Smead Aerospace
UNIVERSITY OF COLORADO **BOULDER**

Link to RSVP

Smead Aerospace Student Projects Symposium 2023

You are invited to attend the Smead Aerospace Engineering Sciences Department showcase of senior and graduate student projects for 2023. Teams will exhibit their projects in the morning in an informal poster session and demonstration of the prototypes and present their work in executive summaries in the afternoon (see the agenda below). **Students with a green dot on their nametags are seeking employment opportunities.**

Please help us recognize the excellent work of our students!

When: Friday, April 21st, 2023, 8:45am – 3:15 pm, Tour of the Aerospace Building 3:15 - 4:30pm

Where: Aerospace Engineering Sciences Building - 3775 Discovery Dr, Boulder, CO 80303

Parking Information: https://www.colorado.edu/aerospace/about-us/visit-us

RSVP Link: https://www.colorado.edu/aerospace/senior-and-graduate-projects-symposium-rsvp

More Information: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects
https://www.colorado.edu/aerospace/current-students/graduates/graduate-projects

Information About Sponsoring Senior/Graduate Projects: https://www.colorado.edu/aerospace/industry

8:45am MDT	**Welcome by Smead Aerospace Department Associate Chair, Dr. Kurt Maute (AERO 111)**					
9:00am – 11:00am	**9:00 – 11:00am Poster Session and Demonstrations of the Prototypes (Aerospace Building, 1st Floor Lobby)**					
11:00am – 11:45am	**Lunch Break - Aerospace Building Backyard (North Patio)**					
11:45am – 12:35pm	**Keynote Speaker: "Artemis I Mission" Dr. Timothy M. Straube, Deputy Manager, Orion Program's Office of Avionics, Power & Software; NASA Johnson Space Center, (AERO 120)**					
12:40pm – 3:15pm	**Presentations** (Graduate Projects in italics, *Senior Projects Pilot Program)					
	Space Track		**Aircraft, Autonomous Systems & GNC Track**		**Sensing Track**	
	Team	**Room**	**Team**	**Room**	**Team**	**Room**
12:40 – 12:53pm	**BOOST***	AERO 120	**TEAM SEVEN***	AERO 111	IICE	AERO 114
12:56 – 1:09pm	**CRATER***		**CARROT***		Etna	
1:12 – 1:25pm	**The Icebox***		**AMADEUS***		MUSIC	
1:28 – 1:41pm	**LunaSim***		SAILR		HOMiE	
1:44 – 1:57pm	**HEIST***		GAINS		ProBE	
2:00 – 2:13pm	**C-THREEPIO***		MARCoPoLo		CU-LATR	
2:16 – 2:29pm	DAISy Cam		*CANVAS*		WIIGLS	
2:42 – 2:55pm	*SWARM-EX*		*SURGE*		ABSTRACT	
2:58 – 3:11pm	*MEDICS*		*RALPHIE*		*FLARE*	
3:15pm – 4:30pm	**Tour of the Aerospace Building – (Please meet in the Aerospace Lobby)**					

2023 Team Sponsors and Mentors

2023 Senior Projects

Acronym	Name and Website	Description
ABSTRACT	**Automated Battery System for Testing Reliability and Continuity Tool** Sponsor: EnerSys Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/automated-battery Presentation Track & Room: Sensing Track,	Team ABSTRACT's objective is to create an automatic system that will replace a technician in testing continuity, voltage, resistance, and isolation for EnerSys batteries. Technicians usually spend over 2 hours manually testing batteries. This system will allow the technician to administer a test automatically and then come back to finalize results. This test is necessary to determine flight readiness for space missions.

Acronym	Name and Website	Description
	AERO 114	
AMADEUS*	**Additively Manufactured Aerial Drone for Emergency Unmanned Surveillance** Pilot Program Topic: Low Budget Additive Manufactured Unmanned Aerial System Airframe Design Pilot Program Mentor: AeroVironment Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/additively Presentation Track & Room: Aircraft, Autonomous Systems & GNC Track, AERO 111	Team AMADEUS is a continuation of the HERD-CU project. The team is tasked with designing a small, low cost, and easily manufacturable UAV/UAS that is capable of being transported and launched by a single person. Its mission is to provide radio relay in remote and austere environments and act as a mission overwatch platform. Additionally, 90% of the aircraft must be built through additive manufacturing technologies and consumer off-the-shelf (COTS) materials.
BOOST*	**Bi-Functional On-Orbit Space Transfers** Pilot Program Topic: Cislunar Space Infrastructure - Navigation & Power Pilot Program Mentor: Ball Aerospace Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/bi-functional-orbit Presentation Track & Room: Space Track, AERO 120	Team BOOST is developing a cost-effective space-based transportation system capable of providing spacecraft with the ability to conduct orbit transfers while simultaneously optimizing maneuver cost, power requirements, and navigation services. The system architecture will provide users the capability to conduct an orbit transfer to trajectories of interest through a transfer of energy while successfully navigating itself. BOOST will be conducting trades studies on each of the chosen high-level objectives of navigation, power services, and return on investment to design a cislunar infrastructure that will find the ideal solution to this problem.
C-THREEPIO*	**Capabilities Training using Hybrid Reality Extraterrestrial Environments in Preparation for Interplanetary Operations** Pilot Program Topic: Lunar Virtual and Physical Hybrid Reality Training System Pilot Program Mentor: Blue Origin Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/capabilities-training Presentation Track & Room: Space Track,	C-THREEPIO is a hybrid-reality simulation that will provide immersive training for human exploration missions on the lunar surface. C-THREEPIO will build capabilities for integrating physical, real-world interactions into an accurate, high-fidelity virtual reality simulation, and will incorporate spacesuit and environmental parameters to create a realistic experience. Specifically, the simulation will aim to provide accurate training for geology-focused EVAs at the lunar South Pole.

Acronym	Name and Website	Description
	AERO 120	
CARROT*	**Compact Aerial Radio Relay for Obscure Terrain** Pilot Program Topic: Low Budget Additive Manufactured Unmanned Aerial System Airframe Design Pilot Program Mentor: AeroVironment Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/compact-aerial-radio Presentation Track & Room: Aircraft, Autonomous Systems & GNC Track, AERO 111	Team CARROT is developing an easily manufacturable, low cost UAS using additive manufacturing techniques. This UAS can be used for purposes such as setting up a communication relay in places such as the mountains for use of emergency services. Team CARROT's UAS is easily transportable and can be deployed in various situations, while also having increased flight endurance due to its aerodynamic design.
CRATER*	**Communications Relaying And Targeted Energy Transfer** Pilot Project Topic: Cislunar Space Infrastructure – Power & Communications Pilot Program Mentor: The Aerospace Corporation Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/communications Presentation Track & Room: Space Track, AERO 120	Team CRATER seeks to provide power and communications logistics to organizations that seek to establish their infrastructure on the Moon. More specifically, the team anticipates a great increase in cislunar operations within the next decade or two. This project will allow companies to tap into a pre-established way of receiving power and communications support which will expedite their processes to further the reach of humanity.
CU-LATR	**CU-Light Aerosol Trace Recognition** Sponsor: Ball Aerospace Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/light-aerosol-trace Presentation Track & Room: Sensing Track, AERO 114	The focus of CU-LATR's NanoSAM-IV project is to expand upon previous NanoSAM years' work by demonstrating the ability to detect and record light measurements via a photodiode. The photodiode will detect light from a stable light source as an analog signal; an ADC will convert the analog signal into a digital format. The relevance of this work pertains directly to satellites' abilities to detect levels of aerosol, ozone, and other particles within the Earth's atmosphere.

Acronym	Name and Website	Description
DAISy Cam	**Docking Arm Integration System for ScoutCam Camera** Sponsor: Astroscale Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/docking-arm Presentation Track & Room: Space Track, AERO 120	Team DAISy Cam team is working to integrate a ScoutCam micro camera into the end of Astroscale's LEXI vehicle's docking arm as well as develop a video card solution to support these cameras. This camera will assist in the final phases of LEXI's docking to a client vehicle. By developing a scaled model of the docking arm, the team will design an interface for the camera to attach to the arm. This will be tested along with DAISy Cam's video card solution to ensure the camera is mounted securely and can transmit data to the video card.
Etna	Sponsor: ASTROBi Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/etna Presentation Track & Room: Sensing Track, AERO 114	Team Etna is designing a 1U Digital Inline Holographic Microscope (DIHM) capable of identifying microbes in fluid samples. This includes the design and production of the DIHM as well as supporting algorithms to analyze samples on-board the spacecraft.
GAINS	**General Atomics Inertial Navigation System** Sponsor: General Atomics Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/general-atomics Presentation Track & Room: Aircraft, Autonomous Systems & GNC Track, AERO 111	GAINS is an inertial navigation system that will be designed for use on various CubeSats in a cislunar mission when GNSS is not an option. This Inertial Navigation System (INS) will design a sensor suite to understand the Attitude Determination (AD) and Orbit Determination (OD) aspects of the mission. Project GAINS will feed relevant AD and OD data back to the parent spacecraft and to various ground stations while also receiving error and drift minimizing corrections from the ground station.
HoMIE	**Holographic Microscope Investigating Enceladus** Sponsor: ASTROBi Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-	The goal of HoMIE is to prototype a flight-like holographic microscope suitable for ASTROBi's mission to Enceladus. ASTROBi is developing a low-cost astrobiology mission to Enceladus, a moon of Saturn that is spewing plumes of water into space. The mission will send a small orbiter to fly through the plumes and collect ice grains. The grains will then be melted in a closed chamber and transferred to a holographic microscope for analysis.

Acronym	Name and Website	Description
	2023/holographic Presentation Track & Room: Sensing Track, AERO 114	
HEIST*	**Hybrid Environmental Immersive Simulation Training** Pilot Program Topic: Lunar Virtual and Physical Hybrid Reality Training System Pilot Program Mentor: Blue Origin Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/hybrid-environmental Presentation Track & Room: Space Track, AERO 120	HEIST is an EVA habitat maintenance and repair Hybrid Reality (HR) training system for lunar missions. It consists of an immersive Virtual Reality (VR) environment that is paired with a Physical Reality (PR) interface. The user can enter the VR and interact with it by acting on the physical hardware elements. The training system includes VR simulated lunar environmental constraints as well as PR upper-body constraint to mimic the range-of-motion limitations of an actual EVA spacesuit.
IICE	**Ice Impact Characterization around Enceladus** Sponsor: ASTROBi Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/ice-impact Presentation Track & Room: Sensing Track, AERO 114	Team IICE's project is to create a proof-of-concept electrostatic sensor for a mission to Enceladus. Enceladus has large ice geysers that spew microscopic ice particles into the upper atmosphere. This sensor is tasked with determining when the satellite encounters these icy particles and characterizing their size, weight, density, etc.
LunaSim*	**Lunar Simulation** Project Topic: Astronaut Hybrid Training Environment Suspension System Pilot Program Mentor: EchoStar Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/lunar-simulation Presentation Track & Room: Space Track, AERO 120	The LunaSim team is designing a suspension system off-loader for astronaut lunar simulation training. The system will allow users to experience a 1/6th gravity environment here on earth while performing a series of hybrid reality mission objectives. Like NASA's ARGOS or reduced-gravity aircraft, astronauts will use LunaSim's system to better prepare for a variety of gravity conditions to further advance the exploration of the moon and beyond.
MARCo PoLo	**Mobile Astronautic Ranging and Control**	MARCo PoLo is designing and prototyping a sensor

Acronym	Name and Website	Description
	for Positioning and Location Sponsor: Lockheed Martin Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/mobile-astronautic Presentation Track & Room: Aircraft, Autonomous Systems & GNC Track, AERO 111	suite for a Lockheed Martin CubeSat like LINUSS. The intention of the CubeSat is to provide on-orbit servicing to existing satellites. The team is tasked with developing an algorithm and processor to refine raw sensor data into relative measurements that informs the CubeSat of location and navigation. MARCo PoLo will test the sensor suite this April at Lockheed's Space Operations Simulation Center (SOSC) facility.
MUSIC	**Micro-particle Unidirectional Sensor for Ice Collisions** Sponsor: ASTROBi Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/micro-particle Presentation Track & Room: Sensing Track, AERO 114	Team MUSIC is tasked with developing a prototype of an acoustic sensor for the company ASTROBi. The purpose of this sensor is to be sent in low orbit around one of Saturn's moons, Enceladus, which expels plumes of ice from the interior liquid layer under its surface. This sensor is tasked with determining when the satellite encounters these icy particles and characterizing their size, weight, density, etc. These particles will then be sampled by the holographic microscope being designed by an adjacent team.
ProBE	**Programmable Battery Examiner** Sponsor: EnerSys Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/programmable-battery Presentation Track & Room: Sensing Track, AERO 114	The ProBE team is developing an automated functional battery tester that would be used to verify flight readiness of Li-ion batteries. Currently, a trained technician takes measurements on hundreds of battery pin combinations by hand over the course of a day using a handheld digital multimeter. This is not only time consuming, but a waste of human resources. ProBE aims to provide such a technician with a GUI controlled tool that would automate this tedious process in a safe and reliable manner.
SAILR	**Semi-Autonomous Imaging Land Rover** Sponsor: Jet Propulsion Laboratory Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/semi-autonomous Presentation Track & Room: Aircraft, Autonomous Systems & GNC Track, AERO 111	The semi-autonomous imaging land rover (SAILR) team is tasked with designing, integrating, and testing a small surveillance-based rover intended for usage in hazardous environments not suitable for human exploration. The rover will be capable of navigating terrain and avoiding obstacles with real-time path planning to reach a target destination specified by the user ground station. Live video and manual control will also allow for user control in situations which demand active human control. The compact rover enables high mobility and access to restricted spaces with potential space exploration and/or law enforcement applications.

Acronym	Name and Website	Description
TEAM SEVEN*	**Trajectory Efficient Autonomous Mission for Surveillance, Endurance, and Vehicle Energy Need** Pilot Project Topic: Advanced Controls System for High Endurance Unmanned Aerial System Pilot Project Mentor: N/A Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/trajectory-efficient Presentation Track & Room: Aircraft, Autonomous Systems & GNC Track, AERO 111	In emergency situations, first responders need a reliable, high-performance means of communication. This is where TEAM SEVEN comes in. TEAM SEVEN is focused on developing enhanced automation of aircraft energy and mission management for a small unmanned aerial system (UAS) to aid first responders in remote areas. By creating an advanced controls system, TEAM SEVEN's goal is to improve the endurance of a standard mission to reduce workload and establish constant communications in isolated environments.
The Icebox*	Pilot Project Topic: Cislunar Space Infrastructure: Fuel Mining & Power Pilot Program Mentor: Ball Aerospace Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/icebox Presentation Track & Room: Space Track, AERO 120	The Icebox is designing a systems infrastructure that will produce resources such as fuel, water, etc. to reduce the cost of space missions. The design will include mining, storage, and processing, and distributing to customers. Additionally, the infrastructure will provide enough power for operation. The overall goal is to achieve return on investment through this process.
WIIGLS	**Weightless Integrated Instrument for Ground-based-deployable Laboratory Sensor** Sponsor: Dr. Francisco López Jiménez Project Website: https://www.colorado.edu/aerospace/academics/undergraduates/senior-design-projects/past-senior-projects/2022-2023/weightless-integrated Presentation Track & Room: Sensing Track, AERO 114	In the study of deployable space structures, it is vital to experimentally characterize all aspects of the deployment dynamics to reduce risk when unfolding on-orbit. There is a need for accurate, swappable, low-cost sensors that can measure the dynamics of these panels in-situ without extravagant cost or complexity. WIIGLS' mission is to create a compact, modular sensor suite to characterize the dynamic motion of a ground-based, deployable panel structure.

2023 Graduate Projects

Acronym	Name and Website	Description
CANVAS	**Climatology of Anthropogenic and Natural VLF wave Activity in Space** Sponsor: National Science Foundation Website: https://www.colorado.edu/aerospace/academics/graduates/graduate-projects/2022-2023-projects/climatology-anthropogenic-and-natural-vlf Presentation Track & Room: Aircraft, Autonomous Systems & GNC Track, AERO 111	The Climatology of Anthropogenic and Natural VLF Wave Activity (CANVAS) CubeSat mission will make continuous observations of very low frequency (VLF) waves in low-Earth orbit originating from lightning and ground-based transmitters. CANVAS is a 4U CubeSat that was funded in February 2019 by the National Science Foundation.
FLARE	**Falling Aerogel Re-entry Experiment** Sponsor: Johns Hopkins Applied Physics Laboratory (APL) Website: N/A Presentation Track & Room: Sensing Track, AERO 114	Design, build, and test of aerogel encapsulated GPS receivers that are launched to the edge of space to explore a potentially cheaper option for performing future high-altitude research.
HERD	**Human Landing System (HLS) Environmental Control and Life Support System (ECLSS) Research and Design** Sponsor: Dr. James Nabity Website: https://www.colorado.edu/aerospace/academics/graduates/graduate-projects/2022-2023-projects/hls-eclss-research-and-design-herd Presentation Track & Room: N/A, poster, and demo only	The HERD Project is focused on the design & development of an Environmental Control & Life Support System (ECLSS) for Northrop Grumman's Human Landing System (HLS). It will support a crew of four on the lunar surface for approximately 31.8 days and will house the major components necessary to keep the crew alive and healthy while on the surface. The crew will be performing EVAs on the surface through an airlock system. The HERD team will be responsible for subsystems regarding atmospheric pressure, temperature and humidity control, and structures and fabrication. The team is made up of five members working with Professor James Nabity and Mr. Stuart Tozer, to create a point of departure estimate for the ECLSS system which will be used in a lunar environment.

Acronym	Name and Website	Description
MAXWELL	**Multiple Access X-band Wave Experiment Located in LEO** Sponsor: University Nanosatellite Program - Air Force Research Laboratory Website: https://www.colorado.edu/aerospace/academics/graduates/graduate-projects/2022-2023-projects/multiple-access-x-band-wave-experiment Presentation Track & Room: N/A poster, and demo only	MAXWELL is a student-led CubeSat team helping pave the way for enhanced RF communications and navigation applications. CU Boulder is building the 6U MAXWELL CubeSat as part of the University Nanosatellite Program funded by the Air Force Research Laboratory. MAXWELL is expected to fly by the end of 2023 and will continue nominal and experimental operations into 2024. The mission is to demonstrate and raise the technology readiness level of X-band radio systems compatible with the NASA Near Earth Network.
MEDICS	**Medical Emergency Designers for Interplanetary Crisis Situations** Sponsor: Trinity Team, led by CU AES professor Dr. Allison Anderson Website: N/A Presentation Track & Room: Space Track, AERO 120	The MEDICS team will be designing a Mars Medical Module (MMM) to be a self-contained, transportable, medical module that supports a crew of four up to one year. The medical module will be used for the Medicine in Space and Surface Environments (MiSSE) class, in support of students learning hands-on medical techniques to be used in the space environment.
RALPHIE	**Radio and Laser Path Agnostic Communications Experiment** Sponsor: BLUECUBE, Amplified Space, University Nanosatellite Program Website: https://www.colorado.edu/aerospace/academics/graduates/graduate-projects/2022-2023-projects/radio-and-laser-path-agnostic Presentation Track & Room: Aircraft, Autonomous Systems & GNC Track, AERO 111	The Radio and Laser Path Agnostic Communications Experiment (RALPHIE) is a cube satellite selected for development as a part of the 11th group of satellites funded by the Air Force Research Laboratory's (AFRL) University Nanosatellite Program (UNP). RALPHIE aims to break down CubeSat barriers of data throughput and electrical power system (EPS) development time through flight demonstration of a Path-Agnostic Communication (PAC) System, a high-throughput optical communication link, both developed by Blue Cubed, and Amplified Space's Software-Defined Power Controller (SDPC) charge controller. RALPHIE is designed to be a 6U CubeSat that draws on flight heritage from the MAXWELL and SWARM-EX CubeSats. As part of UNP, RALPHIE will participate in the Flight Selection Review in January of 2024 where it has the possibility to be chosen for launch.

Acronym	Name and Website	Description
SURGE	**Surface-water UAV Reflectometry GNSS Experiment** Sponsor: Dr. Yang Wang/Dr. Jade Morton Website: https://www.colorado.edu/aerospace/academics/graduates/graduate-projects/2022-2023-projects/surface-water-uav-reflectometry-gnss Presentation Track & Room: Aircraft, Autonomous Systems & GNC Track, AERO 111	Inland water bodies (IWB's) such as rivers and lakes provide important ecological, environmental, hydrological, and socioeconomic services to mankind. The distribution of water and its changes over time are central to many agricultural, environmental, and ecological systems. They are also fundamental to developing theories and understanding the impacts of human activities and climate change on water resources; yet knowledge of changes in the volume of water stored and flowing in the rivers, lakes, and wetlands is poor. The SURGE (Surface-water UAV Reflectometry GNSS Experiment) project aims to design and test a UAV-based system that can fill these knowledge gaps and determine IWB surface slopes, height, and dimensions more rapidly and at higher resolution than current techniques. This will be done by collecting direct global navigation satellite system (GNSS) signals and reflected GNSS signals from lake and river surfaces, precisely logging UAV position data, and recording continuous ground footage of the UAV surroundings.
SWARM-EX	**Space Weather Atmospheric Reconfigurable Multiscale Experiment** Sponsor: National Science Foundation Website: https://www.colorado.edu/aerospace/academics/graduates/graduate-projects/2022-2023-projects/space-weather-atmospheric-reconfigurable Presentation Track & Room: Space Track, AERO 120	Space Weather Atmospheric Reconfigurable Multiscale Experiment (SWARM-EX) is an NSF-funded mission to launch three identical CubeSats into LEO to investigate advanced scientific phenomena in the upper-atmosphere and demonstrate novel formation flying capabilities using a cutting-edge hybrid control scheme which harnesses both propulsion and differential drag. This is an inter-collegiate CubeSat initiative, with contributions from CU Boulder, Stanford University, Georgia Institute of Technology, Western Michigan University, University of Southern Alabama, and Olin College. Each 3U CubeSat will be equipped with a low-rate UHF radio, a high-rate X-Band data downlink, and a scalable cold-gas propulsion system to demonstrate the key technologies of on-board autonomy, inter-satellite links, propulsion, and multiuser communications. A FIPEX neutral oxygen sensor and a Langmuir Probe measuring ion density will also be onboard to address scientific questions related to the spatial and temporal variability of the equatorial ionization anomaly (EIA) and equatorial thermospheric anomaly (ETA).