DALHOUSIE UNIVERSITY

SCIE 4701.03 & SCIE 4702.03

Science and Technology Innovation, Commercialization, and Entrepreneurship

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Course Description

Capstone course providing an introduction to the processes and mindsets around innovation and commercialization of science and technology, including entrepreneurship. Experiential learning format; teams work to develop and pitch a viable business model for a scientific solution to a real-world problem. Complemented by lectures, case studies, and guest presentations.

Prerequisites

Registration is by permission of the instructor only. There are no specific prerequisite classes; however, undergraduates should have completed at least three full years (90 credit hours) of university study. As well, students are strongly encouraged to participate in workshops and weekend events offered by the SURGE Sandbox, or have other exposure to innovation and entrepreneurship, before committing to this full-year class. Because this class is based around team projects, it is valuable to have some exposure to the topics before committing to a full-year class. Please note that SCIE 4701.03 and SCIE 4702.03 must be taken in the same year, and that a grade will be given for SCIE 4701.03 only after SCIE 4702.03 is completed.

Prospective students should email the instructor for permission. Admission decisions will be made by the instructor.

After admission to the class, and prior to the start of the term, students will be provided with some preparatory reading and work. This is expected to be completed prior to the first class.

Background and Rationale

This class departs from traditional science training by emphasizing the processes of **innovation** and **commercialization**: identifying problems that represent real needs in society and/or the world, and creating novel solutions that not only work, but are supported by a viable business model. Students will develop an understanding of how to design solutions that meet a real need, and have the potential to be commercialized or otherwise make it into the hands of people who can benefit from the solutions.

Students will find that the core principles taught in the class can be applied in a wide range of scientific and technological applications. This class will provide a unique perspective and new skills that are not typically offered in undergraduate or graduate programs in science or engineering.

Learning Management System Site Information

We will use Brightspace, Dalhousie's online LMS.

Learning Objectives

At the end of this class, students should be able to:

- Understand and explain the differences between discovery-based research and commercialization-focused research and development

- Identify opportunities for novel, science and/or technology-based solutions to problems, and assess the commercial feasibility of those solutions

- Use the Business Model Canvas ("Lean Canvas") to develop, justify, and pitch a business model for such a solution

- Identify and explain each component of the Business Model Canvas, including value propositions, customer segments, and revenue streams

- Explain different business models, and rationalize decisions concerning the choice of a business model for a given solution, product, or service

- Understand and implement an iterative cycle of "customer discovery", including stages of Build, Measure, and Learn

- Understand and apply the fundamentals of human-centred design in finding solutions to human problems

- Understand the different types of prototypes, explain their purposes, and develop and demonstrate appropriate prototypes

- Explain technology readiness levels (TRL) and be able to assess products in terms of TRL

- Define the basic stages of a product lifecycle

- Define and explain core principles of intellectual property and how it can be protected, including patents and trademarks in the Canadian, U.S., and other systems, and how intellectual property may be licensed

- Analyze ethical issues raised by the use of technology in research or commercial contexts, with reference to relevant ethical guidelines and important legal precedents

- Identify multiple options for funding commercial and not-for-profit ventures, and characterize these in terms of appropriate stages of enterprise growth, as well as benefits and costs of different options

- Stand up in front of strangers and effectively introduce themselves and pitch an idea in 2 minutes or less, in a manner appropriate for the audience

- Work productively with multidisciplinary teams

- Explain roles and responsibilities of senior organizational leadership, and strategies for allocating rewards (compensation and ownership) to founders and executives

Class Format

Class time will be spent on a mixture of instructor-led lectures and discussions; presentations by guest speakers; student-led case discussions; and small-group teamwork. This course emphasizes experiential learning, with the majority of the final grade based on a team project that is conducted throughout both terms. This project (detailed below) requires student teams to develop a business model addressing a significant, unmet need through an innovative scientific application. Central to this process is iterative hypothesis testing, addressing all aspects of their business model, from the scientific and technical feasibility to intellectual property

considerations, to the cost structure and sources of revenue. Another critical step is "customer discovery" in which demand for the proposed solution is assessed, and the target market is identified and validated. This course also requires a significant commitment of time outside of regularly-scheduled class time to conduct customer discovery interviews, develop prototypes, prepare and practice pitches, and other group work in support of the project.

This pair of courses operates over two terms. Across both terms, students will build their understanding of the processes of innovation, commercialization, and entrepreneurship through team-based development of an innovative solution to a real problem, developing a business model for this innovation, and pitching their ideas to various audiences.

In the **Fall** term (SCIE 4701.03), teams will define a specific unmet need, and invent a solution to this need. They will then engage in iterative customer discovery to validate and refine their invention, and begin planning for prototyping, including developing a project timeline and associated milestones.

In the **Winter** term (SCIE 4702.03), students will focus on further developing their invention, continuing to validate with customer discovery, iteratively developing and testing prototypes, and assessing intellectual property developed, with careful attention to defining key metrics and actionable results at each stage of testing.

Course Materials

Required Readings

Constable, G. (2014). *Talking to Humans*. https://www.talkingtohumans.com/

Wasserman, N. (2013). *The Founder's Dilemmas: Anticipating and Avoiding the Pitfalls That Can Sink a Startup*. Princeton University Press.

- Watching Steve Blank's "Lean startup" and "Customer Discovery" videos is required in the first weeks of class:

    https://www.udacity.com/course/how-to-build-a-startup--ep245 (free signup required)

    https://venturewell.org/i-corps/team-materials/

- There is a course pack of required readings available for purchase from Harvard Business publishing. Specific selections will vary from year to year.

- Other material may be posted on the course web site and will be announced there.

Optional Readings

These are not required but students may find them useful in the context of the class, and certainly if they pursue the topics of this class in the future.

Blank, S., & Dorf, B. (2012). *The startup owner's manual: The step-by-step guide for building a great company*. K & S Ranch.

Ingle, B. R. (2013). *Introduction to design thinking*. doi:10.1007/978-1-4302-6182-7_1

Kelley, T. (2001). *The art of Innovation: Lessons in creativity from IDEO, America's leading design firm*. New York.

Maurya, A. (2012). *Running Lean*. Sebastapol, CA: O'Reilly Media, In.

Osterwalder, A. (2010). *Business model generation: A handbook for visionaries, game changers, and challengers*. John Wiley and Sons.

Ries, E. (2011). *The Lean Startup*. Crown Business.

Zenios, S., Makower, J., & Brinton, T. J. (2009). *Biodesign: The process of innovating medical technologies*. Cambridge University Press.

Assessment/Evaluation

Evaluation of performance in this class is not based on how well you can memorize material. Rather, it is focused on how well you can apply the principles you learn in the lectures and workshops to a real-world problem, in the context of your proposed business model. As well, you will be assessed on how well you are able to communicate your ideas orally, including your ability to defend decisions you have made and explain the processes by which you came to make critical decisions in designing your business model.

Much of the work in this class, and correspondingly the assessments, is done in teams. Students will form into teams near the beginning of the course, with each team containing a mix of education levels and backgrounds. Each team will work to create a business venture proposal, using the information from the presentations and workshops in this course. The instructor will meet on a daily basis with each team to review progress, address any problems, and ensure that all students are contributing constructively to their teams. If there are concerns with any student's progress the instructor will raise these as soon as possible with the student(s) in question to mediate a solution.

The evaluation components and weighting will be the same for each term, however the criteria for evaluating the pitches are different for each term (see Rubrics at the end of this syllabus). Note that a grade will be given for SCIE 4701.03 only after SCIE 4702.03 is completed. However, a grade will be assigned separately for each class, based on performance in that term.

Grading will be according to the Dalhousie University standard grading scale:

0-49	50-54	55-59	60-64	65-69	70-72	73-76	77-79	80-84	85-89	90-100
F	D	C-	C	C+	B-	B	B+	A-	A	A+

Grade Breakdown

Attendance (15%)

Attendance at all class meetings is mandatory. Attendance will be taken at the start of each class; if you arrive after attendance is taken, you will get half points for attendance for that day. Your attendance grade will be calculated as the proportion of classes that you attended (e.g., if you attend 95% of class meetings you will get 95% of the 15 possible attendance points, (i.e., 13.5 points).

Participation (15%)

Students are expected to participate in *all* class discussions, including with the instructor, guest speakers, during case presentations, and within their project groups. Each student is also expected to be able to demonstrate productive and substantive contributions to the group projects. All students will also be called upon regularly to introduce themselves and pitch their projects to a variety of people from diverse backgrounds including business, media, and science. As well, a significant part of the class is "customer discovery", which involves making contact with, and interviewing, a significant number of people in the community. Participation will be graded according to the attached rubric.

Interim Pitch (10%)

Student teams will report on their project's progress midway through the course. Grading will be according to the attached Pitch Rubric.

Final Project Presentation (50%)

At the end of the course, each team will pitch their business plan publicly in a 15 minute oral presentation. Grading will be based on the attached Pitch Rubric, with 50% of the grade assigned by an invited panel of experts and the other 50% by the instructor.

Team Peer Evaluations (10%)

Each student will fill out an evaluation form (attached) describing their self-assessment of their own contributions to their team and project, as well as an assessment of other team members' contributions. Students will provide numerical estimates of each team member's overall contribution and these will be pooled across team members to obtain the final mark.

Outline of Schedule

The class format is 2x 1.5 hour sessions each week (Tuesdays and Thursdays, 16:00–17:25), which all students are required to attend, as well as 1x 1-hour tutorial session each week.

In addition to class time, significant time outside of scheduled classes will be required for group work and assignments.

While the overall curriculum is described below, the schedule and assigned readings will vary somewhat from year to year according to availability and schedules of invited speakers. This course will place a heavy emphasis on recruiting high-profile guest speakers.

Topics to be covered will include:

1. Innovation
   - Needs finding
   - Needs screening and market analysis
   - Measuring outcomes and efficacy
   - Principles of design thinking, human-centred design, and industrial design
   - Concept generation and concept screening
   - Brainstorming
   - Concept selection

2. Prototyping
   - Levels of prototypes
   - Purposes of prototyping
   - Developing a test plan with milestones
   - Clearly defining test metrics and associating them with key assumptions in the business model

3. Commercialization
   - Regulatory environments
   - Personnel management
   - Branding and marketing
   - Business development and strategy
   - Technology readiness levels

4. Entrepreneurship
   - The nature of the entrepreneur
   - Customer discovery
   - Business Model Canvas
   - "Lean" startup methodology

5. Founding a Business
   - Legal aspects
   - Founders and founding teams
   - Roles, responsibilities, and rewards
   - Shareholder agreements
   - Vesting

6. Financing a venture
   - Sources of financing
   - Equity and dilution

7. Intellectual property
   - Understanding, protecting, and respecting IP in academia and industry
   - Forms of IP protection
   - IP strategies

8. Ethics
   - Ethical implications of technology
   - Business ethics

9. Communication
   - Designing and delivering effective presentations
   - Graphic design for scientific communication
   - Communicating with non-scientific audiences
   - Pitching

10. Professional Skills
   - Time management
   - Career development
   - Professional networking

Policies

Attendance

Attendance at all classes is mandatory. You may use the Student Declaration of Absence form (submitted via Brightspace) two times over the term to avoid penalty for lateness/non-attendance. If you need to miss more classes than this, please discuss your needs with the instructor before you have to miss the class(es). Requests will require additional, official documentation and will be granted after the absence only in exceptional circumstances.

Class Disruptions

Respect for others extends to consideration of the fact that we come together in this class to learn. Behaviours that get in the way of this will not be tolerated. These include annoyances such as talking during lectures or when others are talking, cell phones ringing, wearing heavily scented products, surfing the net, watching movies, or doing something else not class-related on your laptop, and other such things. If you find the actions of someone else in the class distracting or otherwise disruptive of the goals of the class, you may bring it to the instructor's attention and it will be dealt with anonymously.

Academic Freedom

Freedom of speech and of thought are cornerstones of academic institutions such as Dalhousie. Our goal in science is to observe and characterize the world accurately and objectively. However, we must realize that our perceptions of reality are often coloured by our beliefs and assumptions, some of which we may not be aware of. Academic freedom includes not only your freedom to think as you please, but others' freedom do express their beliefs as well. Please do not hesitate to express your ideas, but do so in a way that is respectful of others. This is the only avenue for the free expression and exchange of ideas.

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. For more details please see: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of: a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (NS, NB, PEI, NFLD). For more information see https://www.dal.ca/campus_life/academic-support/accessibility.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. For more information please see https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/student-lifepolicies/code-of-student-conduct.html

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our

Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). For more information please see http://www.dal.ca/cultureofrespect.html)

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit the office in the McCain Building (room 3037) or contact the programs at elders@dal.ca or 902-494-6803.

University Policies and Programs

Important Dates in the Academic Year (including add/drop dates) http://www.dal.ca/academics/important_dates.html

University Grading Practices: Statement of Principles and Procedures https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Scent-Free Program http://www.dal.ca/dept/safety/programs-services/occupationalsafety/scent-free.html

Learning and Support Resources

General Academic Support – Advising https://www.dal.ca/campus_life/academic-support/advising.html

Fair Dealing Guidelines https://libraries.dal.ca/services/copyright-office/guidelines/fair-dealingguidelines.html

Dalhousie University Library http://libraries.dal.ca

Indigenous Students https://www.dal.ca/campus_life/communities/indigenous.html

Black Students https://www.dal.ca/campus_life/communities/black-student-advising.html

International Students https://www.dal.ca/campus_life/international-centre.html

Student Health Services https://www.dal.ca/campus_life/health-and-wellness.html

Counselling https://www.dal.ca/campus_life/health-and-wellness/frequently-asked-questionsaugust-2017.html

Copyright Office https://libraries.dal.ca/services/copyright-office.html

E-Learning website http://www.dal.ca/dept/elearning.html

Dalhousie Student Advocacy Services http://dsu.ca/dsas

Dalhousie Ombudsperson https://www.dal.ca/campus_life/safety-respect/student-rights-andresponsibilities/where-to-get-help/ombudsperson.html

Writing Centre https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Faculty or Departmental Advising Support: Studying for Success Program http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Participation Rubric

3 points	2 points	1 point	0 points
Demonstrates excellent preparation: has analyzed case exceptionally well, relating it to readings and other material (e.g., readings, course material, discussions, experiences, etc.).	Demonstrates good preparation: knows case or reading facts well, has thought through implications of them.	Demonstrates adequate preparation: knows basic case or reading facts, but does not show evidence of trying to interpret or analyze them.	Absent Present, not disruptive. When called on, does not offer much. Demonstrates very infrequent involvement in discussion.
Offers analysis, synthesis, and evaluation of case material, e.g., puts together pieces of the discussion to develop new approaches that take the class further.	Offers interpretations and analysis of case material (more than just facts) to class.	Offers straightforward information (e.g., straight from the case or reading), without elaboration or very infrequently (perhaps once a class). Does not offer to contribute to discussion, but contributes to a moderate degree when called on.	
Contributes in a very significant way to ongoing discussion: keeps analysis focused, responds very thoughtfully to other students' comments, contributes to the cooperative argument-building, suggests alternative ways of approaching material and helps class analyze which approaches are appropriate, etc.	Contributes well to discussion in an ongoing way: responds to other students' points, thinks through own points, questions others in a constructive way, offers and supports suggestions that may be counter to the majority opinion.	Demonstrates sporadic involvement.	
Demonstrates ongoing very active involvement.	Demonstrates consistent ongoing involvement.		

Pitch Rubric

	3 points	2 points	1 point	0 points
Content/Concept (50%)				
Product/Service Idea	Clearly described problem Clearly described solution Clear unique value proposition (VP)	Mostly well-described problem & solution VP provided, but weak/questionable	Hard to understand problem Solution hard to understand/ unfocused VP not credible or hard to understand	Unclear what, if any, problem exist Unclear what the solution is or too many ideas with no clear focus VP not provided
Customer Discovery	Strong evidence provided from customer/ stakeholder interviews Strong evidence that solution solves a real problem	Weak evidence provided from customer/ stakeholder interviews Weak evidence that solution solves a real problem	Little evidence provided from customer/ stakeholder interviews Little evidence that solution solves a real problem	No evidence provided from customer/ stakeholder interviews No evidence that solution solves a real problem
Customer/market fit	Provide credible market assessment Strong evidence that solution is commercially viable	Market assessment provided but limited Weak evidence that solution is commercially viable	Market assessment very limited or inappropriate Commercial viability of solution questionable	No evidence of market research or research does not support claims No convincing evidence of commercial viability
Use of Lean Canvas	All 9 elements of Canvas addressed/ filled in appropriately Demonstrate clear understanding of canvas	Most elements of the Canvas appropriately addressed Demonstrate good understanding of most aspects of Canvas	At least half of elements of the Canvas appropriately addressed Demonstrate some understanding of some aspects of Canvas	Little or no mention or evidence of how Canvas was used Fails to demonstrate understanding of the canvas and its use
Intellectual property	Demonstrate strong understanding of relevant IP space Demonstrate strong understanding of IP issues relevant to solution Any IP issues identified and well-addressed	Demonstrate moderate understanding of relevant IP space Demonstrate moderate understanding of IP issues relevant to solution Any IP issues are identified and partly addressed	Demonstrate little understanding of relevant IP space Demonstrate little understanding of IP issues relevant to solution Any IP issues are at least identified	Demonstrate no understanding of relevant IP space Demonstrate no understanding of IP issues relevant to solution Failure to identify relevant IP issues

Delivery (20%)				
Grabbed attention	Compelling introduction Clearly identified problem within first 2 minutes Enthusiastic presentation	Clear introduction Problem is reasonably clear within first 5 minutes of presentation Moderate levels of enthusiasm	Introduction is confusing Problem is mentioned, but not clearly stated, early in the presentation Low levels of enthusiasm/ "flat" presentation style	Introduction is jumbled, does not evoke interest Topic/problem area unclear Lack of enthusiasm Negative attitude Audience turned off
Maintained audience attention	Strong delivery, clearly well-rehearsed Clear speech, good volume Intentional movements Consistent eye contact	Acceptable delivery Speech reasonably clear and audible Movements support speech Some eye contact	Delivery not compelling Evidence of poor preparation/no rehearsal No movement or movement is distracting Minimal eye contact	Delivery is jumbled Little/no evidence of preparation or rehearsal No movement or inappropriate movement No eye contact
Clarity/Flow	Concepts were consistently easy to understand Logic was consistently easy to follow	Concepts were sometimes to understand Logic was sometimes easy to follow	Concepts were difficult to understand Logic was difficult to follow	Concepts impossible or nearly possible to understand No or flawed logical flow
Teamwork	Equal contributions by all team members Seamless handoffs between presenters Members not currently speaking are supportive but not distracting	Unbalanced contributions by team members Reasonably smooth handoffs Non-speaking members not creating distraction	Strongly unbalanced contributions by team members/one or more members dominate Awkward handoffs Non-speaking members create distraction	Some members don't contribute at all Inappropriate dominance by one or more members Poor handoffs Inappropriate behaviour by non-speaking members
Visual Aids (15%)				
Relevance	Consistent with speech Supported speech without unnecessary duplication No distractions/ irrelevant information	Mostly consistent with speech Redundancy with speech that is distracting rather than supportive Some irrelevant content	Many inconsistencies with speech Excessive redundancy with speech Much irrelevant/ distracting content	Excessive text; speech essentially duplicated on slides Contradictions between speech and slides Excessive irrelevant content
Clarity/graphic design	Clear, simple, uncluttered Consistent look and feel across slides Strong, appropriate branding	Mostly clear, simple, uncluttered Mostly consistent look/feel Some branding; mostly appropriate	Mostly unclear and cluttered Inconsistent look and feel Little/inappropriate branding	Very unclear and cluttered Inconsistent look and feel No evidence of branding

Innovation/Creativity (15%)				
Novelty	Product/service is clearly novel and innovative Unexpected solution(s)	Product/service is somewhat novel Fairly obvious solution	Product/service is minimally novel Very obvious solution	Product/service is not at all novel/already exists Existing solution or failure to address problem properly
Iterative process	Clear evidence that refinement took place in response to feedback	Some evidence that refinement took place in response to feedback	Little evidence that any refinement took place in response to feedback	No evidence that feedback was sought out, or feedback not used appropriately or at all