Sponsorship Opportunity:
Capstone Projects

Introduction

Capstone projects offer companies direct access to highly trained, intensely motivated students applying their advanced skills and expertise to a wide range of challenges and opportunities.

Working with faculty supervision, teams focus on sponsor-defined projects that result in the exploration of solutions and potentially a proof-of-concept or prototype. Capstones are the culmination of the graduate or undergraduate program experience.

Sponsors Can Expect

- A team of two to eight students focused on a sponsor defined project over one or two semesters.
- Faculty supervision, and mid-term and final presentations.
- Capstones often deliver a publication-quality report and a conference-style presentation. Many of the teams publish their results in top-tier conferences and workshops.

Benefits

- Exposure to innovative, insightful ideas.
- Access to highly trained students for problem-solving and recruitment purposes.
- Developing relationships with world-renowned faculty.
- Building brand awareness within the campus community.
- Input on the problem statement from Carnegie Mellon professor(s).
- Licensing options to student work product(s) developed during the course.

Requirements

- A problem to solve and/or data to analyze.
- A company mentor who is available for a specified number of contacts and meetings with the student team.
- A signed Educational Project Agreement.
- Payment of the capstone fee.

Sample Project Themes

- Develop a new technology product offering (from ideation to commercialization).
- Optimize a delivery distribution network.
- Complete customer discovery.
- Develop autonomous robots.
- Perform market analysis.
- Implement AI systems responsive to market needs.
- Conduct technical research and feasibility evaluation.
- Evaluate privacy enhancing technologies for organizations.

Carnegie Mellon University
School of Computer Science

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At-a-Glance

Pg.	Capstone Programs (Master's)	Date	Sponsorship Fee
3	**Master of Science in Automated Science (MSAS)**	● **September – December** *(fall semester)* **January – May** *(spring semester)*	$5,000 – $15,000 per team, 3-5 teams
3	**Master of Educational Technology and Applied Learning Sciences (METALS)**	**January – August**	$80,000, 4-6 students per team *(discounts for qualifying start-ups and non-profits)*
4	**Master of Human-Computer Interaction (MHCI)**	**January – August**	$85,000 *(for-profit company fee)* $40,000 *(early stage/start-up)* No fee *(non-profit)*
5	**Master of Science in Product Management (MSPM)**	**April – December**	$10,000 or less, depending on the size of the company
5	**Rapid Prototyping of Computer Systems**	**January - May** *(spring semester)*	$10,000 per team, 30-40 students
6	**Master of Software Engineering Degree Program (MSE): "Studio Project"**	**January – December** *(three semesters)*	$30,000 per project $25,000 per project *(non-profit)* 4-5 students per team
7	**MSE–Scalable Systems (SS) and MSE–Embedded Systems (ES) Programs: Software Engineering Practicum**	● **September – December** *(fall semester)*	$13,000 per project $10,000 per project *(non-profit)* 4-8 students per team
7	**Master of Science in Privacy Engineering (MSPE)**	● **Primarily September – December** *(sometimes in the spring or summer)*	$25,000 per team *(discounts available for early startups and non-profits)*
8	**Master of Computational Data Science (MCDS)**	**January – December**	$40,000 *(using public data)* $80,000 *(using private data)*
8	**Master of Science in Intelligent Information Systems (MIIS)**	**January – December**	$40,000 per team, teams of 2-4 students
9	**Master of Science in Artificial Intelligence and Innovation (MSAII)**	**September – May** *(fall and spring semesters)*	$25,000 *small entity (<300 employees)* $50,000 *large entity (300+ employees)*
10	**Master of Science Robotic Systems Development (MRSD)**	**January – December** *(with a summer break)*	$15,000 per student, 4-5 students per team, with a $60,000 maximum *(discounts available for startups)*
10	**Master of Science in Computer Vision (MSCV)**	**Mid-January to early December** *(with a summer break)*	$15,000 per student *(2 student minimum)*
10	**Robotics Systems Engineering and Robotics Capstone (additional Undergraduate major in Robotics)**	● **September – December** *(fall semester)* **January – May** *(spring semester)*	$2,500 per team, 4-7 teams; $10,000 for all projects

Pg.	Capstone Programs (Undergraduate)	Date	Sponsorship Fee
11	**Human-Computer Interaction Undergraduate Project**	**January – May** *(spring semester)*	No fee
11	**Mechatronic Design**	**January – May** *(spring semester)*	$10,000; 3-5 students per team

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Computational Biology Department

Master of Science in Automated Science (MSAS)

○ **September – December (fall semester) | January – May (spring semester)**
Sponsorship Fee: $5,000 – $15,000 per team, 3-5 teams

The MSAS program trains practitioners in the design, implementation, and application of laboratory automation and artificial intelligence in biological research. Students train with world-class faculty, including those from the top-ranked School of Computer Science. Graduates become leaders in the emerging paradigm of Automated Science — the combination of robotic scientific instruments, Machine Learning, and Artificial Intelligence for iteratively building predictive models from experimental data and selecting new experiments to improve them.

PROGRAM LEAD Josh Kangas, Assistant Teaching Professor

Human-Computer Interaction Institute

Master of Educational Technology and Applied Learning Sciences (METALS)

January – August
Sponsorship Fee: $80,000, 4-6 students per team *(discounts for qualifying start-ups and non-profits)*

Our graduates answer Carnegie Mellon University professor and Nobel Laureate Herb Simon's observation that "Improvement in education will require converting teaching from a solo sport to a community-based research activity." To that end, the one-year, interdisciplinary METALS program trains graduate students to become learning engineers and LX (learning experience) designers. METALS graduates apply learning science principles, evidence-based research, qualitative and quantitative cognitive task analysis, and data-driven methods to design, develop, and implement innovative, effective, and desirable educational solutions that enable students and instructors to succeed. Our students are passionate about using technology to develop better learning outcomes.

External clients are invited to sponsor a seven-month educational technology capstone project. In a project for the sponsor and guided by industry, faculty and alumni mentors, project teams of four to six students employ evidence-based principles and methods and advanced learning science technologies in a full product cycle starting with an initial idea and iterating through research, design, and prototyping.

More information can be found here.

Previous projects include:
- An immersive second language learning system that incorporates AI, ML and speech recognition,
- An award-winning job shadowing application which was showcased at the White House,
- A tool for incorporating SEL in K3 students' instructional activities, and
- An app store for professional development with a recommendation engine for what to do next.

PROGRAM LEAD Michael Bett, Managing Director, METALS Program

○ *Starts Fall 2023*

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Human-Computer Interaction Institute *(continued)*

Master of Human-Computer Interaction (MHCI)

January – August

Sponsorship Fee:
$85,000 *(for corporations with discounts available for repeat sponsorship and early contracting.*
$40,000 *for early stage/start-up.*
No fee *for non-profit organizations with a 501c designation.*

The Master of Human-Computer Interaction (MHCI) program is the longest-running and most impactful program of its kind. This three semester program, completed over the course of a full calendar year (August-August), offers a professional degree that includes user-centered research, iterative designs and product development experience. Students are prepared for industry and careers related to user experience, human-computer interaction and beyond.

The two-semester MHCI Capstone project is the crown jewel of this program and is known for attracting industry sponsors such as NASA, Bloomberg, Google, Bank of America, Mastercard, Amazon Music, Nationwide and many others. The sponsoring organization will define a prompt for the project and then collaborate with a team of 4–6 MHCI students who will rigorously apply HCI methods through the full lifecycle of research, design, validation, prototyping and testing in order to reframe problems and develop innovative solutions. Over 200 projects have been completed for sponsors who have challenged students to explore topics such as:

- How visually impaired customers could make sense of their data by delivering through audio,
- How audio output hardware could be situated in interactions between drivers and AI in vehicles with different levels of autonomy,
- How devices made for electrical power management and national power grids could be repurposed for natural emergencies that disable energy and communication infrastructure, and
- Before conversational agents were available to consumers, a MHCI Capstone worked on a project to design, prototype and test an agent embodied in a smart speaker. The resulting project influenced the design and development of a conversational agent the sponsor delivered to the market several years later.

Industry partners can expect:

- A prototype at various levels of fidelity that can be used to convey the experience of using the design,
- A detailed report with an executive summary,
- A public-facing web site that describes the project without revealing confidential information, and
- A presentation to which the sponsor can invite attendees from within and outside of their organization.

Program website and project examples can be found here.

PROGRAM LEAD   Jessica Vogt, HCII Engagement Manager

Skip Shelly, Associate Teaching Professor and MHCI Program Director, Human-Computer Interaction Institute

Human-Computer Interaction Institute *(continued)*

Master of Science in Product Management (MSPM)
April – December
Sponsorship Fee: $10,000 or less, depending on the size of the company

CMU's award-winning M.S. in Product Management (MSPM) program is one-of-a-kind. This program is offered jointly through the CMU's top-ranked Tepper School of Business and School of Computer Science. With MSPM, we combine the best of both schools to produce product managers who empathize with customers, lead cross-functional teams and deliver business results.

MSPM student projects often start with open-ended exploration of a product problem, market or user journeys. We explore the unmet needs of users, customers, and business stakeholders to test and deliver product strategies, models, prototypes and research. Our goal is to deliver meaningful, usable value to our sponsors.

PROGRAM LEAD   Brad Eiben, Executive Director, MSPM

Rapid Prototyping of Computer Systems
January - May (spring semester)
Sponsorship Fee: $10,000 per team, 30-40 students

The aim of the Rapid Prototyping of Computer Systems capstone is to teach students to build complex, product-service systems. Working on project teams of 20-30 students split among multiple subteams, the course is unique in having students integrate mechanical and electrical, hardware, software, human-computer interaction design, sensing systems, cloud infrastructure, and data science together into functional prototypes. The class brings together students from across the university (with heavy representation from Electrical & Computer Engineering, Computer Science, and Human-Computer Interaction) to create a multi-functional team. Past projects have included developing hardware, software, and wearable human interfaces for augmented reality inspection systems, wearable and internet of things devices to support people living with Parkinsons, Alzheimers, and Huntington's disease, and mobile data sensor systems for cars and scooters to evaluate mobility issues within a city.

Sponsors provide a brief for a product-service system they would like to see prototyped. Student teams then conceptualize new design ideas, rapidly prototype subsystems, then integrate their subsystems into a functional final demonstration. Ideal sponsors will provide a liaison who can attend one project kickoff day and three project reviews. Liaisons can also provide professional knowledge and connections to potential users of the systems.

FACULTY LEADS: Nikolas Martelaro, Assistant Professor, Human-Computer Interaction Institute
Asim Smailagic, Research Professor, Electrical and Computer Engineering

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Software and Societal Systems

Master of Software Engineering Degree Program (MSE): "Studio Project"

January – December (three semesters)

Sponsorship Fee:
$30,000 per project / $25,000 per project *(non-profit)*, **4-5 students per team.**
Up to 6,000 engineering hours

The MSE program for professionals includes a Studio Project that occupies one-third of the program's curriculum. Recognized by the IEEE CSEE&T Hall of Fame for its trailblazing development, the Studio Project attracts real-world problems from industry, government, and academic research.

Each sponsored studio project is a team-oriented, real world capstone effort that provides a sandbox in which students demonstrate their grasp of core software engineering concepts. Students design and develop a product, interact with customers, and manage team tasks and processes in a full life-cycle environment. This experience affords students the opportunity to apply theoretical learning to practice in a realistic setting — to implement the ideas they have learned in the classroom to meet realistic challenges.

Past projects include:

- Working on ground communication software for a moon rover,

- Building an app that automatically spots and corrects inventory values while providing insights into "available to promise" inventory for backend execution of the digital experience.

- Developing an integrated simulation environment for autonomous driving vehicles, and

- Developing an AML platform that will provide a software environment that enables the users to easily explore and understand design alternatives.

PROGRAM LEAD   James Berardone, Professor of Product Management, Software and Societal Systems Department

Software and Societal Systems *(continued)*

MSE–Scalable Systems (SS) and MSE–Embedded Systems (ES) Programs: Software Engineering Practicum

○ **September – December (fall semester)**

Sponsorship Fee: $13,000 per project / $10,000 per project *(non-profit)*, **4-8 students per team. Up to 3,000 engineering hours.**

For the Scalable Systems program, students study scalable systems, including large-scale, distributed intelligent systems.

For the Embedded Systems program, students study embedded systems, including Internet-of-Things (IoT) and sensor-based systems.

Students learn best practices for managing, predicting, and delivering quality software. The practicum project provides a sandbox in which students demonstrate their grasp of core software engineering concepts in the last semester of their degree.

Past projects include:

- Developing a modular and portable Electronic Health Record (EHR API),
- Building a unified systems monitoring platform that models and monitors all components across hardware, software, and human activities.
- Building a sensor development kit that would determine an effective way to test and integrate sensor products into different position tracking applications.
- Building an extensible system and method for cryptographically verifying the source of information and checking the tampered information.

PROGRAM LEAD   James Berardone, Professor of Product Management, Software and Societal Systems Department

Master of Science in Privacy Engineering (MSPE)

○ **Primarily September – December (sometimes in the spring or summer)**

Sponsorship Fee: $25,000 per team *(discounts available for early startups and non-profits)*

Carnegie Mellon's Privacy Engineering Master's program is the first and only program dedicated to training computer scientists and engineers to develop products and services that respect user privacy. Classroom instruction, student research projects, internships, and capstone projects done in partnership with industry give students the skill set needed to identify and resolve privacy challenges in modern software systems.

Past projects include:
- Privacy Risk Assessment and Mitigation projects,
- Design and prototyping of novel privacy and security solutions,
- Technical Privacy Compliance projects,
- Privacy & AI/ML Projects, incl. differential privacy and federated machine learning, and
- Consumer surveys, Privacy UX design, Security UX design.

For more information and to contact us, visit here.

PROGRAM LEAD   Lorrie Cranor, Professor, Co-director, MSPE Master's program
Norman Sadeh, Professor, Co-director, MSPE Master's program

○ *Starts Fall 2023*

Language Technologies Institute

Master of Computational Data Science (MCDS)

January – December

Sponsorship Fee: $40,000 *(using public data)* **/ $80,000** *(using private data)*

The MCDS program trains professional master's students in all aspects of design, engineering, and deployment of very large information systems. The multi-disciplinary MCDS brand of computational data science rests on three pillars, namely Analytics, Systems and Human-Computer Interaction. MCDS students gain a solid foundation in all three of these while specializing in one they choose as their concentration. In particular, students in this program learn to build solutions for complex, noisy and incomplete data sources using cutting edge AI and Machine Learning, in order to make the full gamut of multi-modal data sources do valuable work in ways that are innovative, ethical, safe, efficient, effective and able to benefit both societal good and personal quality of life. They learn to do this work with web-scale storage and computing systems and incorporate human-centered designs specific to the developers and users of the analytics and results.

Capstone projects leverage all of this potential to develop solutions that challenge the bounds of the state-of-the-art and meet the real world needs of clients, with teams potentially including students from all three concentrations. Housed in the Language Technologies Institute, MCDS draws from faculty members throughout Carnegie Mellon's top-ranked School of Computer Science, including the Computer Science Department, Machine Learning Department and the Human-Computer Interaction Institute.

PROGRAM LEAD   Carolyn Rosé, Professor and Director, Master of Computational Data Science Program

Master of Science in Intelligent Information Systems (MIIS)

January – December

Sponsorship Fee: $40,000 per team, teams of 2-4 students

MIIS is a practice-oriented, professional degree program that offers both advanced study and practical experience in the processing and analysis of unstructured and semi-structured information (such as text, image, video, speech, and audio), mining, and intelligent information technologies.

Recent MIIS capstone projects include:

- Abstractive Summarization of Medical Conversations
- Avoiding Derailment in Online Conversations
- Code-Mixed (Multi-language) Language Understanding
- Conversational Assisted Search
- Customer Service Call Analysis
- Describing Similarities and Differences Between Video Segments
- Intelligent Code Completion
- Predicting Patients' Conversation Transitions in Online Health Support Groups
- Recipe Generation from Ingredients
- Smart Reply for Text Messages
- Visual Question Generation from Video Clips

PROGRAM LEAD   Teruko Mitamura, Research Professor, Director of the MIIS program

Ralf Brown, Principal Systems Scientist

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Language Technologies Institute *(continued)*

Master of Science in Artificial Intelligence and Innovation (MSAII)

September – May (fall and spring semesters)

Sponsorship Fee:
$25,000 for a small entity *(<300 employees)*
$50,000 for a large entity *(300+ employees)*

The MS in Artificial Intelligence and Innovation Program (MSAII) is a four-semester professional master's degree offered by the Language Technologies Institute. The first two semesters are spent on the building blocks of AI: mathematical foundations, machine learning, natural language processing and engineering AI systems. Students work at company internships during the summer semester.

In the last two semesters (fall 2023 and spring 2024), the students plan and complete a capstone project. During the fall, they take AI Innovation, a course in which problems posed by sponsors are selected by teams of 6-7 students, who then propose an innovative AI application to solve the problem. During the course, the team works with the sponsor to understand the business environment in which the problem has arisen, the interests of the stakeholders and the financial implications of the problem.

Each team works on a different project. The project is shaped during the AI Innovation course, which ends with a presentation to the sponsor of a proposed Minimum Viable Product.

In the spring term, the same students develop a working AI system as part of the capstone course which, at 36 units, is equivalent to three full-semester courses. The resulting system is licensed to the sponsor under the CMU Intellectual Property Policy.

The number of students entering second year in 2023 will be 37, so we will need six projects. The problem must involve an innovative AI application and should be feasible to implement within 3 man-years over the period October 2023-May 2024. The teams will devote approximately 0.5 man-years to understanding the business case and defining the solution in the fall term, and approximately 2.5 man-years during the spring term completing the project.

After the projects are completed in May, all teams participate in a Capstone Prize Competition. A panel of independent judges evaluates presentations made by the teams and a substantial cash prize is given to each member of the winning team: the first prize is $2000 per student, second prize is $1000 per student, and third prize $500 per student.

Descriptions of the projects completed in 2022-23 can be found here.

PROGRAM LEAD Prof. Michael Shamos, Ph.D., J.D., Distinguished Career Professor Director, M.S. in Artificial Intelligence and Innovation, Language Technologies Institute

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Robotics Institute

Master of Science Robotic Systems Development (MRSD)

January – December (with a summer break)
Sponsorship Fee: $15,000 per student, 4-5 students per team, with a $60,000 maximum *(discounts available for startups)*

MRSD is an advanced robotics graduate degree with a focus on technical and business skills. The curriculum provides a broad education in the sciences and technologies of robotics, reinforces theory through hands-on laboratory projects, and exposes students to practical business principles and skills. Students work as a team towards practical system-level robotics development and integration projects. Key business concepts and practices in the curriculum include technology planning, product conceptualization and development, team management, project management, prototyping, production, marketing, and sales.

NOTE: Project proposals from companies are due in mid-July.

Past projects can be found here.

PROGRAM LEAD   John M. Dolan, Principal Systems Scientist

Master of Science in Computer Vision (MSCV)

Mid-January to early December (with a summer break)
Sponsorship Fee: $15,000 per student *(2 student minimum)*

The MSCV is a professional degree that prepares students for industry work in careers related to computer vision. Students gain proficiency at implementing computer vision applications based on state of the art algorithms; presenting the background and implementation details of a state of the art computer vision technique; conducting experimental analysis and testing consistent with current practice in computer vision, including standard metrics and benchmark datasets; and applying mathematical and machine learning tools, such as geometry, optimization, and statistics to computer vision applications.

PROGRAM LEAD   Michael Kaess, Associate Professor

Robotics Systems Engineering and Robotics Capstone (additional Undergraduate major in Robotics)

⭕ **September – December (fall semester) | January – May (spring semester)**
Sponsorship Fee: $2,500 per team, 4-7 teams; $10,000 for all projects

Systems engineering examines methods of specifying, designing, analyzing and testing complex systems. In this course, principles and processes of systems engineering are introduced and applied to the development of robotic devices. The focus is on robotic systems engineered to perform complex behavior. Such systems embed computing elements, integrate sensors and actuators, operate in a reliable and robust fashion, and demand rigorous engineering from conception through production. The course is organized as a progression through the systems engineering process of conceptualization, specification, design, and prototyping with consideration of verification and validation. Students completing this course will engineer a robotic system through its complete design and initial prototype.

Note: Unlike the graduate courses, this undergraduate course is entirely student-driven. Companies are encouraged to sponsor the course as a whole (all projects) rather than individual teams.

PROGRAM LEAD   David Wettergreen, Research Professor; Associate Director for Education and Director of the PhD Program
Cameron Riviere, Research Professor

⭕ *Starts Fall 2023*

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Undergraduate Capstones

Human-Computer Interaction Undergraduate Project

January – May (spring semester)   Sponsorship fee: No fee

The field of Human-Computer Interaction (HCI) is devoted to the design, implementation, and evaluation of interactive digital services and applications. The students come from a variety of backgrounds including Computer Science, Information Systems, Psychology, Cognitive Science, Design, Business, Stats/ML, and related programs.

The HCI Undergraduate Project is a semester-long capstone project course, required for all students who do the HCI primary major or the HCI additional major, in their last semester before graduation. The course integrates everything the students have learned in their coursework into one end-to-end experience. Students work in interdisciplinary teams of four to five students for a client, for a total of close to 1,000 hours of work. Guided by a faculty advisor, and starting with a problem statement provided by the client, students conduct user research and brainstorm design ideas that meet identified needs, go through a design ideation phase to produce and vet design ideas, with client input, and produce prototypes with increasing fidelity and iteratively test them with users to improve the design, ending with a working prototype that serves as a proof of concept of a novel service or product idea for the client.

Examples of previous projects:

- A mobile app that helps dermatologists stage melanoma and decide on treatment,
- An intervention-based app that supports adolescents who are being cyberbullied,
- A web app for community auditing of machine learning services for inherent bias,
- An app to engage solar owners and provide an avenue for non-solar owners to learn about the benefits of solar energy in Western PA, and
- Easy-to-use authoring tools that allow teachers to create personalized learning experiences.

Program website and project examples can be found here.

PROGRAM LEAD   Haiyi Zhu, Daniel P. Siewiorek Assistant Professor of Human-Computer Interaction

Mechatronic Design

January – May (spring semester)   Sponsorship fee: $10,000; 3-5 students per team

Mechatronics is the synergistic integration of mechanism, electronics, and computer control to achieve a functional system. Because of the emphasis upon integration, this course centers around system integration in which small teams of students configure, design, and implement a succession of mechatronic subsystems, leading to an integrated main project. Class lectures cover topics that complement the laboratory work, including mechanisms, actuators, motor drivers, sensors and electronic interfaces, microcontroller hardware and programming, and basic control systems. The class is divided into multi-disciplinary teams of three to five students. During the first half of the class, lab assignments are performed every 1-2 weeks to construct useful subsystems based on material learned in lecture. The lab assignments are geared to build to the main project.

This course is cross-listed in Robotics, Mechanical Engineering, and Electrical and Computer Engineering (ECE). It is also accepted as a capstone course for ECE undergraduates. Each year, teams must select from among a set of 2-3 project options. Sponsors are free to define a project topic that they wish to sponsor.

Past projects include:
- Autonomous window-washing robot,
- Autonomous ship-control robot,
- Autonomous vacuum for stairs,
- Autonomous venous injection robot, and
- Autonomous shingle-laying robot.

PROGRAM LEAD   Zeynep Temel, Assistant Professor
Cameron Riviere, Research Professor; Director of Robotics Undergraduate Programs