policy directions. It will culminate in the first public report on space cybersecurity, policy, and ethics. This two-year grant builds on CCI's work in both the CASCADE II and CADENCE work focused on the overlap of ethical considerations and policy implications for space warfare and cybersecurity.

- January 12, 2022: Nugent participated in a meeting of the Small Satellite Reliability Initiative (SSRI) Working Group. This is a group of about 20 people that is led by NASA and the Aerospace Corporation and is comprised of small satellite professionals with broad collaborative participation from civil, DoD, and commercial space systems providers and stakeholders. The Initiative seeks to define implementable and broadly accepted approaches to achieve reliability and acceptable risk postures associated with several SmallSat mission risk classes—from "do no harm" missions, to those associated with missions whose failure would result in loss or delay of key national objectives.

- January 12, 2022: Jurasin met with with Rachel Grunspan, provost of the National Intelligence University to discuss digital literacy in national intelligence.

- February 2022: Nugent advised and supported an effort driven by the US Space Force to create a "Multi-manifest Design Specification" (MMDS). This was the second in a series of engagements. See the entry from November 2021 for details.

- February 2, 2022: Jurasin met with Major Mikael Magnussen, head of the Cybersecurity Protection Force for the California National Guard about workforce development issues.

- February 4, 2022: Jurasin met with Christine Halverson, Manager of AWS Mission Acceleration Team, about defense and intelligence product development.

- February 16, 2022: Nugent met again with the Small Satellite Reliability Initiative (SSRI) Working Group. See January 2022 entry in this section for details. This meeting included discussion about having an in-person event during the CubeSat Developers Workshops.

- February 24, 2022: Jurasin met with Michael Schwarz, lead of the AWS Mission Acceleration Team, about defense and intelligence product development.

- March 2022: In five separate meetings across the month, Nugent Nugent advised and supported an effort driven by the US Space Force to create a "Multi-manifest Design Specification" (MMDS). See February 2022 entry for details on the project.

- March 9, 2022: Nugent met with the Small Satellite Reliability Initiative (SSRI) Working Group Meeting. See January 2022 entry in this section for details. The meeting included discussion about having an in-person during the CubeSat Conference.

- On March 10, Jurasin met with Major Katherine Carroll, head of the Cloud Center of Excellence, Cape Canaveral, U.S. Space Force.

- March 15, 2022: Nugent and the CubeSat Lab staff gave a tour of their labs to the 533d Training Squadron from Vandenberg SFB, which included about 20 students and 2 instructors. The 533d is tasked with training all space military operators, so all officers and enlisted personnel in the Space Force and space operators from the branches of the military must complete this training at Vandenberg SFB.

- March 23, 2022: Nugent held a follow-on meeting with the 533d Training Squadron to provide technical and programmatic advice about creating a CubeSat program to train officers and enlisted personnel specifically to perform command and control functions for satellites.

- April 5 & 12, 2022: Nugent advised and supported an effort driven by the U.S. Space Force to create a 'Multi-manifest Design Specification (MMDS).' See February 2022 entry for details on the project. This specification document was currently under final review.

- April 13, 2022: Nugent met again with the Small Satellite Reliability Initiative (SSRI) Working Group. See January 2022 entry in this section for details.

- April 28, 2022: In a continuing effort to coordinate and collaborate with Vandenberg SFB, Nugent gave a tour of the CubeSat Lab to two instructors and twelve students from the 533d Training Squadron located at Vandenberg SFB. The 533d is tasked with training all space military operators, so all officers and enlisted personnel in the Space Force and space operators from all branches of the military go through this training at Vandenberg SFB.

- On April 5, Jurasin met with Major Mikael Magnussen, head of the Cyber Protection Force, California National Guard.

- On June 10, Jurasin met with Army Lt. Col. Ty Shepard, Joint Task Force Cyber Command for the California Military Department, to discuss the California National Guard's Cyber Dawn Exercises, a cyber-defense exercise to provide a tactical level response to defend web-based infrastructure.

- On July 18, 2022: Jurasin met with Steve Rogers, Range Technical Director at Vandenberg SFB, to discuss strategy for moving forward on the Challenge, including refining the parameters of the challenge and potential opportunities for maximum impact. Further meetings and contacts are planned for August.

- On August 6, 2022: Jurasin, Cal Poly Vice President for Information Technology Services and Chief Information Officer (CIO) Bill Britton, and AWS executives met with Steve Rogers, Range Technical Director at Vandenberg SFB to focus effort on assisting with setting up a Digital Transformation Office at VSFB to work through Enterprise Level transformation efforts.

- On September 15-16, 2022: Jurasin participated in Vandenberg SFB's second annual Assured Access to Space (AATS) Industry Day Forum.

- On October 8, 2022: Paul Totora, Deputy Assistant National Cyber Director from the White House Office of the National Cyber Director (ONCD) provided closing remarks during the 2022 Space Grand Challenge competition.

- On November 1, 2022: Jurasin met with representatives from the National Security team at AWS to discuss potential uses of AWS cloud computing projects for the project with Vandenberg SFB.

- On November 4, 2022: Jurasin then met with Steve Rogers at Vandenberg SFB to continue refining ideas for the digital transformation effort.

- On December 9, 2022: The Vandenberg Space Force Base digital transformation leadership attended a half-day workshop at the Cal Poly Digital Transformation Hub (DxHub). The DxHub director and digital innovation lead conducted the workshop which focused on the techniques used for developing innovative solutions to challenges. Topics during the workshop included the submission of challenge requests, the structure of the innovation.

- On March 6, 2023: Dustin DeBrum met with the National Security Innovation Network, part of the DoD Defense Innovation unit to introduce CCI workforce development efforts via the Space Grand Challenge game-based cyber training program for middle and high school students.

- On May 13, 2023: Lauryn Williams, Senior Advisor for Strategy in the White House Office of the National Cyber Director (ONCD) provided opening remarks during the 2023 Space Grand Challenge Redux competition.

- On September 7, 2023: DeBrum and Britton traveled to El Segundo, CA for a meeting with Space Systems Command (USSF SSC) to discuss current programs, opportunities for engagement under CASCADE III, and partnership for Cal Poly's Cleared for Success security training program.

Educational Opportunities for K-12 Students interested in the Commercialization of Space

Based on its experience with workforce development supported by the CASCADE II grant, CCI has learned that early interventions are necessary to get students to think about careers in Space and in defense manufacturing. As a California State University's premier polytechnic university, Cal Poly's core mission is to

Space Grand Challenge Logo

The SGC Program is a free global virtual game-based cybersecurity competition for middle and high school students built by Cal Poly students. The SGC helps prepare the next generation of the cyber workforce by expanding the pipeline of talent earlier, promoting STEM, and developing cyber/IT skills. SGC accomplishes this through a unique use of gamification and esports to promote STEM, space themes, and cybersecurity

Student announcers for live event broadcast

provide STEM and engineering education to California's future workforce. CCI has helped to enhance that core role of the university by pursuing programs focused on K-12 students. Specifically, CCI has created the Cyber-to-Schools program and is continuing its support for the Space Grand Challenge.

The Cyber to Schools initiative is about making sure that everyone can participate in the digital revolution. The programs supported through this initiative focus on bringing top education resources and tech leadership to underserved communities, and providing all students with a way to benefit from and contribute to the decade of tech. Through the Cyber to Schools program, CCI and its partners provide students with a variety of free education and certification alternatives to a four-year degree track. It highlights non-traditional learning pathways through training programs and professional certificates that prepare students for future careers by emphasizing the Learn by Doing Cal Poly philosophy. To date 750 students have completed this coursework.

Cyber to Schools Marketing Flyer

Cyber to Schools Social Media Graphic

skills. Additionally, Cal Poly students gain skills in cybersecurity and game based education through hands on platform development and challenge creation. In October of 2022 the CCI launched the Space Grand Challenge (SGC) with 376 registered international players from across 6 countries. During the SGC competition, middle and high school teams compete to solve a satellite hacking crime scenario called, Mission Kolluxium Z-85-0. Over the course of the grant, CCI promoted its Space Grand Challenge, through a newsletter campaign to advertise upcoming virtual information sessions describing the competition. CCI also used social media (Twitter, Instagram, Facebook, LinkedIn, YouTube, Twitch, TikTok) and other outreach channels to hide competition puzzles and clues leading up to the Space Grand Challenge competition. This effort allows teams and potential teams to stay engaged and be on the lookout for challenge hints that will help them solve the Mission.

In March and October of 2023, the CCI expanded game-play opportunities by hosting open practice events, called the SGC: Sandbox Series. The latter of which ran for six days to coincide with Octobers national Cyber Careers week. These practice opportunities are open to anyone interested in the game and have increased engagement with a broader set of players both nationally and internationally. Additionally, CCI hosted the SGC:Redux competition in May 2023. This event mirrored the competition in October 2022, allowing players unable to participate previously and players who wanted to play again the opportunity to compete in the game. These expanded events reached over 700 registered players during the calendar year. . Further information about the Space Grand Challenge can be found on the CCI's website here.

No DoD funds were used to support either Cyber to

Cal Poly President Jeffrey Armstrong and Paso Robles Mayor Steve Martin signing a Letter of Intent in support of Paso Robles' ongoing work to transform its municipal airport into a Space Port

School or the Space Grand Challenge. Nonetheless, CCI believes strongly that it is essential to pursue efforts like these to increase the number of future workers and future college students interested in pursuing careers and training in cybersecurity, space, and space commercialization. These programs are both key examples of an important early intervention in the overall workforce development pipeline.

Developing a Space Port in Paso Robles

As part of this task, Cal Poly team members—most notably Paul Jurasin, Ryan Nugent, and Henry Danielson—helped to conceive and develop the city of Paso Robles' plans to transform its regional airport into a Space Port. Currently there are only 13 designated Space Ports in the United States. This exciting opportunity is designed to attract more commercial space firms and defense manufacturers to Paso Robles and California. Plans include the creation of a connected Tech Park as well.

Both Paso Robles' economic development planning and Cal Poly's educational goals related to the Paso Roble Space Port fit perfectly within the broad goals of the CADENCE program and CCI's specific tasks within the grant. This is exactly the kind of economic development and community impact that CCI is meant to have on the

Paso Robles Economic Development Manager Paul Sloan presenting the purpose of the Space Port designation at Paso Robles town hall meeting

Space commercialization sector through CADENCE. This grant's impact (by fostering Cal Poly's relationship with Paso Robles in Space commercialization, manufacturing and R&D, and space tech) is a monumental win for the region, for California, and for CADENCE. For more details see information in Task 11.

Meetings and engagements to support the development of the Paso Robles Space Port and Tech Park, included:

- July 7 & 23, 2021: Paul Jurasin met remotely with Paul Sloan, the Economic Development Director for Paso Robles, CA, to discuss the city of Paso Robles' plan to license their regional airport as a space port.

- August 20, 2021: Jurasin met remotely with Paul Sloan, the Economic Development Director for Paso Robles, CA, to discuss the city of Paso Robles' plan to license their regional airport as a space port.

- October 7, 2021: Jurasin met remotely with Paul Sloan, the Economic Development Director for Paso Robles, CA, to discuss the city of Paso Robles' plan to license their regional airport as a space port.

- November 3, 2021: Ryan Nugent, Paul Jurasin (DxHub), Bill Britton (Cal Poly ITS), and Henry Danielson (CCI) joined the inaugural meeting of the Paso Robles Mayor's Technical Advisory Group (TAG) for transforming Paso Robles airport into a space port. TAG members include technical experts and entrepreneurs from the surrounding region.

- December 15, Ryan Nugent, Bill Britton (Cal Poly ITS), and Henry Danielson (CCI) joined the monthly meeting of the Paso Robles Mayor's Technical Advisory Group (TAG) for transforming Paso Robles airport into a space port.

- January 24, 2022: Jurasin met remotely with Paul Sloan, the Economic Development Director for Paso Robles, CA, to discuss the city of Paso Robles' plan to license their regional airport as a space port.

- February 10, 2022: The CubeSat team met for the monthly Technical Advisory Group for Paso Robles, related to the effort to create a spaceport there. This month the group discussed doing a marketing and information event to target prospective companies for the spaceport/tech park. Cal Poly was asked to suggest some companies to be targeted.

- February 26, 2022: The CubeSat Lab loaned a 3U CubeSat model of its ExoCube-2 CubeSat for display at Paso Robles City Hall and the library. The purpose of the loan is to: help educate the people in the local area about CubeSats and small satellites; demonstrate how different they are from traditional, very large, satellites; and highlight the types of missions that CubeSats and small satellites can perform.

- March 27, 2022: Nugent completed a review and provided comments to the city of Paso Robles for a Preliminary Technical Review report for the Paso Robles Spaceport effort in advance of a City Council meeting on March 29 to advance the effort to transform their regional airport into a space port. As reported in the local papers, the effort was successful and the City Council voted to pursue transitioning the local airport into a space port.

- April 18, 2022: Nugent completed an interview for local NPR radio, KCBX with Benjamin Purper about the space port effort in Paso. The story aired multiple times on April 20 and is available online here. These public stories are an essential part of highlighting the economic impact Cal Poly is having on the development of commercial Space operations in the region.

- April 27, 2022: Cal Poly President Jeffrey Armstrong and Paso Robles Mayor Steve Martin signed a Letter of Intent in support of Paso Robles' ongoing work to transform its municipal airport into a Space Port.

- May 5, 2022: Jurasin made a presentation to the Cal Poly President's Advisory Committee about Cal Poly's role in conceiving and consulting with the government of Paso Robles, CA, to transform its regional airport

into the Paso Robles Spaceport. Cal Poly President Jeffrey Armstrong's Advisory Committee is a group of local, regional, and national business, economic, and thought leaders who connect Cal Poly to communities across California and the nation.

- June 1, 2022: Jurasin met with Paso Robles Mayor Steve Martin to discuss the creation of a Space Tech Park attached to the planned Paso Robles Space Port. This has a major potential for economic impact on the Paso Robles area.

- June 2, 2022: Jurasin met with Brian Raynard, CEO of Silicon Valley Executive Network, to discuss plans for the Paso Robles Space Tech Park. The Silicon Valley Executive Network is an invitation-only organization made up of Silicon Valley investors, executives, engineers, and investors that uses its network of individuals to accelerate business synergy, shape strategy and innovation, clarify emerging trends, and enable key relationships.

- July 1, 2022: Jurasin met with Paul Sloan, the Economic Development Manager for the city of Paso Robles, to advise him further on Paso Robles decision to create a SpacePort.

- April 8-11, 2023: Jurasin attended the annual Space Symposium in Colorado Springs, where he discussed Cal Poly's work on the Paso Robles Spaceport project, and the campuses Cleared for Success public service security training program. Jurasin met with multiple companies and agencies including Dawn Aerospace, Naval Research Lab, Stellar Exploration, Integrated Launch Solutions (ILS), AWS Argus program and Space & Satellite division teams, members of the Alaska Space Port Authority, Spaceport America, and multiple higher education attendees.

Lessons Learned

Academic groups like Cal Poly are an essential piece of connective tissue allowing for public-private initiatives to be created and function smoothly, whether this be in the form of workforce trainings like the AWS-ETP-UpSkill California platform or in the meeting and outreach Cal Poly preforms with private companies in Space commercialization field, with DoD representatives, or with various local and state government authorities.

While creating innovative workforce training programs like the AWS-ETP-UpSkill California initiative are possible, more time needs to be devoted to marketing and communications strategies to inform employers about these programs. Outreach to the business community is a difficult task in itself, one that needs time and effort to get buy-in from local employers.

Screenshots from the "Cybersecurity Incident Reporting for Executives" Course

Universities are engines of innovation through the technical advice they provide to commercial operations, most notably proven by the CubeSat Lab's support to numerous companies developing new satellite and space technologies.

Institutions of higher learning are an essential piece of the economic development engine as well, most clearly shown in the essential role Cal Poly has played to support Paso Robles movement towards creating a Space Port, a project that has the potential to transform the Central Coast's economic and technology footprint.

Groups like CCI, the DxHub, and the CubeSat Lab are able to design and create innovative solutions to technological problems and process issues felt by DoD contractors like RGNext, but it can be very difficult to find the necessary funds in existing contracts that were codified years earlier. The rigidity of budgets and the pace of the budgeting process significantly hinder the flexibility needed to pursue innovative responses in a swift manner.

Task 11.5: Deliver a 10-hour Pilot Digital Literacy and Security Curriculum to Support Space Commercialization and Manufacturing

Summary

Working at the junction between academia, government, and the private sector, CCI put in place a dynamic team and created a free, interactive educational course titled, "Cybersecurity Incident Reporting for Executives." The course is designed to address the specific needs and concerns of the discrete business vertical of CEOs and executives at small- and medium-sized companies in the Department of Defense supply chain.

Work Completed

The "Cybersecurity Incident Reporting for Executives" course is designed to educate decision makers, especially executive management, at small- and medium-sized companies in the Department of Defense supply industry on how to prepare and manage their organization through a cybersecurity incident. The effort was spearheaded by Henry Danielson, CISSO Technology advisor at CCI. To complete the task he consulted regularly with Ron McFarland at CMTC (a CADENCE partner), particularly regarding Cybersecurity Maturity Model Certification (CMMC). Danielson also worked closely with Bret Hartman, the former Vice President and Chief Technology Officer of the Security Business Group at Cisco. Hartman's insights and experiences proved invaluable for tweaking the course for the specific needs of the C-suite.

Overall, the course describes the structured approach of how a manufacturing organization will go from security incident detection to resolution. For severe incidents the organization must take steps to quickly contain, minimize, and learn from the damage. "Cybersecurity Incident Reporting for Executives" lays out the foundation to understand what procedures a manufacturing IT executive must put in place to detect and mitigate an incident. Course materials and interactive "homework assignments" review terms and describe how to prepare an incident response plan. The class also evaluates real world scenarios and case studies, showing how hackers have exploited vulnerabilities in a wide range of computing systems ranging from personal computers to nuclear power plants and critical infrastructure systems. Given the critical security risks to any manufacturing organization, the course provides essential resources and insights to train executives to understand how to prepare for an adversarial attack and ensure a safe recovery.

Here are some key aspects of the learning experience:

- Half the course is made up of asynchronous work completed over the Thinkific learning portal, including readings, videos, labs, activities, and homework.

- Half the course material in provided synchronously with regularly scheduled, instructor-led Zoom meetings.

- The Thinkific learning platform allows for tasks to be assigned as prerequisites, ensuring that learners move through the material from beginning to end, with later modules building on earlier materials.

- Some homework assignments include interactive, Learn by Doing exercises based on real work case studies. Learn by Doing is an integral part of Cal Poly's hands-on, applied learning pedagogy applied across the university.

- The course consists of four modules that build confidence and knowledge as the executive progresses through the materials.

- Module 1 introduces learners to real world examples of cyber-attacks and corporate responses to them.

- Module 2 focuses on the tools and lessons needed to create an Incident Response Handbook, including pertinent information about the Common Vulnerabilities and Exposures (CVE) database as well as the CISA Hunt and Incident Response Program (CHIRP).

- Module 3 highlights steps members of the Department of Defense supply chain can take to prepare for incidents before they occur.

- Module 4 introduces executives to strategies and procedures for remediation after an attack.

- For those students and executives looking to go further in their educational journey, the course also includes numerous links to further readings and other important resources.

Jose Anaya (El Camino College and CADENCE partner) completed a curriculum review in June 2022. Anaya included these concluding remarks in his review: "I reviewed the curriculum and it looks great! The content was rich with information and the hybrid format is ideal for the executives." He added, "This would be a great resource for our CASCADE III project SBIR companies we will be helping."

The course has been completed and available for enrollment since the end of March 2022. The final course, hosted by Thinkific can be found on the web, here. Online enrollment is streamlined and cost free. Since the beginning of the year, CCI has been working with its partners in the community and at California community colleges to market this learning opportunity.

Lessons Learned

As an institution of higher learning, Cal Poly is well-equipped to create dynamic curriculum and up-to-date course materials on cybersecurity, across numerous sectors.

There is a variety of useful and pertinent information available to create free programs for the top of the defense workforce development pipeline, filling a demonstrated gap in cybersecurity awareness.

Marketing free materials and new courses to the proper audiences and attracting significant interest to create robust enrollment has proven difficult. Future efforts should focus as much (if not more) time and effort on promoting and marketing the curriculum as producing it.

Task 11.6: Design and Implement Communications Strategy Activities

Summary

Building on Cal Poly's reputation as a thought leader, CCI worked closely with CADENCE consortium partners on a variety of communication strategies to enhance workforce development initiatives, including: producing and hosting podcasts, publishing a monthly Space & Cybersecurity Newsletter, and hosting multiple public events (two consortium support webinars and a CADENCE-related symposium).

Work Completed

Podcasts

Over the course of the grant, CCI employee Ryan Vannucci led the CCI team to fulfill its grant metrics. He produced four podcast episodes focused on the overlap of space and cybersecurity. Each podcast provides insights into the interviewee's career path, promoting stories of how to find meaningful work in the areas where defense, space, and cybersecurity overlap. By purposefully highlighting the experiences of more diverse faces in cybersecurity (specifically Eric Escobar and Preston Miller), the podcasts are designed to both inform a broader audience about the importance of cybersecurity in their lives and provide inspirational accounts to broaden the ranks of who might consider pursuing a career in Space and/or cybersecurity, thereby enhancing workforce development efforts.

Thumbnails from the "Cyber Diner" Podcast, led by Ryan Vannucci and the CCI staff, which highlighted the experiences of more diverse faces in cybersecurity, such as Eric Escobar and Preston Miller

The four episodes produced and recorded by Vannucci include roughly half-hour interviews with:

- Eric Escobar, principal consultant at SecureWorks and three-time Capture-the-Flag champion at DEFCON, "Penetration Testing & Space Security Vulnerabilities w/ Eric Escobar";

- Preston Miller, Chief Information Security Officer at NASA's Jet Propulsion Laboratory (JPL), "The Road to Space and Cybersecurity";

- Bill Britton, Cal Poly Vice President for Information Technology Services and Chief Information Officer, "Digital Transformation and Cloud Literacy"; and

- Ulf Lindquist, Senior Technical Director in the Computer Science Laboratory at SRI International, "Securing the Internet of Things (IoT)."

CCI also recorded and fully produced a podcast with Aaron Stevenson, an engineering and cyber workforce manager for the Space Force at Space and Missile Command in Southern California. Due to Stevenson's changing role at Space Force, his podcast was not approved for release by the Space Force public relations division. CCI also completed the story board and proposed the questions for a podcast episode from the series "Today in Space," in which Bill Britton discussed his STEM origin story, the importance of cybersecurity for workforce development in both commercial and defense space jobs, as well as the California Cybersecurity Innovation Challenge.

Vannucci and the CCI staff also created a full social media strategy to promote and market each podcast. CCI utilized Hootsuite to coordinate its posts, providing a detailed electronic trail available from Hootsuite reports. The team posted announcements about podcasts on Twitter and Instagram the most, and occasionally utilized Facebook. The team also listed the podcast on the CCI website, and hosted each podcast on Apple, Spotify, Google, and YouTube. The team also published show notes to help with search engine optimization. Vannucci also coordinated with guests to promote the podcasts through their networks via email sharing and social sharing. CCI also relied on its monthly Space & Cybersecurity Newsletter and information-sharing with CADENCE partners to promote all of these episodes. As a sample of theses podcasts' impact, as of August 2022, 102 people have viewed Eric Escobar's podcast and 80 people have viewed Preston Miller's podcast on YouTube.

Early in the grant period, CCI totally redesigned its website with the help of a $52,000 grant from the William and Flora Hewlett Foundation. While this effort was outside of the specific purview of CADENCE, the effort showcased CCI's ability to leverage funds from private sources to create a new web platform that strengthened the presentation and availability of the communications strategies noted in this task. Generally, the revamped website provided a much more dynamic and engaging forum to greatly improve the public facing materials CCI created, including these podcasts, as well as the newsletters and public events discussed below (visit https://cci.calpoly.edu).

List of exhibitors at the CubeSat Developers conference.

Space & Cybersecurity Newsletter

CCI published 21 issues of its Space & Cybersecurity Newsletter, vastly outperforming the original metrics which called for a quarterly (rather than monthly) newsletter. In total the electronic newsletter was sent to 11,028 addresses from 540 distinct domain names connected to the defense, education, government, and media sectors.

The Space & Cybersecurity Newsletter focuses its attention on space and cyber, two domains that have major implications for national security and geopolitics. The intersection of the two is a rapidly evolving topic that shapes how the US and other space-faring countries can peacefully operate in these domains while also keeping adversaries in check. The newsletter casts light on this intersection and seeks to provide readers an opportunity to stay up to speed with this incredibly dynamic and evolving ecosystem. From workforce development and international efforts to the cybersecurity of Space systems, the newsletter aims to help readers digest these relevant topics on a monthly basis.

Working with a team of Cal Poly faculty, including John Bellardo (professor of computer science and former director of the CubeSat Lab), Ryan Jenkins (associate professor of philosophy), Patrick Lin (professor of Philosophy and director of the Ethics + Emerging Sciences Group at Cal Poly), as well as CubeSat Lab director Ryan Jenkins, DxHub director Paul Jurasin, and the CCI staff, Davis provides a succinct clearinghouse of important articles, announcements, and analyses conglomerated from across the web, each with a short synopsis. The newsletter regularly covers:

- international events connected to actions by both allies and competitors;
- domestic events including federal and state legislative changes, announcements related to DoD policy, and deep news analyses;
- shifts in the private sector connected to the commercialization of Space;
- workforce development initiatives, studies, and opportunities; and
- announcements about important conferences, meetings, and events, including those hosted by CCI and CADENCE consortium partners.
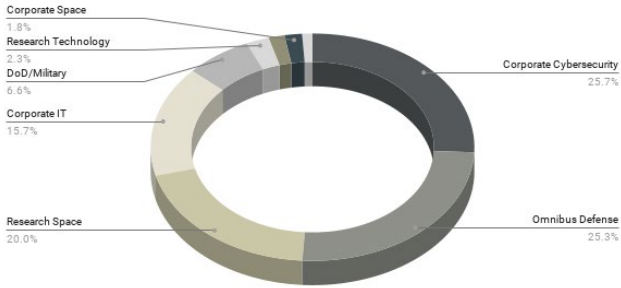
The recipient list for the Space & Cybersecurity Newsletter provides insight into groups interested in Space commercialization with a nearly even distribution of defense contractors (and potential defense contractors), government offices (federal, state, and local government bodies), and educational organizations (from K-12 groups to research-focused PhD granting universities). This insight reinforces the finding that Cal Poly has an important ability to act at the confluence of the public-private-academic partnerships that are the birthplace of new Space commercialization opportunities, particularly for small- and medium-sized businesses. As a California-focused program, outreach was greatest within the state, but the inclusion of both international recipients and recipients from other U.S. states, provides evidence of Cal Poly's and CCI's growing national and international profile, particularly in the education sector. CADENCE support and earlier DoD programs like CASCADE II have played an important role in raising this profile.

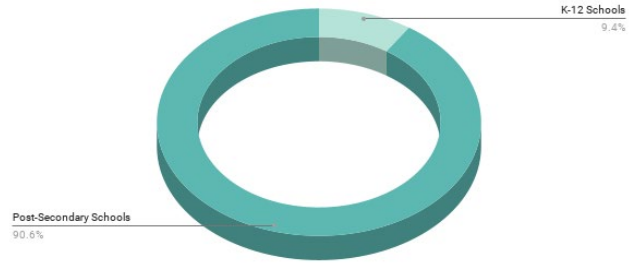*List of Space & Cybersecurity Newsletter recipients, organized by sector*

Defense Sector	
Corporate Cybersecurity	Blacksite Bugcrowd Cisco CloudStrike Darktrace Fortinet Ninjio Remediant SecureWorks Splunk Viasat
Corporate IT	Adobe CDW Deep Blue Integration Google Hewlett Packard Enterprise Netsync New Magellan Ventures International Red Hat Silicon Forensics Verizon West Yost
Corporate Space	SpaceX Terran Orbital Twigs Space
DoD/Military	NATO U.S. Air Force U.S. Space Force California Military Department
Omnibus Defense	Amazon Boeing Booze Allen Hamilton Deloitte Huntingdon Ingalls Kratos Defense Lockheed Martin Northrupp Grumman Raytheon Technologies Siemens Wesco
Research Cybersecurity	Hypergiant National Cybersecurity Center Security Executive Council
Research Security	Center for a New American Security Charles Koch Foundation Tony Blair Institute for Global Change
Research Space	Blue Residuum Space Alliance Cateni CSP Japan Jet Propulsion Laboratory (NASA) Lawrence Livermore National Laboratory Leaf Space Maverick Space NASA National Security Space Association Orbital Micro Systems Parabilis Space Technologies Quark Logic
Research Technology	IEEE NextFlex

Media Sector	
Journalism	Space News Veterans Business Journal Silicon Angle Media

Government Sector	
Federal Executive Branch	NIST TSA
Federal Legislative Branch	Senator Feinstein's Office House of Representatives
California State Executive	California Department of Education California Department of Labor California Employment Training Panel California Office of Emergency Services California Public Utilities Commission California Employment Development Department
California State Legislative	California Assembly California Senate
Law Enforcement	U.S. Department of Homeland Security Immigration and Customs Enforcement Federal Bureau of Investigation California Department of Justice California Highway Patrol Fresno Sheriff Kern County Sheriff's Office Los Angeles County District Attorney Vernon Police Department
Local and County Offices	Alameda Municipal Power Butte County Government City of Cerritos Government Delta Diablo Sanitation District Fresno County Grover Beach Los Angeles County Government Marin County Water Sacramento City Government San Jose City Government Shasta County Government Tulare City Government Ventura County Government
Research on Space	German Aerospace Center Japan Aerospace Exploration Agency Mexican Space Agency

Education Sector	
K-12	Atascadero Unified School District Elk Grove Unified School District Fairfax County Public Schools Los Angeles Unified School District West Contra Costa Unified School District
Post-Secondary	Alamo Colleges District Cal Maritime California State University Bakersfield California State University Chico California State University Dominguez Hills California State University Fresno California State University Fresno California State University Long Beach California State University Los Angeles California State University Northridge California State University Stanislaus California State University System California State Unviersity Channel Islands Contra Costa Community College CSU East Bay Oxford University (UK) Georgetown University Howard University Los Rios Community College District Merced College Naval Postgraduate School Pepperdine University University of California Davis University of California LA University of California Riverside University of California San Francisco University of Maryland Baltimore County Training Centers University of the Cumberlands University of Washington Ventura County Community College District

Space & Cybersecurity Newsletter recipient analytics, organized by sector

Defense Sector Analytics

Corporate Space
1.8%
Research Technology
2.3%
DoD/Military
6.6%
Corporate IT
15.7%

Corporate Cybersecurity
25.7%

Research Space
20.0%

Omnibus Defense
25.3%

Education Sector Analytics

K-12 Schools
9.4%

Post-Secondary Schools
90.6%

Government Sector Analytics

Space Research
2.1%
Federal Legislative
3.0%
California State Legislative
6.1%
California State Executive
11.5%

Law Enforcement
15.5%

Local and County Govt
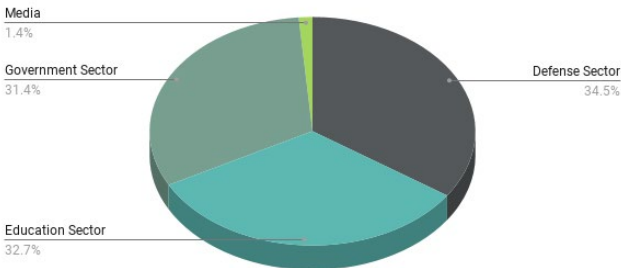60.5%
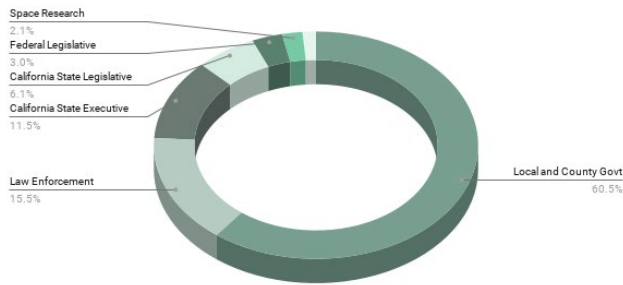
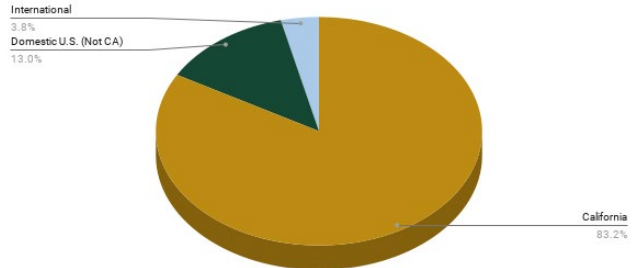*Overall engagement and geographic breakdown for the*
Space & Cybersecurity Newsletter

Overall Engagement Breakdown

Media
1.4%
Government Sector
31.4%

Defense Sector
34.5%

Education Sector
32.7%

Overall Geographic Breakdown

International
3.8%
Domestic U.S. (Not CA)
13.0%

California
83.2%

Public Events

CCI also accessed a third medium to increase the public impact of its own CADENCE-related activities and the activities by CADENCE consortium partners: in person events open to the public. First, CCI helped organize and coordinate two CADENCE-related support symposia—by ETP and Cal Poly's DxHub. CCI also planned and hosted a CADENCE showcase for California manufacturers and companies in the space sector. All three events were scheduled to overlap with the Annual CubeSat Developers' Workshop, leveraging Cal Poly's leadership in the small satellite field to increase CADENCE impact in this vital and growing sub-field of Space commercialization with clear connections to the defense sector (as explained in the overview section of the report).

The 16th Annual CubeSat Developers' Workshop brought together CubeSat developers from academia and industry to share their knowledge and experience developing small satellites using the increasingly popular small satellite platform. There were two key-note speakers (Florence Tan, Deputy Chief Technologist and Chair of the Small Spacecraft Coordination Group [SSCG] at NASA Headquarters, and Doug Hulse, Space Mission Program Manager at Millennium Space Systems), representing different segments of the community. Workshops, talks, and panels ranged in subject from emerging technologies and new developments in the field to mission success stories and current design considerations. Exhibitors from industry were in attendance to offer information and discussion of their own experiences and rolls within the community. The event occurred in person on Cal Poly's conference, and proceedings were live-streamed over YouTube.

Stellar Exploration president Dr Tomas Svitek, Paso Robles Mayor Steve Martin, Cal Poly President Jeffrey Armstrong, and CCI Director Bill Britton

The Cal Poly, City of Paso Robles, and Stellar Exploration team celebrates signing the letter of intent for the Space Port that will advance space commercialization efforts.

At the end of Day 1 of the CubeSat Developers conference (April 26), Robert Meyer from ETP led a session titled simply "Workforce Development," on workforce development strategies in California and the services ETP can provide to small manufactures in the small satellite community. A number of California-based defense manufacturers working in Space commercialization attended the CADENCE Showcase on April 29 specifically to speak with Meyer about the workforce training opportunities supported by ETP. (For a recording of the live session, see this YouTube recording, running from 8:00:12 to 8:13:10. Day 1's proceedings have been streamed more than 3,100 times on YouTube.)

On Day 2 of the conference, Paul Jurasin (DxHub director), Paul Sloan (Economic Development Manager for the City of Paso Robles), and two Cal Poly students (Alice Sukhovstavskiy and Lily Turkstra) presented on "Digital Transformation and the Student Experience – Spaceport Planning," highlighting the important workforce development aspects implicit in the DxHub and Cal Poly's increasing interaction with the City of Paso Robles to create a commercial spaceport at the city's regional airport. (For a recording of this live session, see this YouTube recording, running from 5:46:30 to 6:00:54. Day 2 has been streamed more than 2,400 times on YouTube.)

Selected Groups Represented at the CADENCE SHOWCASE at Cal Poly CubeSat

Directly following this presentation, Cal Poly President Jeffrey Armstrong and Paso Robles Mayor Steve Martin signed a Letter of Intent in support of Paso Robles' ongoing work to transform its municipal airport into a Space Port. Paso Robles Mayor Martin also signed a Letter of Intent with Dr. Tomas Svitek, the president of Stellar Exploration, a California-based company that focuses on affordable aerospace projects with a proven track record of delivering working solutions for military, civil, and commercial customers. The signing ceremony was a symbolic testament to the importance of both the CubeSat Lab's and the DxHub's role in helping to foster this important educational and economic development opportunity. (See task 11.4 for more details.)

As the City of Paso Robles Council noted on March 29, 2022, when discussing signing this letter of intent, there are only currently 13 space ports in the United States. Moreover, "receiving a Federal Aviation Administration (FAA) spaceport designation will allow the City to market the spaceport to firms wishing to conduct research, manufacturing, or launch small-scale satellites and attract high-paying space tech-related jobs. As a launch and landing site for suborbital, reusable launch vehicles as well as a center for innovation, a spaceport can offer a range of economic development opportunities including site leasing, laboratory office space including technology incubator space, and hardware production facilities."

Cal Poly faculty, Cal Poly staff, the DxHub's Paul Jurasin, and CubeSat Lab's Ryan Nugent have already been playing an essential advisory role for the City of Paso Robles regarding this spaceport opportunity. For Cal Poly, CCI, and the DxHub this letter of intent allows the university to continue to pursue Learn by Doing opportunities for Cal Poly students, particularly in the Aerospace Department and College of Engineering, increasing the footprint of the University's educational mission. Both partners are also fostering a symbiotic relationship with this letter of intent in hopes of creating more high-tech and manufacturing jobs to retain more highly qualified Cal Poly graduates employed by companies on the Central Coast, further enhancing the university and the space port's economic impact.

This is exactly the kind of economic development and community impact that CCI is meant to have on the Space commercialization sector through CADENCE. Both Paso Robles' economic development planning and Cal Poly's educational goals fit perfectly within the broad goals of the CADENCE program and CCI's specific tasks within

the grant. This grant's impact (by fostering Cal Poly's relationship with Paso Robles in Space commercialization, potential manufacturing and R&D, and space tech) is a monumental win for the region, for California, and for CADENCE.

The day after the conclusion of the CubeSat Developers Workshop, the CCI hosted the CADENCE Showcase at Cal Poly CubeSat from 8 am to noon. The showcase was scheduled at this time to attract CubeSat Developers Workshop participants before they returned home. The California Office of Planning and Research's Chief Deputy Director Scott Morgan and CADENCE Program Manager Eileen Sanchez opened the symposium and welcomed participants.

Sessions for the Showcase included the following topics:

- Chris Buthe from CMTC, led a threat briefing for the space ecosystem that included focuses on "Nation State Threats," "Insider Threats," and "Cyber Threats" all run by CMTC cybersecurity experts.

- Jo Marie Diamond, East County Economic Development Council chaired a session during which Jose Anaya (El Camino College) discussed "Talent Acquisition and Upskilling with California Community Colleges," Robert Meyer (ETP) spoke on "Leveraging California's ETP to upskill your incumbent workforce," and Charles Eason and Alan Braggins (California Community Colleges) led a discussion on how to "Educate, Train, Connect, and Inspire our Future Workforce";

- Ed Hendricks (NextFlex) spoke about "Technical Assistance in Flexible Hybrid Electronics Manufacturing for Emerging Defense Manufacturing Companies through CADENCE";

- Martin Minnich (CCI) led a panel including Steve Rogers (Range Technical Director, USSF Vandenberg), Paul Jurasin (Director, DxHub), and Nick Osterbur (Digital Innovations Lead, DxHub) on "Digital Transformation Hub for Space Applications"; and

- Lisa Easterly (CEO, Cybersecurity Center of Excellence) chaired a panel titled, "Practical to Tactical: Industry and Academic Solutions to DoD-Championed Challenges," which included John Armantrout (U.S. Naval War System's Command), Darren Bennet (CISO, City of San Diego), and Jesse Gipe (National Security Innovation Network).

Scott Morgan offered closing remarks. Food and beverages were provided throughout the program, which included both in person presentations and virtual material. In total about 50 people attended the Showcase, including a number of individuals from the 533 Training Squadron at Vandenberg SFB.

Lessons Learned

Workforce development is a complex field requiring engagement with constituencies across all levels of government, the private sector, and education. Given its experience forging public-private-academic partnerships, Cal Poly is well suited to excel in these endeavors.

Newsletters, although technologically plain, retain their power to reach large audiences with targeted messages easily, efficiently, and inexpensively.

With the podcast market saturated, it can be difficult to differentiate yourself and create large viewing audiences, even when those podcasts are exposing important personal stories.

Although engagement through virtual means can be powerful, traditional face-to-face events have retained their ability to create breakthrough moments when engaging with constituents and finding new potential partners.