The University of Michigan
College of Engineering
Curriculum Committee
Faculty Meeting Report
October 06, 2010

Agenda Items

For Vote

1. Proposal for EE and EE:S Combined Undergraduate/Graduate Programs with the UM –SJTU Joint Institute
2. Proposal to Replace the EE:S CUGS Programs and SGUS Programs
3. Intellectual Breadth Proposal
4. Proposal to Create Joint Masters Degree in Entrepreneurship

For consideration by the EE and EE:S Graduate programs – March 16, 2010

Proposal for EE and EE:S Combined Undergraduate/Graduate Programs with the UM-SJTU Joint Institute

Summary

We propose a Combined Undergraduate/Graduate Program (CUGP) for students receiving ECE BS degrees from the UM-SJTU Joint Institute (JI) that will allow such students to earn a masters in EE or EE:S, while double counting up to 6 credit hours between their bachelor's and master's programs.

CUGP is available to UM-SJTU JI students who study in Shanghai, but not those who come to Ann Arbor as part of the JI. The latter receive two degrees, one from UM and one from SJTU JI, whereas the former receive only one degree from the UM-SJTU JI. Since credits earned here by the latter (SJTU students studying at UM) count towards two degrees, it is not considered appropriate that they count also towards a third degree (the masters).

The GUGP program is largely patterned after the SGUS programs offered by most CoE graduate programs. However, it allows double counting fewer credits than is typical for an SGUS program.

A template CUGP with SJTU has been approved by the College of Engineering and Rackham. Each graduate program in the College can decide whether or not it wishes to have a CUGP with SJTU for its students. If it wishes to do so, it must partner with an undergraduate degree program in the SJTU JI in Shanghai. Approval is needed from the CoE Curriculum Committee and College faculty. No further Rackham approval is needed.

It is proposed here that the EE and EE:S Graduate Programs partner with the ECE Undergraduate Program of the SJTU JI.

Goals

Goal Statement from the CoE Template Proposal

"This program will afford an excellent education to JI students, an education that would otherwise be hard for them to achieve because of the cost of study in the US. The program will increase the opportunities for Chinese students to complete a masters degree in engineering, a degree that increasingly is seen as the key entry degree into professional practice. Michigan-based employers of UM graduates have expressed enthusiasm for the JI because it allows US educated engineers to be well placed for employment in their Chinese operations. In addition, this program will allow the UM to recruit excellent grad students for both our masters and doctoral programs, and it increases our engagement with China and the internationalization of our student body."

Additional ECE Goal

ECE has the capacity and the interest to increase enrollment in its graduate classes. Moreover, the College is encouraging all graduate programs to consider increasing master's enrollments. Thus, a further goal of CUGP is to attract a sizable number of excellent Master's students to the EE and EE:S MS programs, some of whom are likely to be interested in continuing for the Ph.D.

This year, based only on the knowledge that the College of Engineering was developing CUGP and that it was available in some departments, we received 7, 10 application to EE, EE:S, respectively, from SJTU JI students who expressed interest in CUGP, a handful more who did not, and a handful of applications from UM undergraduates from SJTU. In the longer term we believe there will be sufficient applicants to attract 10 to 20 students to each MS program. Though there is no need to cast a rule into concrete, we anticipate that it makes sense to limit the number of such students to 15-20% of the incoming graduate students, so that the graduate programs are not dominated by students from any one school.

CUGP Requirements

1. Students admitted to the EE or EE:S CUGP will enroll in the chosen master's program upon completion of their JI undergraduate degree. The undergraduate degree must be awarded before matriculation into the master's program.
2. Students must enroll in the masters program for at least two full terms, paying full tuition.
3. Students must complete at least 24 credit hours in residence at UM Ann Arbor.
4. Students may not be simultaneously enrolled in any other UM program.
5. Students may count up to 6 credits from their SJTU JI bachelor's degree towards the master's. These are the "double counted" credits. This happens by transferring the courses to their Rackham transcript. If the specific courses from which the double counted credits are to come total more than 6 credit hours, e.g. two 4 credit classes, then all of the credits appear on the graduate transcript, but only 6 count towards the 30 required for the master's degree. The balance of any credit hours cannot be counted toward any other graduate program at UM or SJTU. The balance can count towards the undergraduate program at the JI.
6. To be double counted, credits must
    a. be graduate level
    b. be taken during the Junior or Senior year
    c. have received a grade of B or better
    d. be acceptable towards the 30 credit Master's requirement
    e. be approved by the graduate program (normally at the time of admission) and approved also by the undergraduate program[1]
    f. not be part of the required core coursework for the JI BS; however, they can be courses taken to meet technical or general elective requirements[1]
7. Double counted credits may have been taken prior to admission to the CUGP.

---

[1] This is one reason why we need to partner with the SJTU EE Program. We need them to tell us what are the "required core courses".

8. No credits can be triple counted, i.e. counted towards any degree other than the JI BS and the EE or EE:S MS.
9. A student's Rackham transcript, including transfer credits and credits in residence must fulfill all master's requirements, with the usual provision for equivalency for courses that do not appear on the transcript.
10. Students earning any two bachelors degrees (e.g. from UM and the JI) are not eligible for the JI-Combined Undergraduate/Graduate Program.
11. By way of comparison, any UM master's student whose undergraduate degree is from another institution may transfer up to 6 credits of graduate level coursework from his/her undergraduate transcript to his/her Rackam graduate transcript, provided these credits received a B or better, did not count towards any degree requirement (not even as free elective), and are approved by our graduate program. A UM master's student whose undergraduate degree is from UM may transfer up to 15 credits, subject to the same restrictions.

Admissions

1. JI students apply for admission to the MS EE CUGP or the MS EE:S CUGP by submitting the Rackham application (including statement of purpose, personal statement, letters of recommendation, etc.), application fee, other required credentials, ToEFL or MeLab scores, and the JI-CUGP Course Election Form (see attached draft). (Financial resource information will be needed if accepted.)
2. GRE scores are not required[2].
3. Applications can be submitted at any time in the second semester (ending in August) of the 3rd year of study at the JI, through March 1 of the senior year. An academic transcript through at least the second semester of the 3rd year is needed for the admissions decision. If the student applies during the second semester of the 3rd year, the transcript will need to be sent immediately after the term ends.
4. On the CUGP Election Form, the applicant lists JI courses proposed for double counting and a plan of study for the master's, both approved by the CUGP undergraduate advisor. Approval by the grad chair, and probably a grad advisor, is required for admission.
5. The EE and EE:S Programs will make admission decisions based on the qualifications of the applicant and the number of students the program can accommodate. For admission, applicants must have a minimum GPA of 3.5 and maintain this

---

[2] SJTU JI Associate Dean Robert Parker has indicated that if the GRE is not required, it will be attractive to JI students because, apparently, Chinese students who take the GRE spend a great deal of time studying English for the exam. On the other hand, aside from the question of whether we need the GRE to make admissions decisions, taking the GRE might be necessary to apply for various fellowships, and there might be some benefit to their spending so much time studying English.

through completion of their undergraduate degree. However, meeting the minimum GPA requirement does not guarantee admission.

6. It is anticipated that when JI students apply during or after the second (summer) semester of the 3rd year, an admissions decision can be made soon enough to permit admitted students to choose the Fall schedule of their senior year to take a class or classes that can be double counted. For this to happen, admissions decisions would need to be made by mid-September, and be based on informal transcripts from the summer semester (followed later by an official transcript).
7. An admission letter and pre-enrollment materials will be sent to applicants offered admission.

JI-Combined Undergraduate/Graduate Program Course Election Form

As part of the application process, the student, in consultation with the SJTU JI undergraduate CUGP advisor, will submit a CUGP course election form, which proposes a plan of study for the MS degree, and courses proposed for double counting. If the student is admitted, the plan of study and the courses proposed for double counting will either be approved, or a modification will be proposed. Changes to the MS plan of study or the courses proposed for double counting may also be made after the student arrives in Ann Arbor, subject to the approval of a graduate advisor.

JI Combined Undergraduate/Graduate Program Course Election Form

Student Name ____________________ JI ID # ________________

Degree Program ____EE or EE:S________________________________

JI Degree Expected ________________ Date/Year to be Awarded ____________

JI Courses to double count & transfer (≤ 6)		UM Courses to Complete MS program (≥24)	
Course	Credits	Course	Credits
Total		Total	

SIGNATURES:

Student ____
(signature) (name printed) (date)

JI Advisor ____
(signature) (name printed) (date)

Graduate Advisor ____
(signature) (name printed) (date)

Graduate Chair

____
(signature) (name printed) (date)

Proposal: To Replace the EE and EE:S CUGS Programs with SGUS Programs

From: ECE Graduate Academics Committee

Approved by the ECE Faculty, March 19, 2010

Summary and Goals

It is proposed to replace the Combined Undergraduate/Graduate Studies (CUGS) Programs in EE and EE:S with Sequential Graduate/Undergraduate Studies (SGUS) Programs.

We subscribe to the oft stated view, that industry and society are better served when more engineering students continue for a Master's degree, which is generally considered to be the first professional engineering degree. Both CUGS and SGUS are mechanisms to encourage UM EE and CE BS students to continue for the Master's by allowing them to double count six to nine credit hours toward both the BS and MS requirements. With such programs it is often possible for students to complete the BS and MS in 5 years.

In the late 1980s, EECS became the first CoE dept. to permit such double counting by adopting a CUGS program, along the lines of CUGS programs already in LSA. There are, however, some drawbacks to the CUGS program that tend to discourage students, such as (a) the coursework to be double counted must be taken in semesters in which the student is registered simultaneously in Engineering and Rackham, which is expensive since the student pays graduate tuition for the double counted courses[1], and which prevents a student from double counting a class taken prior to admission to CUGS, and (b) registration as a Master's students can void some sources of financial aid.

Due most likely to such drawbacks, the admissions to CUGS have been modest. (EE averaged 4 per year over the past 7 years; EE:S averages 2.8 over the past 6 years) To our knowledge only one or two other Engineering graduate programs adopted CUGS. However, many Engineering programs were interested in allowing students to double count credits, and with their encouragement, a new double-counting program, SGUS, was created in which students "admitted" to SGUS complete their BS before enrolling in the Rackham MS program[2]. Hence, the term "sequential" in SGUS, in comparison to "combined" in CUGS. It is here proposed that the EE and EE:S Master's programs switch from CUGS to SGUS. CSE has already proposed switching from CUGS to SGUS, and this proposal borrows significantly from the CSE proposal.

ECE has the capacity and the interest to increase enrollment in its graduate classes. Moreover, the College is encouraging all graduate programs to consider increasing Master's enrollments. Thus, a further goal is to increase enrollment in ECE graduate classes. With this in mind, it is believed that SGUS will be more attractive than CUGS.

---

[1] For a number of years, the EE and EE:S Programs have subsidized the difference between graduate and undergraduate tuition for in-state students.

[2] As explained later, they may also enroll in Rackham when they have six or fewer credits remaining for the BS degree.

There are no plans to propose changes to the "3.4" program, by which UM EE and CE undergraduates with a 3.4 or better GPA can gain automatic admission to the EE or EE:S Master's programs simply by applying to Rackham, with no requirement for GREs or letters of recommendation.

Current CUGS Program

Statement of Purpose (from Dept. webpage)

"The EECS CUGS program was created to offer our best students an opportunity to complete the Master's requirements as part of a seamless program of five years at Michigan. This is done by allowing students to enroll with both undergraduate and graduate status for up to eight hours of credit. These eight hours are "double counted" and are used to fulfill both Bachelor's and Master's requirements."

Double Counting

- Can double count up to 8 credit hours taken while in the CUGS program.
- Must be "Rackham graduate classes", e.g. 400 or 500 level EECS classes.
- These classes appear on both the undergraduate and graduate transcripts. The grades appear on both transcripts, but are included only in the undergraduate GPA.
- If, for example, a student registers for three 3 credit classes, all 9 credits will appear on both transcripts. However, only 8 credits can be used toward the total of 30 required for the MS. All three classes can be used to satisfy Master's kernel requirements.
- Note: Rackham normally allows students to transfer from an undergraduate transcript to the graduate transcript up to 15 credits of graduate level coursework that was not used to satisfy any BS requirement, including the requirement for 128 credit hours total. SGUS students may similarly transfer graduate level credits that were not used to satisfy any BS requirement, provided the total of double counted and transferred credits does not exceed 15.

Eligibility

- Enrolled in EE or CE.
- Not enrolled in two undergraduate degree programs or in a dual-degree program.
- At least 85 credits completed toward the BS.
- At least 3.6 GPA (necessary but not sufficient; an admissions decision is made).

Application

- Rackham application for Master's program, including statement of purpose, personal statement, three letters of recommendation.
- Transcript (can be unofficial).

- GRE not required.
- Email requesting consideration for CUGS
- Apply by March 1 for Fall term, by Oct. 30 for Winter term.
- The usual application fee.

Proposed SGUS Program

Statement of Purpose

The EECS SGUS program is intended to provide our best students the opportunity to complete the Master's requirements as part of a seamless program of five years at Michigan. This is done by allowing students to "double count" up to eight hours of credit in graduate level classes toward both the both Bachelor's and Master's requirements.

Double Counting

- Can double count up to 8 credit hours taken before or after admission to SGUS.[3]
- Must be "Rackham graduate classes", e.g. 400 or 500 level EECS classes.
- The grade must be B or better.
- Must be classes acceptable toward the 30 credit Master's requirements. As an example of something not allowed, EE:S does not allow both EECS 455 and 554 to count toward the Master's, so 455 could not be double counted if 554 is also taken.
- The double counted classes appear on both the undergraduate and graduate transcripts. On the graduate transcript, they appear as transferred credits. The grades appear on both transcripts, but are counted only toward the undergraduate GPA.
- Only whole classes (and not, say, half of a 4 credit class) can be transferred to the graduate transcript for double counting. However, if, for example, a student wishes to double count three 3 credit classes, all 9 credits will appear on both transcripts. However, only 8 credits can be used toward the total of 30 required for the MS.
- The double counted classes may have been taken prior to admission to SGUS.
- For BS EE students, the double counted classes may not include any EE "Program Core" Courses (of which EECS 401, EECS 496, Tchnclcm 496 are at the 400 level), any courses chosen to satisfy the EE "Core Electives" requirement (8 credits from a

---

[3] It is anticipated that with 8 credits allowed for double counting, some students can finish the Master's in two semesters, by taking a total of 22 credits, and others will need an additional Spring semester in which to take, for example, a directed study or Math class. Moreover, students who enter the BS program with advanced placement or who take more than the nominal 16 credits per semester can easily graduate with more than 128 credits, some of which can likely be transferred to the graduate transcript, making it easier to finish the MS within 5 years.

list including 400 level classes EECS 451, 455, 460), or any course chosen to satisfy the EE MDE requirement (one from EECS 411, 413, 425, 427, 430, 438, 452, 470).

- For BS CE students, the double counted classes may not include CE "Program Subjects" (EECS 401, Math 435, Stat 412, EECS 496, Tchnclcm 496, Tchnclcm 497), or any classes chosen to satisfy the CE "Core Electives" requirement (two courses from a list that includes EECS 451), or any class chosen to satisfy the MDE requirement.
- For BS CS students, the double counted classes may not include CS "Program Subjects" (including STAT 412, STAT, Stat 426, EECS 496, Tchnclcm 496 at the 400 level), or any class chosen to satisfy the MDE requirement.
- For all SGUS students, EECS 499 credits may not be double counted. (For graduate directed study credit, students should take a graduate directed study or research class, e.g. 599, 698, 699.)
- Note: Rackham normally allows students to transfer from an undergraduate transcript to the graduate transcript up to 15 credits of graduate level coursework that were not used to satisfy any BS requirement, including the requirement for 128 total credit hours. SGUS students may similarly transfer graduate level credits that were not used to satisfy any BS requirement, provided the total of double counted and transferred credits does not exceed 15.

Degree Requirements

- To attain the BS degree, the undergraduate transcript must satisfy all requirements for the BS degree.
- To attain the MS degree, the graduate transcript must satisfy all requirements for the Master's degree, assuming the usual rules for allowing equivalency for courses that do not appear on the transcript.
- The student must enroll for at least two full terms in Rackham (minimum of 9 credits each term), paying full tuition.
- Students must either have finished the BS requirements or be within 6 credits of completing their BS at the time they "Officially Enroll" in the Master's Program, and in the latter case, they must complete the BS requirements in the first semester of such enrollment.[4]

---

[4] As an example, suppose an SGUS student finishes the Winter semester of his/her fourth year with 126 of 128 credits required for the BS. Then to finish an MS in 5 years and to satisfy the requirement to register two full semesters as a Rackham student, the student needs to register the next Fall and Winter semesters as a Rackham student. He/she will complete the remaining two credits of the BS in the Fall, and assuming he/she has 8 credits to double count, needs to take an additional 22 credits during the Fall, Winter and, possibly, Spring terms.

- Each degree may be awarded upon completion of the requirements for the degree. Students will normally graduate at the end of the term in which the degree requirements are met.

Eligibility

To be eligible to apply for the SGUS Program a student must:

- Be enrolled in EE or CE or CS.
- Not be enrolled in two undergraduate degree programs or in a dual-degree program
- Have completed at least 80 credits toward the BS
- Have a 3.6 or better GPA. (This is necessary but not sufficient. An admissions decision will be made.)

Application Process

Overview: The application process has two stages. In the first, a student applies to the EE or EE:S Graduate Program for admission to the SGUS Program. (This application goes only to the Graduate Program and not to Rackham). If admitted, the SGUS student remains an undergraduate engineering student through completion of his/her BS[5]. In his/her last semester as an undergraduate, the SGUS student applies to Rackham to become a Master's student, effective the following semester. This second stage is basically just a formality, as the admission into the SGUS Program in the first stage essentially guarantees admission into Rackham in the second stage, provided the SGUS student still satisfies the eligibility requirements. The only substantive hurdle is that international students need to certify funds for graduate study.

Stage 1: Admission to SGUS

Obtain the EE or EE:S SGUS Admission Form from the EE or EE:S Graduate Coordinator, respectively, and submit the following (as indicated in the form): (Students do to Rackham at this time.)

- Completed EE or EE:S SGUS Admission Form.
- Unofficial copy of transcript, showing at least 80 credits towards the BS.
- Plan of study, which includes, courses proposed for completion of the BS and MS degrees, as well as a list of courses proposed for double counting. This plan will be reviewed by the admissions committee and can be updated after admission to SGUS, if desired or needed.
- Statements of purpose, personal statement, and letters of recommendation are not required.

---

[5] The exception being an SGUS student, who as described earlier, becomes a graduate student with 6 or fewer credits to be completed for the BS.

- GRE is not required. However, students who are seriously considering the pursuit of a Ph.D. are generally advised to take the GRE in their senior year.
- The applicant must meet with an advisor (or advisors) and obtain the advisor's signature on his/her application. (The purpose is to make sure the SGUS program makes sense for the given student, and to assist the student in preparing a plan of study.)

An SGUS Admissions Decision will be made by the program to which the student has applied based on this submitted material.

If admitted to SGUS, then within two weeks of admission, the student meets with an SGUS Advisor or Advisors to discuss his/her plan of study, and possibly to revise it.

Stage 2: Apply Online to Rackham for "Official MS Enrollment"

During an SGUS student's last semester as an undergraduate, he/she completes an online Rackham application to enter the Master's Program. This initiates the "Official Enrollment" into the Rackham Graduate School and the Master's Program. As mentioned earlier, admission to Rackham is a formality, assuming the student continues to be eligible for SGUS and, in the case of international students, sufficient funding is certified.

To be included in this Rackham application are, among other things:

- The statement of purpose, personal statement, and letters of recommendation are not required.
- GRE is not required.
- Rackham admissions fee.

Application Timing

- Students normally submit the Stage 1 application for SGUS in the second semester of their junior year, but they may also apply during their senior year.
- Stage 1 applications are accepted until Oct. 30 in each Fall term and until March 1 in each Winter term.
- Stage 2 applications must be submitted in the Fall or Winter semester prior to enrolling as a graduate student. The deadlines are Oct. 30 in a Fall term and March 1 in a Winter term.
- In rare circumstances, a student might only become eligible for SGUS after completion of the BS degree. In such cases, a student who desires to be admitted to SGUS (so as to be able to double count coursework already taken toward a Master's) should immediately contact the Graduate Program of choice to see if special arrangements for an application to SGUS are possible.

Note about SGUS for PhD students

Undergraduate students who are seriously interested in the PhD program are not likely to benefit significantly from the SGUS program (since PhD students almost always take more than 30 graduate credits) and are encouraged to apply directly for a PhD Program rather than SGUS, which will make them eligible for funding.

SGUS students who become interested in pursuing a PhD while pursuing the Master's should take the GREs and apply for the PhD program (and funding) in the usual way.

Note About Administering SGUS Programs

Faculty are needed to make admission decisions on SGUS applications and to advise students on their plans of study. Someone from each program should be designated to make admissions decisions (possibly the Graduate Chair or a member of the Admissions Committee). The advising is probably best done by designating one or more undergraduate advisors to serve as an "SGUS Advisor", and having the plan of study approved both by this SGUS Advisor and by the Graduate Advisor in the student's proposed major area.

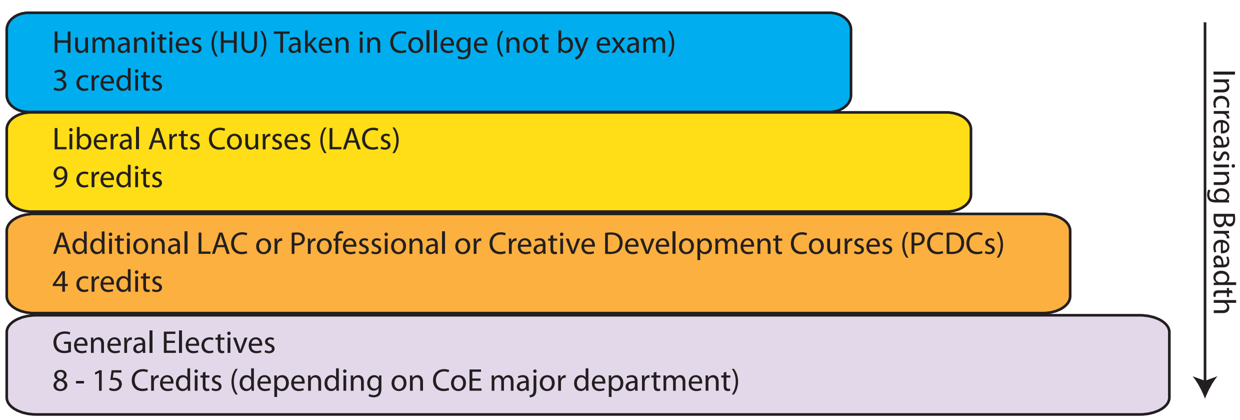
*If approved by the CoE faculty, the following text will replace two clauses in the CoE Bulletin, effective Fall 2011. The clauses replaced are Foreign Languages (**http://www.engin.umich.edu/bulletin/uged/reqs.html#lang**) and Humanities & Social Sciences (http://www.engin.umich.edu/bulletin/uged/reqs.html#hums)*

Approved by CoE Curriculum Committee – Sept 14th, 2010

Intellectual Breadth

It is important that our students learn about modes of thought and areas of human accomplishment beyond the purely technical. This breadth can be designed by students to provide context to their engineering work by learning about human modes of thought, the structure and history of the human societies that they serve as engineers, how humans behave and interact, and how humans express their aspirations in the arts, literature and music. This breadth will help students to understand the impact of engineering solutions in a global, economic, environmental, and societal context. This breadth makes our students more flexible, creative, and better able to work with diverse groups.

We cannot precisely define all of these possibilities for every student so we strive to create a broad intellectual opportunity for students to pursue their interests both beyond and within engineering. Students are encouraged to use these credits in a coherent way to build a foundation of understanding in both the liberal arts and other disciplines that might contribute to their development of creativity or professional foundation.



The College of Engineering requires all students to complete 16 credits of intellectual breadth courses and between 8 and 15 credits of general electives (depending on engineering major). These credits are arranged in a hierarchy of 4 levels, each broader and more flexible than the previous:

1. **Humanities**: 3 credits of Humanities classes marked HU in the LSA course guide; credit by test cannot be used to meet this requirement.
2. **Liberal Arts Courses**: 9 credits of Liberal Arts Courses (LACs) as defined below.
3. **Liberal Arts and Professional & Creative Development Subjects**: 4 additional credits of any combination of LACs or Professional & Creative Development Courses (PCDCs). PCDCs are defined below.

4. **General Electives**: 8 to15 credits of general electives (as defined below), depending on degree program.

At least 3 credits in the Humanities or LACs must be at the 300 level or higher.

The currently approved numbers of general elective hours are:

Degree Program	Credits of Gen Electives	Degree Program	Credits of Gen Electives	Degree Program	Credits of Gen Electives
AERO	9	CHE	12	ID	14
BME	11	CS	15	MSE	12
ESSE	11	EE	11	ME	9
CEE	8	EP	9	NAME	9
CE	13	IOE	9	NERS	10

Definition of Liberal Arts Courses

Liberal Arts Courses (LACs) are intended to give students that broader education in qualitative critical thinking and human society that can give context to their engineering practice and to their contributions as citizens. For the sake of the College of Engineering's intellectual breadth requirements, Liberal Arts Courses (LACs) are meant to exclude mathematics and science courses, as well as some courses that are considered preparatory to the CoE experience. Student's elections of LACs are expected to be in this spirit. The precise operational definition of a LAC is:

- Any course offered by any UM-Ann Arbor unit and marked as HU or SS in the LSA course guide is considered a LAC.
- For a course not marked as HU or SS but offered under one of the LSA subjects listed below, it is considered a LAC if it is *not marked* BS, NS, QR/1 or QR/2 in the LSA course guide.

Arabic, Armenian, Persian, Turkish & Islamic Studies
Ancient Civilizations & Biblical Studies
American Culture
Anthropological Archaeology
Cultural Anthropology
Armenian Studies
Asian Studies
Asian Languages
Bosnian, Croatian, & Serbian
Buddhist Studies
Afroamerican & African Studies
Chinese Studies
Japanese Studies
Classical Archaeology
Classical Civilization
Classical Linguistics
Complex Systems
Communication Studies
Comparative Literature
Comprehensive Studies Program
Czech
Dutch
Economics
English
Environment
French
Geography
German
Greek
Great Books
History of Art
History
Hebrew & Jewish Cultural Studies
College Honors
Institute for the Humanities
Italian
Judaic Studies
Latin American & Caribbean Studies
Latin
Lloyd Hall Scholars
Linguistics
Mass Communication
Medieval & Early Modern Studies
Middle Eastern & North African Studies
Modern Greek
Museum Studies
Museum Methods
Museum Practice
Organizational Studies
Philosophy
Polish
Political Science
Portuguese
Psychology
Russian & East European Studies
Religion

Romance Languages & Literatures
Romance Linguistics
Russian
Screen Arts & Culture
South Asian Studies
Scandinavian
Southeast Asian Studies
Slavic Linguistics, Literary Theory, Film, & Surveys
Sociology
Spanish
Ukrainian
Women's Studies
Yiddish

- In addition, if a course is not marked HU or SS in the LSA course guide, but is marked EXPERIENTIAL or INDEPENDENT, then explicit permission of a CoE program advisor is needed to use it for a LAC course.
- Study Abroad Courses (STDABRD) might be counted as LACs, but only by explicit permission of a CoE program advisor. This is not meant to discourage study abroad, but reflects the broad nature of the STDABRD designation, which otherwise defies classification. As described below, transfer credit from US and foreign institutions may also be accepted as LACs credit.

Note: Chemical Engineering, Civil & Environmental Engineering, Interdisciplinary Engineering, Mechanical Engineering, and Materials Science & Engineering each requires one course in economics. This economics requirement can overlap with the LAC requirement.

Professional or Creative Development Courses (PCDC)

Professional and creative development courses offer a student the opportunity to build on non-engineering and non-technical courses to develop their creativity and professional capabilities as engineers. PCDC courses include any course from the following subjects in the indicated units, provided they are not marked BS or NS in the LSA course guide:

- Taubman College of Architecture and Urban Planning: Architecture (ARCH), Urban Design (UD), Urban Planning (UP)
- School of Art & Design (ARTDES)
- Ross School of Business: Accounting (ACC), Business Administration (BA), Business Economics and Public Policy (BE), Entrepreneurial Studies (ES), Law History & Communication (LHC), Marketing (MKT), Management and Organization (MO), Strategy (STRATEGY)
- School of Music, Theatre & Dance: Music Composition (COMP), Music Theory (THEORY), Theater & Drama (THTREMUS)
- School of Natural Resources and Environment (NRE)
- Ford School of Public Policy (PUBPOL)
- School of Public Health: Health Behavior & Health Education (HBEHED), Health Management & Policy (HMP).

Transfer Credit and Credit by Test

College course credit transferred as any course meeting these requirements will be accepted as a LAC or PCDC. Courses transferred as departmental credit can be accepted at the discretion of a CoE program advisor. Credit by test (e.g. Advanced Placement, A-Level, and International Baccalaureate) can also be used to satisfy any of these requirements except for the 3 credit humanities requirement and except that language credit by test must be at the 200 level or higher (language credit by test at the 100 level can be used for General Electives), and language credit by test is limited to 8 credits.

General Electives
[Note: this is not a change – this language is currently in the CoE Bulletin]

General electives are intended to allow students to explore any dimension of intellectual endeavor that they elect, in both technical (including engineering) and non-technical fields. This requirement can be met by any course offered by the UM Ann Arbor, subject to the following restrictions, or by transfer credit subject to the same restrictions in spirit.

> Restrictions: Courses that require tutoring of other students enrolled in courses are limited to a maximum of 3 credits, with the exception of Physics 333 & Physics 334 which are both allowed for a maximum of 6 credits.
>
> All undergraduate degree programs in the College of Engineering will accept credits earned in 200-, 300- and 400-level courses in military, naval, or air science.
>
> Tutorial courses are not acceptable for credit of grade points but will be included on the student's official record.

PROPOSAL TO CREATE A JOINT MASTER'S DEGREE IN ENTREPRENEURSHIP

SEPTEMBER 2010

SUBMITTED BY:

CENTER FOR ENTREPRENEURSHIP, COLLEGE OF ENGINEERING

SAMUEL L. ZELL AND ROBERT H. LURIE INSTITUTE FOR ENTREPRENEURIAL STUDIES, ROSS SCHOOL OF BUSINESS

IN COLLABORATION WITH:

OFFICE OF TECHNOLOGY TRANSFER, UNIVERSITY OF MICHIGAN

MEDICAL INNOVATION CENTER, UNIVERSITY OF MICHIGAN MEDICAL SCHOOL

CONTENTS

1 PROGRAM OVERVIEW

The Center for Entrepreneurship (CFE) and the Samuel L. Zell and Robert H. Lurie Institute for Entrepreneurial Studies (ZLI), as representatives from the College of Engineering (CoE) and the Ross School of Business (RSB), respectively, propose the establishment of a joint professional master's degree to arm students with the critical multidisciplinary knowledge necessary to create new technology-focused ventures, either as standalone entities or within established innovative organizations. Students will learn to create and capture value from novel technologies within the context of entrepreneurship. The Joint Master's Degree in Entrepreneurship (JMDE) described in this proposal brings together curricula and faculty from the CoE and the RSB, organizing them within a structure that leverages the strengths of both institutions.

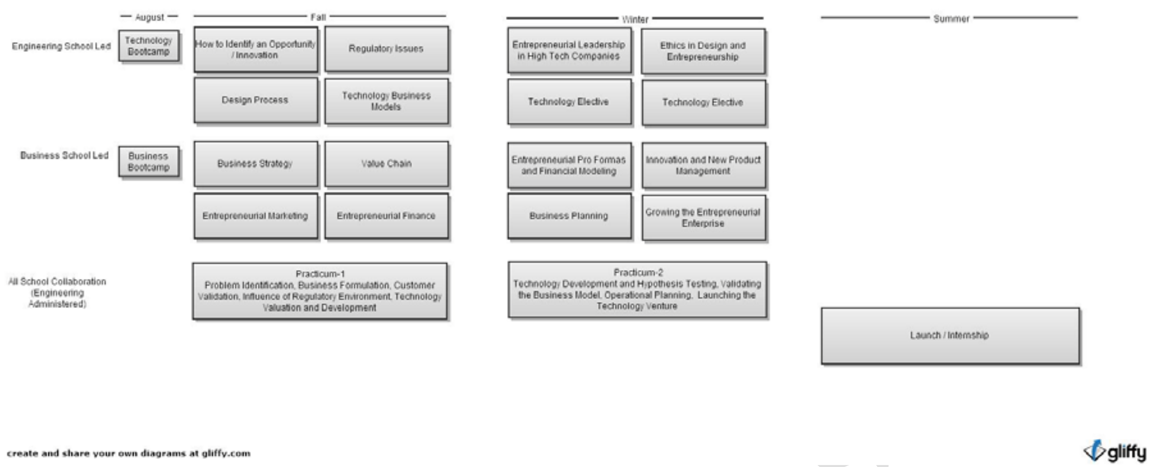
1.1 PROGRAM OBJECTIVES

The program objectives are as follows:

1. Provide graduate level scientists and engineers with a comprehensive understanding of technology opportunity identification and implementation.
2. Educate students in the scientific design approach to product development, emphasizing the importance of customer input throughout the design phase.
3. Provide students with fundamental entrepreneurial business skills for venture creation.
4. Provide students with the opportunity to integrate the key principles of entrepreneurship and technology development and to experience the added-value of this cross-disciplinary approach.

Figure 1 illustrates the overall structure of the program. The JMDE has been designed to be a scalable program that can be customized to individual technical specializations. Content will be delivered in concentrated modules such that specific technical curricula can be taught while leveraging a core curriculum. The degree will initially be launched with an as yet undetermined number of specializations.

Figure 1. Proposed Joint Masters Degree in Entrepreneurship (see Appendix 1 for magnified graphic.)



The JMDE will have a 36 credit hour requirement, separated into three areas as seen in Appendix 1: Business Courses, Practicum, and Technology Focused Courses.

A traditional master's degree in the CoE or RSB typically takes 1-2 years to complete. However, this degree program has been developed such that the concurrent courses and practicum enable students to finish in one calendar year. This approach promotes a cohesive cohort of students concentrating their efforts on the advancement of real world technology. Students will have the opportunity to focus on launching viable ventures at the conclusion of the academic year.

A Joint Master's Degree in Entrepreneurship will offer students a supplement to a Master in Engineering or Master in Business Administration. In this one-year option, students will be prepared to assume fundamental driving positions in a technology-based organization. This is in contrast to both a two-year Master in Business Administration degree, which traditionally trains executive level management, and a Master in Engineering that is research-based, focusing on developing advanced technical competence. Students that participate in the Joint Master's Degree in Entrepreneurship will be more than managers; they will be future ***technology change agents***.

The entrepreneurship degree brings together nationally recognized programs from the CoE and the RSB:

College of Engineering: The College of Engineering at the University of Michigan is consistently ranked among the top engineering schools in the world. All of its undergraduate degree programs and nearly all of its graduate degree programs are top-ranked nationwide. Approximately 1,000 bachelor's degrees and 1,100 master's and doctoral degrees are awarded annually. Degree students may select from more than 1,000 engineering courses offered at U-M. The CoE to provide a continuously improving educational and research environment that educates students to lead, make an impact, and contribute to their profession, industry, government, academia and society.

Stephen M. Ross School of Business School: The Ross School of Business (RSB) is regularly ranked among the top 10 business schools in the world. The RSB manages a broad portfolio of degree programs including a BBA, full- and part-time MBA, Executive MBA, Global MBA, Master of Supply Chain Management, Master of Accounting, and Ph.D. Total enrollment for fall 2009 was 2,957: 1,082 undergraduate and 1,875 graduate students. Their 124 tenure-track and 61 adjunct faculty members are thought-leaders in their fields, holding highly influential editorial and administrative positions in prominent academic organizations, as well as governmental appointments affecting public policy.

2 Employment Opportunities

The proposed Joint Master's Degree in Entrepreneurship has been designed to give students the opportunity to pursue advanced training in technology development without a Ph.D., and to develop highly-valued business skills without an MBA. By learning how science creates value in the marketplace, students pursuing this degree will be prepared to become science and engineering change agents within their own ventures, established businesses, government or nonprofit organizations. Students will be subjected to a comprehensive program that includes rigorous study in science, engineering, and business. The program emphasizes team work and development of the skills necessary to transform cutting-edge technology into a viable business, through a hands-on, year-long practicum. The exposure to real-world uncertainty, under the mentorship of world-class University of Michigan Faculty and entrepreneurs will offer students an unparalleled experience that will help them learn to create change in any organization.

Upon completion of the degree, students will be prepared to create their own venture, or to join a high-tech start-up or a large technology company, and will be prepared to translate technology for commercialization. Graduates with an interest in intellectual property and technology transfer will also be able to work for the federal government or university technology transfer operations. Students will also be well suited to pursue careers in venture firms or patent law firms.

3 Intellectual and Societal Need

For the past several years, there has been national concern that the United States is falling behind in training students in innovation, engineering and science. There is a growing belief that the future of education calls for a new way of teaching, as students will be faced with an entirely different professional landscape than that of their professors. Students will have to compete in a global economy where the rate of technology development outpaces their education and they are constantly pushed beyond the limitations of their education. Engineers will no longer be able to count on a one-job career in a traditional engineering discipline, such as mechanical, electrical, or chemical engineering. Career choices have transitioned to include multidisciplinary pursuits, where individuals are expected to take their primary skill sets and apply them to entirely new specialties (i.e. sustainability, biotechnology, health engineering). As a result of these changes, engineering schools are looking for new ways to educate engineers of the future.

At the same time, the overall landscape of business has been in a state of change. In the mid-20th century, the US economy was dominated by a finite number of big corporations. As we approached the 21st century, small, and high-growth potential new businesses became the main driving force of employment and economic growth. Today, small businesses are playing a larger role in the economy on state, national and global levels. The United States Small Business Association reports an average of 2,356 people per day go into business for themselves. Indeed, small businesses represent 99.7% of all employer firms and create more than half of nonfarm private gross domestic product. During the late 1990s and early 2000s, small businesses provided 60 to 80 percent of the net new jobs in the US economy and most of these new jobs were a result of start-ups in the first two years of operation[1]. More than 500,000 "employer" firms (businesses with employees) are started in the United States every year. [2] Of these firms, the Kauffman Foundation estimates that about 1000 (0.2%) of these firms end up having significant impact on the nation's gross domestic product (GDP)[3]. These temporarily small, innovative firms have been responsible for the commercialization of radical new technologies that are transforming the way we act and interact. The impressive economic contribution of start-up ventures, in conjunction with the changing role of engineers in the global economy has sparked a growing interest in entrepreneurship education across engineering college campuses.

Entrepreneurial tendencies are also at the heart of the future of large companies. These companies face the same environment of change, and entrepreneurs are needed within these companies (often called "intrapreneurs") to identify opportunities, adjust products and exhibit a new sense of agility and flexibility. Companies do not just need good managers, they need entrepreneurs and leaders.

While entrepreneurship-education originated in business schools over 50 years ago, the demand of entrepreneurial training outside of traditional business schools has been increasing since the 1990s. Lateral interest can be seen across specialties, particularly among technologists, engineers, and scientists interested in commercializing their

[1] *Overview and Discussion*. in *Entrepreneurship in the 21st Century*. 2004: U.S. Small Business Administration Office of Advocacy and The Ewing Marion Kauffman Foundation.

[2] Schramm, Carl J., "Building Entrepreneurial Economies," Transition Studies Review (2005); 12 (1); pp 163-171.

[3] Private conversation with Carl J Schramm, President and CEO, and Robert E. Litan, Vice President of Research and Policy, Ewing Marion Kauffman Foundation, December 15, 2009, at Kauffman Institute in Kansas City, MO.

technologies. Traditional business school entrepreneurial education has been seated in graduate business schools helping students with venture creation, business plans, organizational skills and leadership principles. However, the technical innovations that are fueling today's scalable new businesses are evolving from technologists, scientists and engineers.

Today, successful venture creation from these innovations requires much more than knowledge of a single discipline. It not only requires a sound intersection of knowledge across business, engineering and law, but individuals that embody the entrepreneurial mindset. The University of Michigan has the opportunity to create a premier professional master's degree that integrates both technology development and entrepreneurial business fundamentals in real time.

3.1 Student Interest

In April 2010, University of Michigan engineering students were interviewed and surveyed to assess student interest in graduate entrepreneurship education. During personal interviews and two focus groups, students expressed an interest in access to entrepreneurship curricula with the following characteristics:

- *Hands-on, focused training on research specific to University of Michigan*. Students were interested in integrating entrepreneurship education with their ongoing research so as to not distract from their primary research focus.
- *Different than curricula currently offered by the business school*. The program should be technologically based or related to their research.
- *Provide an opportunity to gain real-world experience in creating a start-up or with a functioning start-up.* The program should enable students to put curriculum into practice such that they learn about entrepreneurial business practices through an internship or the creation of their own venture.
- *Teach effective leadership.* Students are interested in learning about effective leadership, management and best practices in change management as change agents in both domestic and international environments.
- *Exposure to leading entrepreneurs.* Students want leading entrepreneurs to be a part of the program, integrating academics, theory and practice in the classroom.
- *Condensed.* The program should be short and upfront, nothing more than one calendar year.
- *Supportive environment.* Ideally the program should offer a hands-on, safe environment, for students to explore the potential of their ideas with the support of top University of Michigan institutions, network and resources.
- *Faculty support.* Students are sensitive to the need to have faculty support in the pursuit of entrepreneurship in an academic environment.
- Additionally, CoE graduate students were surveyed through departmental e-mail-based surveys. One hundred forty seven students responded and results indicated that students have a genuine interest in entrepreneurship programs. More than half of the respondents were interested in participating in entrepreneurial courses, mini courses, or online curricula programs. Thirty three percent (n=42) of the respondents (n=147) stated that they are currently working on a technology that has entrepreneurial potential.

3.2 Programs at the University of Michigan

The University of Michigan has a long history of teaching entrepreneurship. The University's first course in entrepreneurship was offered in 1927 and the annual campus-wide business plan competition started in 1984. The Samuel Zell and Robert H. Lurie Institute for Entrepreneurial Studies (ZLI) was established in 1999 to focus on and build upon the entrepreneurial activities that existed on campus. As the entrepreneurial courses and activities historically resided in the Ross School of Business, early on the Institute focused primarily on expanding business courses and programs in entrepreneurship and creating outreach events open to students across campus.

In 2005, the Institute received a gift for a collaborative business/engineering entrepreneurial education initiative. This gift inspired the creation of several new joint graduate courses between the two schools, in addition to creating several new graduate entrepreneurship courses in the College of Engineering.

In 2008, with the encouragement of the ZLI, the CoE formed its own Center for Entrepreneurship (CFE). The CFE significantly expanded the entrepreneurial offerings for students in the CoE, and extended entrepreneurial offerings to the undergraduate engineering population. That same year, the ZLI assisted the Medical School in the creation of their Medical Innovation Center, thus creating three entrepreneurial pillars across the University of Michigan's Ann Arbor campus.

To date, entrepreneurship course offerings at the University of Michigan have been high quality, a la carte courses, ranging from exposure to entrepreneurship to experiential learning courses that allow students to develop their entrepreneurial skills. With the establishment of the CFE and strong collaborations with the ZLI, University of Michigan students at all levels (graduate and undergraduate) in all schools can enroll in entrepreneurship classes. As University of Michigan entrepreneurship programs continue to evolve, the next step is the establishment of a collaborative graduate degree program that integrates the strengths of both the CFE and the ZLI. The proposed program is a comprehensive approach to entrepreneurship where students learn to connect technology, innovation, and entrepreneurship. Not only will this program be at the forefront of entrepreneurship education nationally, it will establish the curricular foundation for additional program development opportunities for students across the university including a Rackham Certificate Program and continued education for faculty and staff.

3.3 Programs at Other Institutions

For over 10 years, academic institutions have been working to address the changing professional needs of science and engineering graduates by leveraging:

1. Concentrations/Certificates programs, and
2. Professional Science Master's (PSM) degrees.

Concentrations/Certificates: Certificate-based programs typically provide one to four courses of instruction built around introductory knowledge that may be beneficial within entrepreneurship, technology assessment, and technology innovation. These programs, due to a limited timeframe, provide only an introduction to entrepreneurship; they do not create an environment of intensive application of this information to the market, or of business development and translation into a technology or service.

Table 1: Institutions offering certificates in entrepreneurship for engineering and science graduates. (A more detailed description of specific programs can be found in Appendix 4.)

Graduate Science and Engineering Certificates in Entrepreneurship
• Georgia Tech • Purdue University • North Carolina State University • Stanford University • University of South Carolina • MIT • University of Central Florida • Clemson University

Professional Science Master's Degrees: In 1997, the Sloan Foundation funded the first Professional Science Master's Degree with the intent of creating an alternative for the talent pool of scientists and engineers that do not want to pursue academics. The Sloan Foundation "perceived a gap between bachelor-level math and science education and the level of expertise required by employers in industry. In response to this need, the Foundation created the PSM degree to provide a pathway for science and math majors directly into jobs, configuring it in response to employer's desires."[4] As of June, 2010, there were 198 Professional Science Master's Programs and 96 PSM-Affiliated Institutions (www.sciencemasters.com). In addition, in June 2010, the National Science Foundation awarded 21 schools funding to create new Science Master's Programs ($14.7M) as part of the American Recovery and Reinvestment Act of 2009. To date, over 2,500 students are enrolled in Science Master's Programs and 2,500 have graduated.

Table 2: List of 2010 NSF Science Masters Recipients

2010 NSF Science Masters Program Recipients	
• North Carolina State University	• Humboldt State University
• Purdue University	• Clemson University
• SUNY College at Buffalo	• Cornell University
• Rutgers University New Brunswick	• University of Florida
• Grand Valley State University	• Northwestern University
• University of Idaho	• University of Texas – El Paso
• University of Georgia	• Arizona State University
• San Diego State University	• University of New Mexico
• University of Maryland Eastern Shore	• Northern Arizona University
• Rochester Institute of Technology	• University of Alaska Fairbanks
	• San Francisco State University

Professional Science Master's programs are characterized as "science-plus" curricula that combine science and technology coursework with professional skills. A Professional

[4] Gitig, Diana. "Professional Science Master's Degrees" AAAS Science, sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2010_06_18/science.opms.r1000091, June 18, 2010.
[2] http://www.sciencemasters.com/, August 22, 2010

Science Masters program prepares graduate students for careers in business, industry, nonprofit organizations, and government agencies by providing them with a strong foundation in science, technology, engineering and mathematics (STEM) disciplines, but also with research experiences, internship experiences, and the skills to succeed in those careers. Within the community of Professional Science Master's Programs, the focus areas with regard to science and technology and professional skills are diverse, ranging from geology to life sciences and entrepreneurship to capital markets. The PSM programs are two year programs that present students with practice and knowledge in business, communications and regulatory affairs, these programs "have been developed in concert with employers and are designed to dovetail into present and future professional career opportunities".[2]

More recently, several institutions have launched individual Master in Entrepreneurship programs (Table 3). While the actual success of these individual programs has yet to be determined, the number of programs launching is increasing.

Table 3: Masters in Entrepreneurship Degrees

Institution	Degree Title	Launch Date
Northeastern University	Master of Science in Technological Entrepreneurship (School of Technological Entrepreneurship)	2006
University of Rochester	Master of Science in Technical Entrepreneurship and Management (Graduate School of Engineering and Graduate School of Business)	1/2010
Brandeis University	Master of Arts in Computer Science and Information Technology Entrepreneurship (Graduate School of Arts and Science)	9/2009
University of Southern Florida	Master of Science Degree in Entrepreneurship in Applied Technology (Colleges of Business, Engineering, and Health)	2005
University of Texas - Dallas	Master of Science in Innovation and Entrepreneurship (UTD School of Management)	1/2010
Southern Methodist University	Master of Science in Entrepreneurship (SMU Cox Business School)	Fall 2008
University of Notre Dame	Engineering, Science and Technology Entrepreneurship Excellence Master's Program (ESTEEM) (College of Engineering, College of Science & College of Business)	9/2009
Case Western Reserve	Science and Technology Entrepreneurship Program (STEP) Master of Science	1999
Brown University	Program in Innovation Management and Entrepreneurship Engineering (PRIME)	2005
University of Florida	Thomas S. Johnson Master of Science in Entrepreneurship Program	2004
University of Rochester	Master of Science in Technical Entrepreneurship and Management	Fall 2007

4 PARTICIPATING FACULTY

The strength of the entrepreneurship degree lies in the outstanding faculty from across the University of Michigan committed to entrepreneurship and technology translation. The following faculty members have committed to or have been invited to be active participants in the proposed Joint Master's Degree in Entrepreneurship Several prominent entrepreneurs and venture capitalists have also committed to serve as guest lecturers, practicum advisors, practicum mentors, and technical resources.

4.1 COMMITTED COLLEGE OF ENGINEERING FACULTY

Professor Thomas Zurbuchen
Associate Dean for Entrepreneurial Programs, Professor of Aerospace Engineering and Professor of Atmospheric, Oceanic and Space Science

Professor Farnam Jahanian
Professor of Electrical Engineering and Computer Science and College of Engineering Chair

Professor Mohammed Islam
Professor of Cardiovascular Medicine and Professor of Electrical and Computer Engineering

Professor Peter Adriaens
Professor of Civil and Environmental Engineering, Professor of Natural Resources and Professor of Entrepreneurship

Professor Elliot Soloway
Arthur F. Thurnau Professor, Professor of Electrical Engineering and Computer Science, Professor of Education

Aileen Huang-Saad
Lecturer III, Biomedical Engineering
Assistant Director for Academic Programs

Doug Neal
Lecturer, Center for Entrepreneurship
Managing Director, Center for Entrepreneurship

Professor William Hall
Professor of Entrepreneurial Studies, Center for Entrepreneurship

4.1.1 INVITED COLLEGE OF ENGINEERING FACULTY

The Office of Technology Transfer has provided the following list of entrepreneurial faculty that should be invited to participate in the program.

Professor Daryl Kipke
Professor of Biomedical Engineering, College of Engineering

Professor Steve Skerlos
Associate Professor of Mechanical Engineering and Chair, Associate Professor of Civil and Environmental Engineering, College of Engineering

Professor Stephen Forrest
William Gould Dow Collegiate Prof of Electrical Engineering, VP for Research, Office of the VP for Research, Prof of EECS, Prof of Materials Science and Engineering, College of Engineering and Professor of Physics, College LSA

Professor Levi Thompson
Richard E Balzhiser Collegiate Professor of Chemical Engineering, Hydrogen Energy Technology Laboratory, Professor of Chemical Engineering & Professor of Mechanical Engineering, College of Engineering

Professor Ann Marie Sastry
Professor, Biomedical Engineering, Materials Science & Engineering and Mechanical Engineering

Professor Shu Takayama
Associate Professor of Biomedical Engineering and Associate Professor of Macromolecular Science and Engineering, College of Engineering

Professor Michael Bernitsas
Professor, Naval Arch & Marine Engineering Department

Professor Sugih Jamin
Associate Professor of Electrical Engineering and Computer Science, College of Engineering

Professor Joerg Lahann
Dow Corning Asst Prof of Chemical Engineering, Assoc Prof of Chemical Engineering, Assoc Prof of Materials Science & Engineering, Assoc Prof of Biomedical Engineering & Asst Prof of Macromolecular Science & Engineering, College of Engineering

Professor Almantas Galvanauskas
Professor of Electrical Engineering and Computer Science, College of Engineering

Professor Khalil Najafi
Professor, Electrical Engineering & Computer Science
Professor, Biomedical Engineering

Professor Sridar Kota
Professor, Mechanical Engineering Department

Jignesh Patel
Adjunct Associate Professor of Electrical Engineering and Computer Science, College of Engineering

Dean/Professor Erdogan Gulari
Associate Dean for Research and Graduate Education, College of Engineering,

Donald L. Katz Collegiate Professor of Chemical Engineering

Professor Noel Perkins
Professor, Mechanical Engineering Department

Professor Ken Wise
Professor, Electrical Engineering & Computer Science

Professor Roy Clarke
Director of Academic Programs, LS&A Physics Department
Professor, LS&A Physics Department

Professor Jerry Lynch
Associate Professor of Civil and Environmental Engineering and Associate Professor of Electrical Engineering and Computer Science, College of Engineering

Professor Alec Gallimore
Arthur F Thurnau Professor, Professor of Aerospace Engineering, College of Engineering and Associate Dean for Academic Program and Initiatives, Rackham Graduate School

Professor Brian Gilchrist
Professor of Atmospheric, Oceanic and Space Sciences
Professor, Electrical Engineering and Computer Science

Professor Jyoti Mazumder
Robert H. Lurie Professor of Mechanical Engineering, Department of Mechanical Engineering; Professor, Materials Science and Engineering; Director, Center for Laser-Aided Intelligent Manufacturing, Mechanical Engineering Department; Director, NSF I/UCRC for Lasers and Plasmas for Advanced Manufacturing

Kathleen Sienko, Assistant Professor of Mechanical Engineering, Assistant Professor of Biomedical Engineering

4.2 Committed Business School Faculty

Professor Thomas C. Kinnear
Professor of Marketing and Executive Director of the Zell Lurie Institute for Entrepreneurial Studies

Professor David Brophy
Associate Professor of Finance and Director of the Center of Venture Capital and Private Equity at the Ross School of Business

Clinical Professor R. Erik Gordon
Associate Director of Zell Lurie Institute for Entrepreneurial Studies, Clinical Associate Professor for Entrepreneurial Studies, and Managing Director of the Wolverine Venture Fund

Adjunct Professor Paul Clyde
Adjunct Professor of Business Economics and Public Policy, Academic Director of the Evening MBA Program and William Davidson Institute Research Fellow

Adjunct Professor Tim Faley
Adjunct Professor of Entrepreneurial Studies
Managing Director, Samuel Zell & Robert H. Lurie Institute for Entrepreneurial Studies

Professor Bill Lovejoy
Professor of Business Administration and Professor of Operations and Management Science

4.2.1 Invited Business School Faculty

To be determined by our Ross collaborators.

4.3 Committed Outside Affiliates/Partners

Several strong supporters of entrepreneurship education at the University of Michigan have agreed to participate in and support the Joint Master's Degree in Entrepreneurship.

Arvids A. Ziedonis, Ph.D., MBA
Academic Director, Lundquist Entrepreneurship Center
Assoc Professor of Management
Charles H. Lundquist College of Business
University of Oregon

Rosemarie Ziedonis, Ph.D.
Assoc. Professor of Management
Charles H. Lundquist College of Business
University of Oregon

Jeff Schox, Esq.
Schox, PLC

Susan Kornfield, Partner, Bodman, LLP

Marc Weiser, Venture Capitalists, RPM Ventures

Steve Blank, Lecturer, University of California, Berkley

4.4 Admissions and Advising

The admissions process to the JMDE will be overseen by both the College of Engineering's Center for Entrepreneurship and the Ross School of Business' Zell Lurie Institute for Entrepreneurial Studies and takes the following course:

1. Interested students should follow all necessary application requirements to apply to the University of Michigan as agreed upon by the CoE and RSB.
2. The entrepreneurship joint-admissions committee will evaluate the application.

3. Faculty members from both the CoE and the RSB participating in the JMDE will advise the student throughout his/her program of study.

Due to the stringent entrance requirements of both the CoE and the RSB, it is expected that admission to the joint master's degree will be very selective. It is expected that individuals applying to this program will have an undergraduate science, technical, or engineering degree. The expected enrollment in the entrepreneurship program is 30 students within the first year and 50-75 students within three years.

5 Program of Study

The proposed Joint Master's Degree in Entrepreneurship (JMDE) can be completed within one year, as shown in Figure 2. The overall structure of the program has been developed to provide students with the fundamental knowledge and skills necessary to shape, assess, and launch a scalable technology-based company (Appendix 2). The degree can also be customized to address the unique aspects of individual technologies. One of the fundamental principles of the degree is experiential learning. Students will be guided through a series of project oriented modules that are designed to lead the students through the business creation process from opportunity assessment to launch.

Student success is not based upon a commercial successful launch of a new venture, but rather the student's ability to master the material and develop the appropriate skill set required to successfully do so either during or following their participation in the program. The course work allows students to gain an entrepreneurial mindset and expand their knowledge on the process of creating commercial value from science, thereby allowing them to bridge the gap between science/engineering and business. The experiential program takes the learning to the next level, by providing students with the opportunity to develop their confidence and turn knowledge gained in the classroom into effective skills.

Figure 2: Sample Joint Master's Degree in Entrepreneurship (JMDE) Schedule

Sample JMDE Schedule	Unit of Instruction	CH	Term 0	Fall A	Fall B	Win A	Win B	Sp/Su
"Boot Camp" preparation (0)								
Business Boot Camp	Ross	0						
Tech Boot Camp	CoE	0						
Subjects required of all specialties (21)								
Business Strategy	Ross	1.5		1.5				
Entrepreneurial Marketing	Ross	1.5		1.5				
Value Chain	Ross	1.5			1.5			
Entrepreneurial Finance	Ross	1.5			1.5			
Identifying Opportunities/Innovations	CoE	1.5		1.5				
Design Process	CoE	1.5		1.5				
Regulatory Issues	CoE	1.5			1.5			
Technology Business Models	CoE	1.5			1.5			
Entrepreneurial Pro Formas & Financial Modeling	Ross	1.5				1.5		
Business Planning	Ross	1.5				1.5		
Innovation and New Product Management	Ross	1.5					1.5	
Growing the Entrepreneurial Enterprise	Ross	1.5					1.5	
Entrepreneurial Leadership in Technology Companies	CoE	1.5					1.5	
Ethics in Design & Entrepreneurship	CoE	1.5					1.5	
Technical elective (3)								
Advanced engineering technical elective	CoE	3				3		
Practicum (6)	CoE	6		3		3		
Business Launch (6)	CoE	6						6
Total		36	0	7.5	7.5	7.5	7.5	6

The JMDE consists of a number of well-coordinated academic modules (Appendix 1-3).

- A technology and business "boot camp", designed as a leveling platform to provide all incoming students, regardless of background, with necessary technology and business fundamentals. This will ensure that students have a basic understanding of the key technology spaces, processes to be addressed in the program, and business vocabulary. This will equilibrate the backgrounds of the diverse cohort of students in the degree program.

- A two-semester practicum series in which commercialization paths for technologies are being developed and new ventures are potentially launched.
- A series of business and technology modules focused on specific stages of the entrepreneurial process, and which is linked to the practicum experience.
- A launch opportunity experience, which may be an internship in an existing young, scalable company, or creation of a new student-led venture.

These academic elements can be taken in their entirety by JMDE students, or in part, by non-enrolled JMDE master-level students, and PhD students in engineering or the sciences, as electives for MBA students in RSB, or by some advanced undergraduates.

5.1 Boot Camp

Students begin the year with a technology and business boot camp. These boot camps are intended to provide students with common terminology and basic understanding of topics to be addressed in the upcoming courses. These courses are critical when bringing together diverse technical backgrounds. The technology boot camp will also offer students insight into the current state of the art of technologies to be discussed during the year.

The business basics boot camp will introduce general business topics and provide a common vocabulary and base level understanding of: nonlinearity of new business creation; small businesses versus high growth-potential firms; finance, marketing, strategy, company creation and assessment framework tools.

5.2 Modules

During the academic year, students will participate in science and engineering-focused courses in parallel with business-focused courses. The courses are designed to take students through the entire stages of entrepreneurship. The order of course delivery has been specifically designed such that the course work can be integrated and implemented in the Practicum in real time. While faculty from different schools will be responsible for the implementation of specific courses, they will work together to coordinate content for maximum value to students. Each module focuses on a specific discipline related to technology entrepreneurship. Lessons are targeted to give students key entrepreneurial tools and frameworks. Each module also introduces students to the vocabulary that dominates a given focus area and therefore provides students with the tools and confidence needed for interdisciplinary discussions that are required for any entrepreneurial outcome.

Each module is 1.5 credits, totaling 24 credits.

5.2.1 Fall A

How to Identify an Opportunity/Innovation (Tech): Students will learn about finding technology opportunities in specific business spaces through innovation. Students will explore creative problem-solving, how to identify the real problem to solve and the correct solution.

Design Process (Tech): Students will learn about the engineering design process, the importance of developing the correct design criteria, and how to relate the design criteria to customer requirements. This course will cover the strategies, methods and means to the design process and how to manage the design process.

Business Strategy (Bus): This strategy course will include models to evaluate competition; intellectual assets, required competencies, technology and product/technology adoption.

Entrepreneurial Marketing (Bus): This marketing course explores the discovery of customer needs; customer identification and persona development; segmentation; and sizing of markets.

5.2.2 Fall B

Regulatory Issues (Tech): Students will be enrolled in either a course focused on biotech regulatory issues (FDA approval process, GMP, etc.), a course focused on environmental issues, or an independent study that will address regulatory issues specific to their technology. The goal is to understand the role of the industry regulatory environment in commercialization and its economic justification.

Technology Business Models (Tech): Students learn about the technology specific business models and the influence of the model selected on long term technology implementation.

Value Chain (Bus): This strategy course investigates the relationships among businesses in a given vertical structure, how they cooperate and interact, their relative values and profitability and their interrelation.

Entrepreneurial Accounting and Finance (Bus): This course will address income statements, balance sheets and cash flow. This course will also explore all of the means by which a start-up firm can finance its growth; develop a valuation methodology and a proposed valuation for the firm; and explore cap table issues, relationships and their implications. Legal aspects of company financing will also be covered.

5.2.3 Winter A

Technology Elective (Tech): Students enroll in an elective course that will add engineering value to their technology development.

Business Elective (Bus): Students enroll in an elective course that will add business value to their venture development.

Entrepreneurial Leadership in Technology Companies (Tech): Students will formulate skills to become effective entrepreneurial managers, including how to appreciate and act on the difference between leadership and management, understand and develop ethical principles of entrepreneurial leadership, and recognize various entrepreneurial strategies and apply them as appropriate.

Entrepreneurial Pro Formas and Financial Modeling (Bus): This finance course will take the nontraditional approach of building an integrated financial model from a blank spreadsheet for start-up organizations. The complete model includes income statements, balance sheets, cash flow statements, revenue projections, capital budgeting, etc.

5.2.4 WINTER B

Technology Elective (Tech): Students enroll in an elective course that will add engineering value to their technology development.

Business Elective (Bus): Students enroll in an elective course that will add business value to their venture development.

Ethics in Design and Entrepreneurship (Tech): Students will learn about the consequences of their technical choices, reconciling conflicting obligations, and the practical ethics of implementation.

Growing the Entrepreneurial Enterprise (Bus): This concluding course will serve as a repository for special topics relevant to start-up firms. Examples of lectures within this course include team selection, managing high performing teams, leadership, growth considerations, strategic alliances, partnerships, transactions, etc.

5.3 PRACTICUM

Like the admissions process, the practicum projects will also by jointly overseen by the College of Engineering's Center for Entrepreneurship and the Ross School of Business' Zell Lurie Institute for Entrepreneurial Studies.

As entrepreneurial skills are developed from the application of knowledge, students will pursue a practicum component in parallel with all the business and technology modules focused on their technology-based new venture. The objective of the practicum is to provide students with the opportunity to apply the material they are learning in the classroom to the spectrum of activities that could lead to a real-world, high value, scalable technology-based new venture. Students will select teams and a technology in Fall A and develop the commercialization strategy, product concept, business model, marketing plan, and translatable prototype throughout the year. Teams will interact with industry relevant mentors throughout the year. This practicum will enable students to see the value of iterative design based on feedback from both engineering and business.

The practicum component will have two features: 1) project specific exposure (including regulatory process, agencies etc.) and 2) project development. The project development component will require students to apply the information they gain in their individual modules to their specific technical project, including but not limited to the selection of an innovation to pursue, development of an IP strategy, business strategy and market analysis, business plan, and operations plan.

The practicum runs through both semesters for a total of 6 credits.

5.4 LAUNCH

During the summer following the academic curricula, students will be provided with the opportunity and support to launch their venture or product. Students will be given three months and seed funding (should their ventures look viable) to pursue their venture or product launch. Students that find that their projects are not viable will be given an opportunity to work in a local start-up venture or company, applying the entrepreneurial knowledge they have accumulated in practice.

5.5 GROWTH AND PROVISIONS FOR EXPANDING

The creation of the JMDE has broad impact and application across the university. The modular design will allow units from across campus to leverage the degree program and establish their own specializations (Figure 1). Such future specializations may include medical devices (Medical Innovations Center) and medical therapeutics or diagnostics (Medical School, Dental School, Life Sciences Institute). In addition, with the establishment of the core Master's Curriculum, UM doctoral students, faculty and staff will be able to access these courses and pursue a Rackham Certificate in entrepreneurship.

The process for establishing new specializations in the entrepreneurship degree is defined as a 4 step process:

1. Assess student interest for the proposed specialization.
2. Assemble core faculty members in the proposed specialization departments(s).
3. Seek approval from the Department Chair or Program Chair.
4. Seek approval from each Academic Unit Dean (College of Engineering and Ross School of Business)

5.5.1 EXAMPLE OF MODULAR FLEXIBILITY FOR SPECIALIZATION

The Medical Innovations Center has already expressed a great deal of interest in developing a Master in Entrepreneurship Specialization in Medical Device Development. The Medical Innovation Center (MIC) at the University of Michigan Medical School has been nationally recognized for its innovative approach to advancing the commercialization of medical technologies and for its educational programs for medical innovators and entrepreneurs. The MIC's inaugural Fellowship Class launched their own medical device company in 2009 even before they had graduated from the program. Through its Inventor Assistance Program, the MIC provides assessment and management services (regulatory path, reimbursement strategy, clinical assessment, prototype development and testing) to medical innovators. Its state-of-the-art Design and Prototype Lab helps innovators realize their product ideas. The creation of a medical device specialization will significantly augment the program offerings of the MIC while leveraging current available resources.

Students interested in pursuing the medical device specialization would enroll in the Master in Entrepreneurship and take classes as defined in Figure 1, substituting medical device specific modules for their technical elective and regulatory module. These two courses would be sponsored by the MIC. Descriptions of these courses are as follows:

Regulatory Issues (Tech): Students will be enrolled in either a course focused on biotech regulatory issues (FDA approval process, GMP, etc.), a course focused on environmental issues, or an independent study that will address regulatory issues specific to their technology. The goal is to understand the role of the industry regulatory environment in commercialization and its economic justification.

For students interested in medical entrepreneurship, this course will provide an understanding of the regulatory bodies and processes that must be understood to bring a medical technology to market both in the US and in major medical technology markets across the world. Students will learn how the design and intended use of their ideas can significantly affect the timeline and costs associated with regulatory path and, therefore, their go-to-market plan. Topics covered include the FDA (Food and Drug Administration), IRB (Institutional Review Board), IDE (Investigational Device Exemption), Design Controls, 510K, PMA (Premarket Approval) as well as pre-clinical and clinical trial design and execution.

Medical Reimbursement Technology Elective (Tech): For students interested in medical entrepreneurship, this course will provide an understanding of the players and processes that must be understood to secure insurance coverage for a medical technology in the US and in major medical technology markets across the world. The course will focus on the three major components of reimbursement: coverage, coding and payment. In addition, the nuances of how medical technology purchasing decisions are made and executed will be covered. Students will learn how the intended use, user profile and location of use can significantly affect the timeline and costs associated with reimbursement path. The topics discussed will include the CMS (Centers for Medicare and Medicaid), regional and local CMS approval processes, private insurance plan, Medicaid, Medicare, the Technology Assessment process, Comparative Effectiveness as well how the design and execution of clinical trials can lead to the success or failure of coverage approval.

5.5.2 Committed Medical School faculty

Dr. James Geiger, Professor of Surgery, Executive Director Medical Innovation Center Clinical Assessment, Observation and Engagement Techniques, Medical Opportunity Identification and Assessment

Dr. Sam Silver, Professor Department of Internal Medicine, Medical Reimbursement

Dr. Blake Roessler, Associate Professor Internal Medicine, Associate Director for Research Innovation (MICHR)

5.5.3 *Invited Medical School Faculty*

Professor David Humes
Professor, Int Med-Nephrology

Professor Arul Chinnaiyan
American Cancer Society Research Professor
DIRECTOR, Michigan Center for Translational Pathology
Investigator, Howard Hughes Medical Institute
Professor of Pathology and Urology
S. P. Hicks Endowed Professor of Pathology

Professor Gary Smith
Professor of Obstetrics and Gynecology, Professor of Molecular and Integrative Physiology, Professor of Urology, Medical School and Research Professor, Reproductive Sciences Program

Professor Brian Ross
Professor of Radiology and Professor of Biological Chemistry, Medical School

Professor David Sherman
Hans W Vahlteich Professor of Medicinal Chemistry, Prof of Medicinal Chemistry, College of Pharm, Prof of Micro & Immun, Med Sch, Prof of Chemistry, LSA, Res Prof of Life Sciences, Life Sciences Inst

Professor Steve Goldstein
Associate Chair for Research, Orthopaedic Surgery
Henry Ruppenthal Family Professor of Orthopaedic Surgery and Bioengineering
Professor Mechanical Engineering
Professor, Biomedical Engineering
Senior Research Professor, Institute of Gerontology

Professor Bruce Richardson
Professor of Internal Medicine, Medical School

Professor Jim Baker
Professor of Internal Medicine and Biomedical Engineering
Ruth Dow Doan Professor of Nanotechnology

6 Administration

6.1 ORGANIZATION AND GOVERNANCE[5]

The College of Engineering is the administrative home of the Joint Master's Degree in Entrepreneurship (JMDE). The program will be run under its unique department ID to enable good management of its resources and expenditures.

The program shall be run by a **faculty program director** which includes the following functions:

- To be a single-point interface to the Ross School of Business (RSB) and the College of Engineering (CoE)
- To run marketing activity, in connection with all partners, to ensure adequate growth of the program
- To provide personal guidance of students entering the program
- To be a steward for contacts and an interface to industrial and professional partners
- To track success and impact of the JMDE on students for possible program improvements.

The faculty program director will be supported by the **Interdisciplinary Professional Programs Office (InterPro),** which already offers a wide range of interdisciplinary graduate programs. The back-office and support functions include the processing of applications, and will also serve as a point of contact for routine questions.

The governance of the JMDE program will be modeled on InterPro programs and will be held by an **Executive Committee** which includes two faculty members from both the RSB and the CoE. The InterPro director and the faculty program director will be two non-voting members of the executive committee.

6.2 ADMISSION

Admissions will focus on candidates who exhibit critical core skills that are relevant to becoming a technological change agent. These are:

- **Leadership:** Success in this program will depend on the ability of candidates to lead. Leadership skills can be demonstrated through a variety of activities such as student project experience or running a startup.
- **Intellectual Quality:** High-quality academic performance should be demonstrated based on GPA and also the results of the GRE. Previous educational experience should include strengths in analytical, technical and quantitative concepts at the level of undergraduate or graduate experiences in engineering, science or other technical fields. If applicable, TOEFL success or relevant work experience should also be demonstrated.

[5] This section has not been discussed in detail with our Ross School of Business Partners and will be adjusted based on inputs from RSB faculty and administrators.

- **Teamwork and Communication:** Entrepreneurial success strongly depends on the ability of an individual to work in teams and to communicate effectively.

These core skills should be explained in an essay and goal statement that should not exceed five pages in length. Beyond that, the application process should follow the InterPro standard with a GPA of 3.4-4.0. Admission recommendations should be prepared by the program faculty advisor, with support from InterPro staff. Final admissions shall be approved by the Executive Committee through a consensus decision. In case of grid-lock, the faculty program advisor shall cast the deciding vote.

6.3 Operating Issues

Each participating school (Ross School of Business, College of Engineering) will handle its own teaching assignments and determine GSI/LEO needs for its allocated courses. Each school will also provide advising for their own courses and also provide access to career placement services. In coordination with the faculty program advisor, each school will be responsible for advertising the program to its own constituency.

Each participating school also should manage its own boot camp through a fee-structure that is approved by the Executive Committee.

As administrative home, the College of Engineering will bear a disproportionate cost for the programs, a per student service fee will be agreed on by both colleges and the RSB will compensate the COE annually for this support. During the first five years of operation, Graham Foundation support may offset that service fee.

6.4 Faculty Incentives and Consulting

During a recent poll of forty COE faculty, of the 50% of all COE faculty who have disclosed an invention during the past ten years, 70% have agreed to support and mentor student projects without any additional incentives or credits. Of the respondents, 20% would seek teaching or service credit or financial support for services rendered by them or their PhD students. More than 90% of the responding faculty also confirmed that they would encourage their PhD students to engage in such mentorship activities, or even to actively participate in the proposed entrepreneurship program.

To enable faculty incentives in the few cases it is needed, we will initially allocate Graham gift funds, enabling a consulting arrangement between a technology owner (faculty, PhD student) and the program. Enabling consulting engagements from outside of the University of Michigan should also be considered.

6.5 Transition Plan

The executive committee should be created as soon as possible to manage the course development. The COE, through the CFE's Associate Director for Academic Programs, will coordinate the rollout plan and approval process. Funds by the Graham Foundation will support initial costs related to course development, program roll-out and marketing based on a budget approved upon by the Executive Committee. This budget should also include any special space, equipment or materials needs, as well as staff assistance. The budget should also include faculty incentives and consulting funds.

The executive committee also shall determine the initial specializations of the Masters Program, as well as rollout of other specializations over time, based on the anticipated needs, importance, and available partnerships and overall student interest in such specializations.

7 CONCLUSION

The past twenty years has seen a renewed interest in innovation and entrepreneurship, with a particular focus on technology-enabled entrepreneurship. As the world becomes more global and converges on the theory that the "world is flat," businesses, policy makers and universities are attempting to redefine themselves in terms of innovation and entrepreneurship. In doing so, strategists have been trying to identify the best business practices to foster innovation, while policy makers and funding agencies are trying to identify policies to facilitate innovation and metrics on how to measure innovation success for future investments. Lastly, universities are responsible for educating the best and brightest future leaders of tomorrow and for "teaching innovation", while also becoming innovative themselves in promoting a more healthy economy for their local communities.

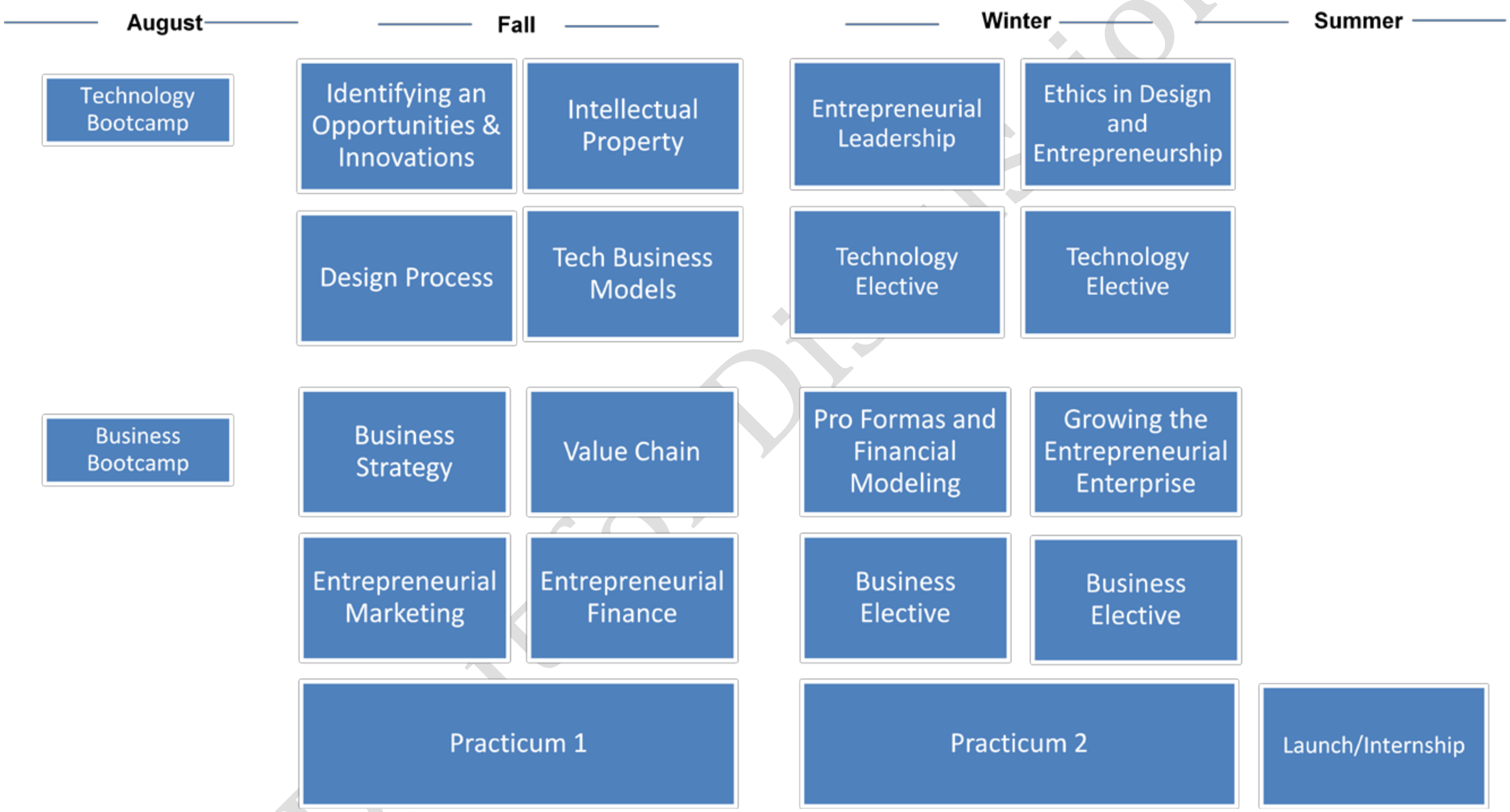
The deans of both the College of Engineering and the Ross School of Business support the creation of the Joint Master's Degree in Entrepreneurship and are committed to its success. The creation of this joint degree aligns with the primary goals of the University as outlined by President Mary Sue Coleman at the 2009 National Summit (Detroit, MI):

> Research universities can be major hubs for entrepreneurial activity and technology innovation, but this environment is not inherent.
>
> Our economic survival as a region and nation is dependent upon a willingness to embrace untested ideas and inventions, encourage risk-taking, and acknowledge failure as simply part of the creative process. Research universities, particularly those in the Midwest, have the opportunity to deliver a profound impact upon tomorrow's knowledge-driven industries: advanced manufacturing, alternative energy, health care delivery, and drug development.
>
> Scholarship and generating new knowledge will always be the foundation of research universities. That must include teaching and nurturing entrepreneurs, be they faculty, staff or students. We do this through coursework, incubator space, student-driven organizations, technology transfer initiatives, and supportive leadership.
>
> Equally important, our job is to convince those holdouts within the academy that "entrepreneurism" is not a dirty word.

When an English professor writes a novel or a collection of poetry, and that work is rewarded with a Pulitzer Prize or the National Book Critics Circle Award, we in higher education celebrate the achievement. When a bioengineering professor develops a medical device with the potential to improve lives, or a scientist licenses a software innovation to industry, we should be just as effusive with our institutional praise and rewards. It should not be viewed as sacrilege, as it sometimes is from wary corners of campus, for entrepreneurial faculty and students to commercialize their work.

Research universities have long been engines of technology and innovation in America. We have shaped the Internet, created the artificial heart and the integrated circuit chip, and developed vaccines to prevent polio and cervical cancer. Now more than ever, we must embolden the academy to provide a thriving culture for entrepreneurs in our community who are determined to make a difference with their innovation and invention.

APPENDIX 1: JOINT MASTER'S DEGREE IN ENTREPRENEURSHIP OVERVIEW (GRAPHIC)



APPENDIX 2: JOINT MASTER'S DEGREE IN ENTREPRENEURSHIP OVERVIEW (DESCRIPTIVE)

A Term	C Business Course	D Practicum: "Supervised practical application of previously studied theory"[6]	E Technology Course
Late August	**Business Boot Camp** (for students outside of the business school): This introductory 2.5 day program will cover general business topics and provide a common vocabulary and base level understanding of: nonlinearity of new business creation; entrepreneurship vis-à-vis small business and high growth firms; finance, marketing, strategy (including concepts of value chain and competition); company creation and assessment framework tools.	**Practicum Objective:** The objective of the practicum is to provide students with the opportunity to apply the material they are learning in the classroom to real-world, high value, technology. Students will select teams and a technology in Fall A and develop the commercialization strategy, business model, marketing plan, and translatable prototype throughout the year. Teams will interact with industry relevant mentors. This practicum will enable students to see the value of iterative design based on feedback from both engineering and business perspectives	**Tech Boot Camp** (for all students). An intensive program designed to educate the students on the basic fundamental technical issues that will be encountered in working with their idea or product through the program. Industry analysis of the technologies to be addressed over the next year will also be covered

[6] Practicum track
- Practicum will be real time implementation of coursework on a specific, real technology
- Information learned from business analysis will be used to influence the technology development
- Each team will be assigned mentors to guide them through the year
- Students will be responsible for coming together as a cohort at least 3 times a week for group feed back
- Entrepreneurs will be brought in to provide feedback specific to the topics students are working on

		Note: This will follow the same framework used in the current CFE Practicum course.	
Fall A	**Business Strategy:** This strategy course will include models to evaluate competition; intellectual assets, required competencies, technology and product/technology adoption. Note: ENGR520 and ES715 cover some of these topics	**Problem Identification:** Students select teams to work on a specific technology focused problem. Students will use this problem to shape technological solutions and commercialization strategies. In this module, students are responsible for - Incorporating - Identifying the current intellectual property that exists with regard to their project - Gap analysis – identifying where their technology fits in the current market and technology situation, strength and weakness of their proposed solution	**How to Identify an Opportunity/Innovation:** Students will learn about finding technology opportunities in specific business spaces through innovation. Students will explore creative problem solving, how to identify the real problem to solve and the correct solution. Note: Material from ChE 405 can be adapted for this module.
Fall A	**Customers and Markets:** This marketing course explores the discovery of customer needs; customer identification and persona development; segmentation; and sizing of markets. Note: ES730 covers some of these topics	**Customer Validation:** Students will identify who their proposed customer is and how they will benefit their customer. This information will be validated by reaching out to real customers and validating or disproving their hypothesis. Information gathered through this process will be used in the	**Design Process:** Students will learn about the engineering design process, the importance of developing the correct design criteria and how to relate the design criteria to customer requirements. This course will cover the strategies, methods and means in the design process and how to manage the design process.

		development of their technology design criteria. Students will develop a deep understanding of their proposed industry.	Note: Materials from the Design Program may be applicable here.
	At the end of Fall A, teams should reliably complete the Business Design exercise through which the product, customer and initial business model are identified.		
Fall B	**Value Chain:** This strategy course investigates the relationships among businesses in a given vertical, how they cooperate and interact, their relative values and profitability and how their role within the chain is defended and economically justified. Note: ENGR520 and ES715 cover some of these topics	**Regulatory Environment and Technology Plan:** Students are required to develop a technology development plan that reflects the current regulatory environment that influences their selected technology and the proposed technology evolution.	**Regulatory Issues**: Students will be enrolled in either a course focused on biotech regulatory issues (FDA approval process, GMP, etc.), a course focused on environmental issues, or an independent study that will address regulatory issues specific to their technology. Example: ChE/Pharm 597 Regulatory Science for Scientists and Engineers
Fall B	**Entrepreneurial Accounting and Finance:** This course will address income statements, balance sheets and cash flow. Students will also explore all of the means by which a start-up firm can finance its growth; develop a valuation methodology and a proposed valuation for the firm; and explore cap table issues, relationships and their implications Legal aspects of company financing will also be covered	**Technology Value Development:** Students will determine the current valuation of their technology based on the current state of development, functional specifications, and regulatory environment. Students will also determine the projected market size based on technology development. This information will be used to influence development of their technology and the commercial	**Technology Business Models:** Students learn about the technology specific business models and the influence of the model selected on long term technology implementation.

	Note: ENGR520, FIN615 and LHC509 cover some of these topics	venture.	
Winter A	**Entrepreneurial Pro Formas and Financial Modeling:** This finance course will take the nontraditional approach of building an integrated financial model from a blank spreadsheet for start-up organizations. The complete model includes income statements, balance sheets, cash flow statements, revenue projections, capital budgeting, etc. Note: Materials would have to be drawn from several courses.	**Technology Development and Hypothesis Testing:** Students will work on furthering the development of their technology to address the information gained in the previous modules. Students will also be instructed to learn through an iterative process of testing their hypotheses. Students' proposed commercial components will also be evaluated and changes to the model based on new information will be encouraged.	**Technology Elective**: Students enroll in an elective course that will add engineering value to their technology development.
Winter A	**Business Elective**	**Technology Development and Hypothesis Testing**	**Entrepreneurial Leadership in Technology Companies:** Students will formulate skills to become effective entrepreneurial managers, appreciate and act on the difference between leadership and management, understand and develop ethical principles of entrepreneurial leadership, and recognize various entrepreneurial strategies and apply them as appropriate. Note: Material being developed for Entrepreneurial Ownership (Pilot W10)

			will be applicable to this course.
	At the end of Winter A, teams will complete a feasibility study and use the results to iterate on the original Business Design.		
Winter B	**Business Elective**	**Validating the Business Model:** Students use the information learned throughout the year to identify the formal, launching business model for their technology through interactions with industry and technology mentors.	**Technology Elective**: Students enroll in an elective course that will add engineering value to their technology development.
Winter B	**Growing the Entrepreneurial Enterprise:** This concluding course will serve as a repository for special topics and their relevance to start-up firms. Examples of lectures within this course include team selection, managing high performing teams, leadership, growth considerations, strategic alliances, partnerships, transactions, etc. Note: ES569 and MO617 cover some of these topics.	**Launching the Technology Venture:** Students finalize their business plan, identify necessary resource aggregation (capital resources, human resources and technology resources), and establish performance standards for their launch. Students will be required to develop the appropriate metrics to evaluate their venture going forward.	**Ethics in design and entrepreneurship:** Students will learn about the consequences of their technical choices, reconciling conflicting obligations, and the practical ethics of implementation. Note: The U-M Center for Ethics in Public has offered to collaborate and co-fund on the development of this course.
	At the end of the Winter term, teams will have completed a full business plan. Teams looking to eventually raise equity capital will also complete an investor pitch. In the latter half of the Winter term, teams will also undertake resource acquisition activities to position themselves for a more successful launch in the summer term.		
Total			

Summer	**Launch/Internship**

Appendix 3: Joint Master's Degree in Entrepreneurship Sample Schedule

Sample JMDE Schedule	Unit of Instruction	CH	Term 0	Fall A	Fall B	Win A	Win B	Sp/Su
"Boot Camp" preparation (0)								
Business Boot Camp	Ross	0						
Tech Boot Camp	CoE	0						
Subjects required by all specialties (21)								
Business Strategy	Ross	1.5		1.5				
Customers and Markets	Ross	1.5		1.5				
Value Chain	Ross	1.5			1.5			
Entrepreneurial Accounting and Finance	Ross	1.5			1.5			
How to Identify an Opportunities/Innovations	CoE	1.5		1.5				
The Design Process	CoE	1.5		1.5				
IP Strategy	CoE	1.5			1.5			
Technology Business Models	CoE	1.5			1.5			
Entrepreneurial Pro Formas & Financial Modeling	Ross	1.5				1.5		
Growing the Entrepreneurial Enterprise	Ross	1.5					1.5	
Entrepreneurial Leadership in Technology Companies	CoE	1.5					1.5	
Ethics in Design & Entrepreneurship	CoE	1.5					1.5	
Technical elective (3)								
Engineering elective	CoE	3				3		
Business elective (3)								
Business elective	Ross	3				3		
Practicum (6)	CoE	6		6 (Ygraded)				
Business Launch (6)	CoE	6						6
Total		36	0	7.5	7.5	7.5	7.5	6

Potential Specializations

1. Biomedical Engineering
2. Clean Tech
3. Mobile Phone Applications
4. Social Entrepreneurship

Joint Master's Degree in Entrepreneurship Example: Biomedical Engineering

Sample JMDE Schedule	Unit of Instruction	CH	Term 0	Fall A	Fall B	Win A	Win B	Sp/Su
"Boot Camp" preparation (0)								
Business Boot Camp	Ross	0						
Tech Bootcamp	CoE	0						
Subjects required of all specialties (21)								
Business Strategy	Ross	1.5		1.5				
Customers and Markets	Ross	1.5		1.5				
Value Chain	Ross	1.5			1.5			
Entrepreneurial Accounting and Finance	Ross	1.5			1.5			
How to Identify an Opportunities/Innovations	CoE	1.5		1.5				
The Design Process	CoE	1.5		1.5				
IP Strategy	CoE	1.5			1.5			
Technology Business Models	CoE	1.5			1.5			
Entrepreneurial Pro Formas & Financial Modeling	Ross	1.5				1.5		
Growing the Entrepreneurial Enterprise	Ross	1.5					1.5	
Entrepreneurial Leadership in Technology Companies	CoE	1.5					1.5	
Ethics in Design & Entrepreneurship	CoE	1.5					1.5	
Technical elective (3)								
Engineering elective	CoE	3				3		
Business elective (3)								
Business elective	CoE	3				3		
Practicum (6)	CoE	6		6 (Y Graded)				
Business Launch (6)	CoE	6						6
Total		36	0	7.5	7.5	7.5	7.5	6

Technology Boot Camp:

- BA518/HMP 630/Parma620 Business of Biology

Eligible Biomedical Technology Electives (this is a representative list of potential electives – In instances where courses require prerequisites, students will be required to do them or to seek permission from the instructor)

- ChE/Pharm 597 Regulatory Science for Scientists and Engineers
- BME430 Rehabilitation Engineering and Assistive Technology

- BME530 Rehabilitation Engineering
- BME 584 Tissue Engineering
- BME 582 Medical Radiological Health Engineering

Example Course Content

for

College of Engineering Core Courses

Technology Boot Camp: Biomedical

Adapted from: BA518/HMP 630/Parma620 Business of Biology

Background: During the past decade, advances in life sciences research have continued at a breathtaking pace, enhancing our understanding of the human genome, human genetic variation, and the role that genes play in our everyday health, response to treatment and susceptibility to disease. These advances -- coupled with faster, better and cheaper information technology -- are opening new opportunities in health care. Health care providers are using more genetic information in treating and preventing disease. Health care consumers have more direct access to genetic information than ever before to guide wellness choices. This new frontier in genomic medicine ushers in both opportunity and peril for individuals, companies and societies. Accelerating our progress toward genomic medicine or "personalized health care" will require:

- Continued advances in the life sciences
- Improvements in technology to make these advances "work" in human populations
- Thoughtful commercialization to make these advances available to affected human populations on a safe and cost-effective basis
- Knowledge and empowerment to help consumers understand the individualized risks and opportunities that lie in genomic medicine
- Enlightened public and private policies to increase the value-added intersections between the life sciences, technologies, commercialization, and the consumer.

Objective: To explore the intersections between science, technology, commerce and social policy as they come together to advance (and in some cases retard) progress toward more-personalized health care; to provide a framework to enhance the understanding of the complex scientific and socioeconomic trends, opportunities and challenges that are taking place in the rapidly evolving field of personalized medicine, molecular diagnostics, and targeted therapeutics.

Topics Covered:

1. Personal or Direct-to-Consumer Genomics Companies: Business, regulatory and ethical issues
2. Genomic Medicine in Cancer Treatment: Research progress and the Case of Genomic Health and Myriad Genetics
3. Science of Human Genetic Variation and Disease
4. Genetics Research and Genomic Medicine – A View from a Physician/Scientists
5. The Esperion Story: An Example of a Biotech Success in the Midwest
6. Drug Discovery and the Biopharmaceutical Industry
7. Venture Investing: Biotechnology and Medical Devices

How to Identify an Opportunity/Innovation

Adapted from:

- ChE 405/ENG 405 Problem Solving, Troubleshooting, Entrepreneurship and Making the Transition to the Work Place
- MBC 610 Opportunity Recognition and Ideation (Syracuse University)

Objective (as described by Johan Wiklund, MBC 610): Many people believe that they could never start a business because they are not creative enough to come up with a great business idea, much less several of them. However, that belief is rooted in a misunderstanding of entrepreneurial opportunity and creativity. Entrepreneurs are not poets, sitting at a desk dreaming up ideas. They are problem solvers looking for ways to do things better. You cannot walk down the street with an entrepreneur without him or her pointing out a half dozen ways that things could be improved. This is not the whining of "life's victims" or the ranting of the "disenfranchised." It is the genuine surprise of someone who is sensitive to unmet potential and unexploited opportunity.

Assuming that businesses solve problems for profit, the question emerges: whose problems are these businesses solving? For the most part, the answer is someone else's. Therein lies the challenge of coming up with great venture ideas: the entrepreneur needs to know what other people need and what obstacles are currently preventing those needs from being met as well as they could be. The good news is that problems are never being solved as well as they could be and there is always a better way. This suggests that creativity is indeed essential to the entrepreneurial process, but it is everyday creativity and something that every single human being already possesses in abundance. People are highly adaptive. Often they make do with what they have without paying much attention to whether a better way exists.

This course seeks to provide students with the skills, tools, and mindsets to enable them to discover other people's problems upon which entrepreneurial ventures may be built and to use their own creativity to generate solutions to these problems.

Topics to be covered:

1. What is innovation? How do you translate new innovations?
2. Identifying a need versus finding a need
3. Problem-solving strategies
4. Characteristics, attitudes and environment necessary for effective problem solving
5. Breaking down the barriers to generating ideas
6. Observing users, interviews, testing ideas
7. Generating Solutions

The Engineering Design Process

Adapted from:

- DESCI 501/ARTDES 300-16, ME455 Analytical Product Design

Background: The design of artifacts is addressed from a multidisciplinary perspective that includes engineering, art, psychology, marketing, and economics. Using a decision-making framework, emphasis is placed on understanding basic quantitative methods employed by the different disciplines for making design decisions, building mathematical models, and accounting for interdisciplinary interactions throughout the design development process.

"America's schools and universities must move up to the next level in math and science. And far more people should be graduating in the "soft" sciences of anthropology, sociology, and psychology. Whether it's redesigning hospitals to improve patient stays (and lower costs) or building stores to increase the experience of shopping (and raise profits), the best jobs in the future will be found in the sweet spot where design, customer understanding, and emerging technologies come together for business." - Business Week (March 21, 2005)

Objective: Students learn about the analytical approach to product design through prototyping and design verification.

Topics Covered:

1. Early prototyping for concept exploration;
2. Development of mathematical models for design decisions from engineering, economic, and marketing perspectives;
3. Use of engineering analysis tools and software, Excel-based economic analysis, and conjoint analysis via statistical packages;
4. Conduct of scientific surveys to support user preference modeling;
5. Prototype construction to test design concept prior to finalizing the design
6. Product market fit

Entrepreneurial Legal Transactions and IP Strategy

Adapted from:

- ENGR408 Patent Law

Overview: Inventors and entrepreneurs have several concerns related to legalities around venture formation including: venture formation, protecting their inventions in the very early stages of product development, determining the patentability of their invention, avoiding infringement of a competitor's patent, and leveraging their patent as a business asset. This course will address each of these concerns through the application of law cases and business cases to an invention of the student's choice.

Topics to be discussed:

1. Start-up legal transactions – venture formation
2. Types of Intellectual Property
3. Overview of the patent system
    - Kinds of Patent Protection and Patent Process
    - Sections of a Utility Patent
    - HOW TO: Read a patent
4. Proper subject matter
    a. Subject Matter and Usefulness Requirement
    b. HOW TO: Capture an invention
5. Patentability
    - Novelty and First-to-Invent Requirements
    - Non-Obviousness Requirement
6. Establishing a priority date
    - Publication, Public Use, and On-Sale Limitations
    - Enablement and Best Mode Requirements
    - HOW TO: Prepare and File a Provisional Application
7. Infringement
    - Infringement Analysis (Literal Infringement and Doctrine of Equivalents)
    - Defenses and Remedies
    - HOW TO: Avoid infringement
8. Inventorship and ownership
    - Inventorship Rules
    - Ownership, Assignment, and Licensing of Patent Rights
    - HOW TO: License your technology
9. Patent filing strategy
    - Foreign Filing Considerations
    - HOW TO: Build an affordable portfolio that attracts investors

I. Establishing the Legal Foundation if IP (all of the above)

II. Strategic Management of IP
   a. Corporate Patent Strategies
   b. Licensing and other IP business models
   c. Managing IP in a weak enforcement regime

III. Integrating IP into Corporate Strategy
   a. Optimizing Present Value Creation and Capture
   b. Enabling Future Corporate Growth
   c. Protecting Future

Technology Business Models

Overview: The purpose of this course is to increase the student's ability to understand, analyze, and implement strategy in new technology-based companies. Students will learn how technology impacts and is impacted by a company's specific business model. Students will learn the long-term implication of the business model selected through the review of current models being implemented in the industry.

Topics to be discussed will include:

1. Feasibility assessments of intellectual property landscape;
2. Evaluating business opportunities;
3. Analyzing competition;
4. Review of current and past business models and strategies across industries and; across time;
5. Transformation of the new technology into a market-ready technology-based business;
6. Understanding economic incentive and value extraction;
7. Customer response to business models;
8. Implication of business model choice.

Entrepreneurial Ownership in Technology Companies

Adapted from:

- W10 Pilot Employee Ownership Course

Background: Today, most entrepreneurs are unaware of how their funding decisions affect their businesses. Many believe that in order to scale their ideas, they must raise venture capital and surrender half of their venture's ownership to outsiders; however, this is not necessarily true. This class will explore the various funding mechanisms available for entrepreneurs and discuss their implications for employee ownership, management control, firm culture, strategic direction, and long-term viability. In addition, it will take an in depth look at the value of employee ownership to a business and the specific mechanisms that entrepreneurs can use to create an employee ownership structure and culture.

Course Structure: This course will rely heavily on case-based teaching and group work/presentations. Cases will depict real life management challenges that do not have clear-cut solutions. Students will work in teams and be required to critically evaluate case situations and provide well thought-out recommendations. Several of the entrepreneurs featured in the case studies will be invited to class to share the wisdom of their experience.

Objectives: After taking this course, students should have a good understanding of the following:

1. Value of employee ownership in a business, both financially and culturally;
2. Specific mechanisms that can be used to foster an employee ownership structure and culture;
3. Various sources and usages of capital for a start-up ;
4. Stages of a venture's lifecycle;
5. How industry structure affects a venture's business model and capital structure.

Topics to discuss:

1. Entrepreneurial Ownership: evaluating alternative models;
2. Dealing with equity distribution;
3. Angel investing in technology companies;
4. The search for capital growth in technology companies;
5. Transitional capital in technology companies;
6. Reenergizing entrepreneurial growth in a large technology company;
7. The value of entrepreneurial ownership.

Ethics in Design and Entrepreneurship

Content for this course to be developed in collaboration with the U-M Center for Ethics in Public Life.

Representative curriculum:

- Business Ethics PHIL207 Carroll College (Dr. Mark Smillie)

Background: "Building a business means facing all kinds of ethical decisions. Should you skip a creditor's bill in a cash flow crisis? Help an alcoholic employee get on the wagon? Stretch the truth to win an important client? There are rarely clear-cut answers, and following your conscience can often have unfavorable consequences for your business." – Inc. (http://www.inc.com/guides/leadership_strat/20698.html)

Description: In this course, students will consider business actions and decisions in the light of moral principles and values, and ask whether ethical motives in entrepreneurial activity and technology development would make business better and more successful.

This course will question whether ethical values are already implied in entrepreneurship and market activity, or whether introducing ethics into entrepreneurial development will cause fundamental changes to the development of the venture. Students will also assess how new venture creation around scalable technologies does and should affect our individual and social lives, and ask what role business and its values (could) play in our society as a whole. Students will also examine issues and conflicts that typically arise in new ventures that have moral aspects to them, such as the way employers treat their employees, employees their employers, and the ways businesses treat their competitors, their customers, their society, and even their environment. Finally, the course will consider the practical question of whether a (morally) good life can be lived by those who wholehearted devote themselves to entrepreneurial success. The principle focus in this course will be the **understanding** and **appreciation** of a way of life in which money and profits play an important but not exclusive role.

Topics to discuss:

1. Methods for moral problem solving;
2. Engineering and Science Codes of Ethics;
3. Risk, safety, liability in engineering;
4. Ethics as a technology developer, employer, employee;
5. Ethics in strategic alliances;
6. Ethics in venture creation;
7. Managing people and your conscience.

Practicum

Adapted from:

- ENGR490-094 CFE Practicum

Proposed Text Books:

1. "The Four Steps to the Epiphany: Successful Strategies for Products that Win", by Steve Blank
2. "Business Model Generation", by Osterwalder and Pigneur

Background: As entrepreneurial skills are developed from the application of knowledge, students will pursue a practicum component in parallel with all the business and technology modules focused on their technology-based new venture.

Objective: The objective of the practicum is to provide students with the opportunity to apply the material they are learning in the classroom to the spectrum of activities that could lead to a real-world, high value, scalable technology-based new venture. Students will select teams and a technology in Fall A and develop the commercialization strategy, product concept, business model, marketing plan, and translatable prototype throughout the year. Teams will interact with industry relevant mentors throughout the year. This practicum will enable students to see the value of iterative design based on feedback from both engineering and business.

The practicum component will have two features: 1) project specific exposure (including regulatory process, agencies etc.) and 2) project development. The project development component will require students to apply the information they gain in their individual modules to their specific technical project, including but not limited to the selection of an innovation to pursue, development of an IP strategy, business strategy and market analysis, business plan, and operations plan.

Topics to be covered:

1. Problem identification;
2. Industry gap analysis;
3. The product development model;
    a. Industry specific regulatory environment
    b. Industry specific intellectual property strategy
4. The customer development model;
5. Customer discovery;
6. Customer validation;
7. Customer creation;
8. Company building.

Example Course Content

for

Ross School of Business Core Courses

Business Boot Camp

Objective: This introductory 1.5 day program will cover general business topics and provide a common vocabulary and base level understanding of: nonlinearity of new business creation; entrepreneurship vis-à-vis small business and high growth firms; finance, marketing, strategy (including concepts of value chain and competition); the company creation and assessment framework tools.

Topics to be discussed:

1. Basic Business Structure;
    a. Intro to Marketing
    b. Intro to Strategy
    c. Intro to Finance
    d. Role of Innovation in Company Growth;
2. Overview of various business legal structures;
3. Government regulatory responsibility;
    a. Privacy
    b. Taxes
4. Purpose and management of a board (governance).

Entrepreneurial Business Strategy

Adapted from:

- ENGR520 and ES715 and Entrepreneurship and Innovation Strategy at Tuck School of Business at Dartmouth (Prof. Ron Adner)

Course Overview (as described by R. Adner): The essence of entrepreneurship is new combinations – combinations of ideas, resources, partners, customers – in the effort to create new market space. The entrepreneurial challenge is one of selecting among the many potential combinations that you see, and then finding a way to organize the venture (whether startup, corporate, or non-profit) that will allow you to realize your ambition for the opportunity.

This course will examine the challenges of entrepreneurial innovation. How should entrepreneurs approach the challenge of picking the right opportunity, aligning the right partners, and targeting the right market and, perhaps most importantly, setting the right expectations for a new venture.

The course will focus on the challenges and opportunities confronted by venture leaders. However, it will also consider the perspective of non-entrepreneur stakeholders (e.g., analysts, investors, partners, employees) who are not directly in charge of the new venture, but are directly impacted by its success, and must conduct their own due diligence before committing their allegiance and resources. In class, students will develop a set of analytic lenses that will help assess the potential of new opportunities and to strategize about how to best exploit them.

The course will tend to take an external, strategic, view on the entrepreneurial challenge. It will **not** focus on (critical) internal management questions such as how to foster the creativity and teamwork which is necessary to generate the entrepreneurial ideas in the first place. Hence, students will start their analyses at the point where the business plan for a venture is already well articulated and proceed from there. (Of course, these analyses may then lead to modifications of the original plans).

Topics to be discussed:

1. Overview of Strategy;
    a. Value Chain / Value System
    b. Core Competency
    c. Competitive Advantage
    d. Industry Analysis
    e. Business Landscape
2. Models to evaluate competition;
3. Intellectual assets;
4. Required competencies;

5. Technology and product/technology adoption;
6. Building liquidity.

Entrepreneurial Marketing: Customers and Markets

Adapted from ES730: Marketing for Entrepreneurs

Objective: The purpose of this class is to teach students about marketing strategy and proper implementation through a marketing plan from the perspective of a new business and a new product. Students will be taught how to successfully assess the competitive climate by analyzing the business environment, competitive landscape, and how to segment the market. Students will also be taught how to understand customer behavior. Students will learn how to create target customer profiles by identifying target customers, demographics, lifestyle choices and values. Students will also learn how to assess a customers' need to buy a product, the external factors that could prohibit them from buying, and the motivation that leads to sales. Finally, students will learn about product promotion, and price distribution for a complete understanding or product marketing strategy, from development to sale.

Topics to discuss:

1. Discovery of customer needs;
2. Customer identification;
3. Persona development;
4. Segmentation;
5. Sizing of Markets;
6. Customer acquisition;
7. Product promotion;
8. Developing a Marketing Plan.

Value System

Adapted from:

- ENGR520 and ES715 and GRBUS 510 Understanding the Value Chain (Duquesne University)

Description (adapted from John R. Mawhinney, John F. Donahue Graduate School of Business): This course is designed to familiarize students with the concept of the value chain or system that exists external to their venture. Company specialization has created the need to understand the overall business landscape in which your new venture will exist. What firms will you be collaborating, competing, servicing, or being serviced. How is value created and distributed in that system? How will the entrance of your venture shift that current equilibrium? "The evolution of the value chain concept and the impact of technology on value chain management will be demonstrated, as well as the impact of effective value chain management on a firm's competitiveness and profitability."

General Course Objectives (as described by Mawhinney):

1. Provide students with the opportunity to identify the relationships in the external environments of the firm that are key to creating value in the marketplace;
2. Provide students with the opportunity to analyze effective value chain management and its impact on a firm's success.

Specific Course Objectives (as described by Mawhinney): After completing this course, students should be able to:

1. Define the external value chain (or value system), recognize its key elements, and explain the difference between the value chain and the supply chain;
2. Explain the roots and evolution of the value chain concept;
3. Identify the dimensions of competitiveness and provide examples of how an effectively managed value chain contributes to a firm's competitiveness and profitability.

Topics to be discussed:

1. Value chain concept;
2. Dimensions of competiveness, profitability, the role of the value chain;
3. Value chain foundation;
4. Identifying critical participants in the value chain;
5. Value creation process;
6. Role of technology in the value chain;
7. Value chain in practice.

Entrepreneurial Accounting and Finance

Adapted from:

- ENGR520, FIN615, LH509

Description: This course will address income statements, balance sheets and cash flow. Students will also explore all of the means by which a start-up firm can finance its growth; develop simple methodologies to value the potential of new ventures; and explore cap table issues, relationships and their implications. Legal aspects of company financing will also be covered

Objectives:

1. Understand the role of financial reporting in a business enterprise;
2. Understand how economic outcomes of business decisions are reflected in financial statements;
3. Understand financial performance ratios;
4. Understand how to value high tech companies;
5. Understand how VC's value high tech companies.

Topics to be discussed:

1. Valuation fundamentals;
    a. Cash flows
    b. Cost of capital
    c. Risk
2. Company Valuation;
3. Financial Statements;
    a. Balance sheets
    b. Income statement
    c. Statement of retained earnings
    d. Statement of cash flows

Entrepreneurial Pro Formas and Financial Modeling

Adapted from:

- FIN325 Entrepreneurial Finance (David Brophy)

Objective: This course presents the fundamentals of entrepreneurial venture capital and private equity finance. Financing startup, early stage, and later stage investments will be discussed from the perspective of the entrepreneur and the venture capitalist. The course covers venture capital market structure, institutional arrangements, and the application of financial theory and methods. Four main aspects of venture capital are covered: valuation, deal structuring, governance, and harvesting. Case studies are used to demonstrate the practical, hands-on application of techniques following their development in class. This finance course will also take the nontraditional approach of building an integrated financial model from a blank spreadsheet for start-up organizations. The complete model includes income statements, balance sheets, cash flow statements, revenue projections, capital budgeting, etc.

Topics to discuss:

1. Valuation in a venture capital context
    a. Overview of VC/PE system
    b. The venture capital method
    c. Alternative valuation methods
    d. Pre and post money valuation
    e. Staged investment
    f. Capitalization tables
    g. Expected return rates: IRR vs. "cash on cash"
    h. Retention Ration
2. Investment structuring
    a. Venture capital deal structuring fundamentals
    b. Use of preferred stock and subordinated debt in structuring VC/PE investment agreements
    c. The venture capital term sheet
    d. Harvesting the VC Investment

Growing the Entrepreneurial Enterprise

Adapted from:

- ES569 and MO617

Objective: This concluding course will serve as a repository for special topics relevant to start-up firms. Examples of lectures within this course include team selection, managing high performing teams, leadership, growth considerations, strategic alliances, partnerships, transactions, among others.

Topics to be discussed:

1. Managing high performing teams
2. Leadership
3. Growth considerations
4. Partnerships
5. Negotiations

APPENDIX 4: GRADUATE PROGRAMS IN ENTREPRENEURSHIP

Institution	Program	Assists Student's Research	Geared to Science and Engineering Students	Inclusive to fields	Certification	Length of Program
Georgia Tech	Graduate Certificate in Engineering Entrepreneurship	No	Yes	Yes/mainly for BMEs	Certificate	1 year
Purdue University -- BIOMEDSHIP program	Biomedical Entrepreneurship Program	No	Engineering Specifically	Yes/mainly for BMEs + MBAs	Certificate	2 semesters
North Carolina State University	MBA Concentration in High Technology Entrepreneurship and Commercialization	No	Yes	Yes	Minor (Certificate)	1 semester
Purdue University	Technology Realization Program	No	Yes	Yes	Certificate	2 years
North Carolina State University	MBA Concentration in Innovation Management	No	MBA program, so can be	Yes	MBA	N/F

Stanford University	Product Creation and Innovative Manufacturing Graduate Certificate	No	Yes	Yes	Certificate	1 year
University of Southern California	Graduate Certificate in Technology Commercialization	No	Yes	Yes	Certificate	1 year
Duke University	Masters of Engineering Management	No	Yes	Yes	Masters	1 year
University of Notre Dame	ESTEEM (Engineering, Science, and Technology Entrepreneurship Excellence Master's Program)	No	Yes	Yes	Masters	1 year
Case Western Reserve University	Science and Technology Entrepreneurship Program (STEP) Master of Science	No	Yes	Yes	Masters	3-4 semesters
Brown University	Program in Innovation Management and Entrepreneurship Engineering (PRIME)	No	Yes	Yes	Masters	1 year

University of Florida	Thomas S. Johnson Master of Science in Entrepreneurship Program	No	Yes	Yes	Masters	1 - 1.5 years
University of Central Florida	Graduate Certificate in Technology Ventures	No	Yes	Yes	Certificate	1 semester
Massachusetts Institute of Technology	Sloan Certificate in Entrepreneurship & Innovation	No	No, MBA Specific Concentration	MBA	Certificate	2 years interspersed through MBA
Clemson University	Technology Entrepreneurship Certificate	No	Yes	Yes	Certificate	1 year
University of Texas at Austin	Master of Science in Technology Commercialization (MSTC)	No	Yes	Yes	Masters	3 semesters
Georgia Tech	TI:GER	Yes	Yes	Yes	Certificate	1.5 - 2 year