

Guide

SDM Core Integrated Team Project

revised 1 October 2021

OVERVIEW

The integrated team project is part of a nine-month core course on the foundations of systems architecture (SA), systems engineering (SE) and project management (PM). In these projects, teams dive deeply into the design and management of particular technologically enabled system. These Team Projects run for 4 months, from January to May.

Industry and government sponsors are encouraged to prepare a proposal, to pitch, and to support these projects. The proposal should regard a (solution neutral) problem rather than an anticipated solution. Not all proposals are selected. Students vote on preferred topics, from which teams of 4 to 5 are formed.

Types of Projects

Projects must involve a technical system to be designed and developed; however there is flexibility in the type of projects and we will work with sponsors to refine proposals. Options include:

- Bringing a promising new cutting-edge technology from the lab to market
- Enhancing an existing product by infusing one or more new technologies
- Proposing a next-generation architecture or assessing threats to the dominant design
- Investigating a troubling or dysfunctional product and suggesting significant improvements

Projects should be non-trivial and involve a complex **technical** system with significant societal, technological or programmatic challenge. Projects should have a non-obvious answer: projects supporting existing designs with no decision at stake will be less likely to be adopted. Consulting projects, business models, organizational design, process improvement, and portfolio pruning projects are not at this time acceptable proposals.

Expected Minimum Time Commitment

Each team will coordinate with MIT and Sponsor mentors for regular dialogue and guidance.

Students are expected to spend approximately half of their out of class time (5 hours each week) on team project activities.

Sponsors are expected to spend a minimum of 24 hours supporting the project:

- 4 hours preparation during the fall and pitch of project on 1/10/2022
- 1 hour per week supporting students during the term (16 hours total)
- 4 hours to view final presentations, assessment and feedback (May 9-10, 2022)

Team Project – MIT Presentation Events (May 9 and 10, 2022)

Each team will deliver a presentation and executive memo that summarize their results and recommendations. The presentation from each team must exhibit the framing, design, analysis, and future recommendations for their system including architecture, systems engineering, and project management. A schedule and evaluation criteria for the projects are shown below.

Team Project – Sponsor Final Briefing (May & June, 2022)

Sponsors are encouraged to set up a briefing by students at the conclusion in May & June 2022.

General Guidance

Guidance for Student Teams

- Cover context, systems architecture, systems engineering and program management aspects of a system, resulting in in-depth analysis, insights, and executive level recommendations.
- Explain the team's choice to select and apply certain SA, SE, or PM methods and tools.
 - Please touch on all three core areas and how the design choices made across SA, SE, and PM relate to one another.
 - Project management content shall not emphasize the team's work during the semester, but rather plans for implementation of the system in future phases.
- Balance past experience with new thinking, methods and techniques introduced in the course.
 - Methods may be different from approaches used in specific companies or industries, yet exploration of differentiated approaches is an expectation for this project.

Guidance for Sponsors

The primary role of the sponsor is to **provide real-world context, review progress as requested by students, and advise on the relevance of the team's focus -- the "voice of the challenge."**

- Team projects are selected, managed, and ultimately delivered by the students themselves. *The students have the prerogative to choose* where to focus, how to evolve, and what to deliver. We ask that sponsors remain flexible as students explore, even if their efforts diverge from the expectations of the sponsor.
- In a university, students may choose an unexpected path, make errors, or simply do a mediocre job earning a lower grade. This academic liberty is important to promote ownership and motivated learning.
- *The team projects are part of a course, and thus are not sponsored research.* It is not appropriate to require a contract, specific deliverable or tool, nor to require any agreement (e.g. NDA).
- If data is core to the project, data shall be supplied by the Sponsor, pre-packaged, and available for student team use in a university course setting, by Jan. 11, 2022.
- Overall, the experience of past sponsors has been very positive, including regular interaction with MIT students, insights from different ways of framing the challenge, and access to the latest techniques in SA, SE, and PM. *The team project can stimulate follow-on* internships, thesis work, and sponsored research with a deeper dive and research deliverables.

Student Team Coordination with Sponsors

Be sure very early to agree on a regular coordination schedule and style with the sponsor. Please adapt the approach to reflect the busy schedule of both sponsors and fellow students. A minimum bi-weekly communication is recommended, as well as 1 or 2 major reviews of intermediate progress during the semester.

- Group chats (slack, WhatsApp, etc) which include the sponsor and team are a good idea, but tend to be abandoned as the project goes on and teammates shift an internal channel
- Group folders (dropbox, google docs, etc) are also a decent idea, but like the chats, these get neglected as teams want privacy
- There may be tension between assignments and the nature of the challenge or sponsor expectations. If these tensions surface, please discuss with TAs and faculty how the assignment might be leveraged to close this gap.

2020-2021 Schedule

Nov 2021	<ul style="list-style-type: none"> • Candidate sponsors submit a draft of their proposed challenge topics. MIT SDM core instructors provide feedback for refinement. The 1 pager summary is based on a common format (see powerpoint slide template and examples). • Students receive a list of topics in December, and access to 1-page summaries at the start of January.
Jan 10 - 28, 2022	<p>1/10 (Mon): Integrative Project Showcase</p> <ul style="list-style-type: none"> • AM: Students present technology posters from assignment OS6 in the fall, exhibiting emerging technologies from across MIT. • PM: Proposals presented* by sponsors in 5-min pitches. Students vote on top choices. <i>* in person pitches are recommended and more likely effective, but arrangement can be made for online pitches</i> <p>1/11 (Tue)</p> <ul style="list-style-type: none"> • AM: Proposals presented by sponsors in 5-min pitches. Students vote on top choices. • PM: Project teams selected and kick off of Integrated Projects with Design Challenge 3 <p>Initial meetings with sponsors and refinement of project challenges and definitions. Daily workshops for newly formed student teams (week of Jan 11-14, 2022). Design Challenge 3: Launch Teams, Frame Problem, Establish Charter, Communicate Your Approach to peers and instructor team by end of January</p>
Jan 31 – May 10, 2022	<p>Spring Term</p> <ul style="list-style-type: none"> • Team project work ongoing through the semester • “OS” assignments are applied to the team’s project topic • Meetings / check-ins with mentors a few times each month • A TA is assigned to each team for supports throughout the semester.
Mar 19 – May 6, 2022	<p>Systems Argument, Plan and Pitch Readiness</p> <ul style="list-style-type: none"> • Mid-course reviews on March 24 • Argument drafted (by 4/25) for rehearsals
May 9 - 10, 2022	<p>Integrative Project Final Presentations</p> <p>Presentation final version to be submitted by May 8 @ 11pm EDT Executive Memo to be submitted by May 6 @ 11am EDT.</p> <ul style="list-style-type: none"> • The final presentations will be grouped into 4 sessions of ~6 teams each; 2 sessions on Monday, May 9 and 2 sessions on Tuesday, May 10. • Each two-hour session will begin with six teams delivering 10-minute presentations, then a breakout into an online forum of six parallel sessions for informal dialogue. <ol style="list-style-type: none"> 1. Students are only required to attend the session in which they present. 2. Teams will be scheduled to avoid conflict with their other classes. 3. The 1-hour forum in the latter half of each session is informal, and open to the MIT community, alumni, and sponsors. 4. Students are encouraged to attend presentations and forums, to view peer team results, to celebrate and to learn from one another. 5. The topics will be grouped and visible to ease attendance at team presentations and forums in which one is interested • A final panel with all instructors, TAs, and Q&A from students will be held for 1 hour on May 10 in the afternoon.

Team Deliverables

Design Challenge 3 (Jan 11 - 28, 2022)

Design Challenge 3 (DC3) is based on an intense set of workshops over 3 days just following the formation of teams for the spring project. DC3 concludes on January 28 with the following deliverables:

1. Prepare a short pre-recorded 7 min presentation, video or demo explaining the problem the team is trying to solve, the stakeholders involved, high level concept & teamwork approach.
2. Submit an initial Charter* and Project Concept for your Team (3 pages or less)
 - a. Frames the technical problem, system and project boundaries, potential value, and authorizes the team to plan and proceed
 - b. Focuses on the next 4 months (Jan – May 2022) as the initial phase of a full systems development project
 - c. Includes team roles and teamwork approach including coordination agreement

** See OS6 for reference and expectations; a charter is NOT a plan, therefore no need for Gantt charts, milestones, or other detailed estimates, but rather targets of strategic relevance.*

DC3 counts for 20% of the EM.412 grade; 12% for presentation and 8% for the Charter

Final Deliverables for week of May 9, 2022

- Final project **presentation**: PowerPoint, also submitted to Canvas as PDF, length 10 minutes including questions
- 5-page **executive memo** (Word document, submitted to Canvas as PDF) that summarizes results and recommendations. Appendices are acceptable, but will not be considered for evaluation.

Presentation

- Audience is SDM instructors, peers and sponsor mentors
- Emphasize problem framing, options, evaluating value, and recommendation options. What is the primary value that it delivers, to whom, and how is the value measured?
- Describe the team's analytic and synthesis strategy. Therefore, what is excluded from the recommendation and why?
- At most two of the team members must be involved in synchronous delivery of the presentation online. We encourage teams to involve all team member in preparation, and that those who have presented less often in the past be out front.
- At most 3 minutes of pre-recorded video/animation may be included.
- *Any detailed figures (such as those from OS) should be included if a pattern is discernable and tied to a key insight. Detail for detail sake without a role in the analysis and argument of the project is discouraged.*

Executive Memo

- Audience is sponsor executives, with recognition of key stakeholders
- The memo is a written argument that leads to a call for action, which frames the problem and guides executives to support the proposal. Relevant deeply held assumptions and conventional biases should be exposed. The memo should be compelling integration of the detailed work completed throughout the semester.

Evaluation

As a reminder from the syllabus, the overall grade for EM.413 course consists of:

- 42% Opportunity Sets (2 each for SA, SE, and PM, 7% each)
- 8% OS12 - Integrative Reflection
- 20% Professionalism (Participation, DLOs, Teamwork incl. peer review)
- **30% Team Project Deliverables (Presentation 18%, Executive Memo 12%)**

Evaluation of Team Project Final Deliverables

The Team Project Deliverables will be graded using the following criteria:

System Architecture (20%) Did the team apply relevant analysis and logic to reach conclusions about the architecture? (See next page)

System Engineering (20%) Did the team apply relevant methods from SE to produce a credible recommended system solution? (See next page)

Project Management (20%) Did the team design realistic, optimized, and risk mitigating plan(s) aligned with SA and SE strategy for subsequent stages of the project? (See next page)

Argument and Communication (20%) Does the recommendation follow from evidence-based motivation and problem framing followed by clear arguments? Does the recommendation deliver value to the most important stakeholders? Is the document effective, persuasive and appropriate for a non SDM executive decision maker?

Unique Insights (20%) Does the analysis produce non-obvious, interesting results? (a.k.a nuggets)

Project Evaluation Criteria by Topic

<p>System Architecture</p>	<ul style="list-style-type: none"> • A representation of the system architecture, including the architectural decisions that the team made and why, and potentially functional or form decomposition if relevant. • An analysis of value delivery and prioritization of stakeholders and / or goals. • A system problem statement and an explicit system boundary. • A description of the broader context in which the system sits, a matched rationale for the rate of architectural change to expect • An articulation of the competitive strategy to be used in the market with the chosen architecture.
<p>System Engineering</p>	<p>In addition to the problem statement, system boundary and stakeholder analysis above, the project shall clearly demonstrate the follow aspects:</p> <ul style="list-style-type: none"> • System requirements including requirements traceability from system value and stakeholder needs to subsystem and component requirements • Systems Engineering methods and tools used – why did you choose them and what methods you considered not to be appropriate for your project. • Different concepts you generated and how you down-selected to the preferred system concept • Verification and Validation strategy • Operations and lifecycle considerations • Final recommendations • Reflection on team learning about systems thinking
<p>Project Management</p>	<p>An approach for implementation of the system (product or service) shall be designed to optimize scope quality, cost, and schedule. Targets (driven by value) and estimates (driven by feasibility) are compared related to scope, cost, and duration.</p> <ul style="list-style-type: none"> • The expected scope is clearly described, structured at a level of sustainable granularity, related to the system and its value, and measurable. • A project organization approach is selected for a forward-looking implementation of the system. Critical resources and skills are called out. • Choices for structuring and integrating the product system, workflow process, and project organization are highlighted, particularly those choices which are exceptions to standards or conventional wisdom. • The results of design, prototyping, and validation tasks by the project team to date are reflected in an estimate of future implementation activities. • Risks and mitigations are assessed and integrated in the project plan. Uncertain work, re-work, and coordination activities are considered. • Amongst a set of project scenarios, the team proposes a preferred and backup scenario for system implementation. If meaningful, these options are shown in a tradespace diagram. Concerns from stakeholders are anticipated and addressed.

Some Failure Modes to Consider

1. No data to convince the audience that this is a “problem” (statistics, past studies), making it more difficult to promote your solution.
2. A method is shown even if it doesn’t fit or produce a useful “nugget”.
3. Tradespace shows no clear driving architectural decision emerging
 - a. No clear color clusters, everything looks like a blend of colors
4. Metrics evaluation not credible and/or not anchored to a past design
 - a. If the project estimate for cost of a new cryptocurrency platform is \$400k, it seems many orders of magnitude too small
 - b. IF no “baseline” system is shown , against which new concepts are evaluated, rendering the relative benefit/cost of the new ambiguous
5. Tradespace seems to anchor a favorite
 - a. All of the other architectures are shown at 1-2% difference in metric values
6. There is no tension between the axes of the tradespace
 - a. Tradespace exists to help weigh metrics that are in conflict. If you choose covariant axes (like cost and complexity of solution), you’re not representing independent information on each axis.
7. Listing stakeholders, but no “nuggets” or observations from the analysis that wouldn’t have been obvious before the stakeholder analysis.
8. Arguing for a system architecture change when industry is consolidated around a dominant design and doesn’t have underlying technology likely to change the architecture
9. The project is based on scope that is unworkably large, resulting in superficial evaluations; or, the scope is uninterestingly small, with feature-level detail not treatable by analysis.
10. No clear statement of the system purpose and quantification of the value the proposed system create (and to whom those benefits accrue)
11. No synthesis of the analysis into a coherent system concept that is more than the sum of the analyses.
12. No clear and concise executive-level representation of the system which performs the missions that create the intended value.
13. Little acknowledgment of the uncertainties and technical risks that exist and the recommended mitigating strategies to reduce them to acceptable levels.
14. No description of the operating behavior of the system, including missions, use cases, and off-design operations (and strategies for addressing robustness, safety, resilience, etc.)
15. A plan is presented only as a Gantt Chart, without the related targets, scope, resources, coordination and governance project elements.
16. Project Plan is not budget and resource realistic, as it does not include overhead, indirect, material, and other coordination costs
17. Only a single project forecast is considered and recommended.
18. Project targets are not shown, nor if shown not compared with estimates.
19. Project estimates are only schedule and do not show trade-off with cost, scope, and risk.
20. Project plan options are not evaluated for risk, including likely delays and rework
21. The value in achieving strategic targets in not considered for the recommended plan options.