1. Communication as a Key Step in the Learning Process

In the course philosophy document, we presented the position that the activities of a research scientist offer the most appropriate paradigm for stimulating the critical thinking and imparting the lifelong learning skills most observers agree are needed by today’s generation of engineering students. In this document we lay out the structure of the communications assignments for this course. They are closely modeled on that paradigm and represent a large portion of the credit assignment scheme for the course. As outlined in that philosophical document, we specifically embrace the model of technical communication associated with engineering science – an increasingly important trunk on the tree of human knowledge – as it has come to be practiced in most academic communities throughout the globe.

The high value scientists place on communication has at least two origins. First, from the view of the community, no information can be considered as stable, established knowledge until it is codified and recorded in a standard, accessible form. Second, from the point of view of the individual, the obligation to communicate formally drives insight and crystallizes understanding. Even intensely motivated scholars cannot properly know what they know until they have communicated it to others. This course will emphasize the formal process and mechanics of acquiring and presenting a body of complex, technical knowledge as a cyclic undertaking whose key steps sharpen the student’s identification of what is still uncertain – in particular, distinguishing that which is cloudy to the individual from that which remains unknown to the entire community of scholars in the area.
2. Communications-Related Assignments

2.1. Summary of Assignments

Written Technical Report (Section 2.3)
Produced in stages, beginning with Proposal (C.3; G=0.1), Initial Draft (C.7; G=0.1), Final Draft (C.10; G=0.2) with feedback on each stage from EIC Fellows.

Oral Presentations (Section 2.4)
Midterm proposal slides and oral class presentation (C.4; G=0.1), and Final report draft slides (C.8; G=0.1) and final slides and oral class presentation (C.9; G=0.1).

Literature Search (Section 2.2)
Technical resource identification and location (C.1; I=0.1) and technical literature review (C.2.a; I=0.1) and group wiki article (C.2.b, G=0.1).

Peer Review (Section 2.3)
Feedback to peers on proposal (C.5; I=0.1) and final technical report (C.11; I=0.1). Collegial evaluation of self and group members’ efforts and accomplishments (C.12, G=0.1).

2.2. Literature Search

Skills targeted during first quarter of class

C.1) Source Acquisition Assignment (I=0.1)

Overview
This is the first opportunity in the class to become acquainted with a particular set of locomotion capabilities in machines and animals. Hopefully, the background reading you do here will shape the group project you participate in and possibly motivate you to work up a bit of a self-tutorial effort on some technical aspects of the material that you think are important but found very hard to understand.

General Quality:

C.1.1) Venue
Provide evidence that defends the quality of the venue

C.1.2) Authors
Provide evidence that supports the reliability of the authors

C.1.3) Source Identification Methods
Describe Librarian Consultation and response to advice.
Specific Annotations

**C.1.4) Bioinspired Robotics Literature**
Two Curiosity-Driven Quality Sources from Bioinspired Literature: what is the problem or capability that animals possess with which we do not know yet how to endow our robots?

**C.1.5) General Robotics Literature**
Three Claims-Checking Quality Sources from Robotics Literature: which investigators have tried to develop the capability and why/how have they fallen short?

**C.1.6) Biology Literature**
Three Fact-Checking Quality Sources from the Biology Literature: are the animals’ capabilities relevant to machine builders’ needs?

Submission
Mandatory Consultation with Librarian: 1/22 – 1/28
Submission of Draft to Class Wiki: 1/29
Scoring of Mechanics (Librarian scores C.1.1 – C.1.6)
Scored Draft emailed back: 2/12

**C.2) Source Annotation Assignment (G=0.1 & I=0.1)**

Overview
This is a split assignment that starts out as an individual set of annotations to the papers you’ve collected in C.1 and then ends with a group collaborative attempt to compile all the individual annotated bibliographies into an encyclopedia article on the subject. The resulting group essay is then posted to the Wikipedia with references.

Structure of Annotation Essay (~ 5 – 6 paragraphs = ~2 pages)

**C.2.1) Behavior or Capability**
What is the robot behavior or capability in question and why is it important?

**C.2.2) Capabilities of Existing Technology**
What are the 3 – 5 most highly cited robotics papers in this area and what is their contribution?

**C.2.3) Potential Biological Solutions or Bioinspired Approaches**
What are the 3- 5 most highly cited biology papers in this area and how are they useful to the roboticists?
C.2.4) Value of Quality Sources
Describe some 3 – 5 sources encountered as part of the “automated” (i.e. purely keyword or search-engine driven) early stage search process that are less useful in this problem domain and why they should be taken less seriously (or ignored) in relation to the prior two classes of sources. Typically (with some exceptions) these less useful sources are reasonable or high quality but ill-suited to the problem at hand because the search engine missed the point of the inquiry in bringing them to your attention.

C.2.5) Open Problems
What are the most important open problems in this area?

Structure of the Annotation Bibliography (~ 10 papers)

C.2.6) Pre-Cursors
For each paper being annotated cite the two or three most important pre-cursor papers (those paper the entry cites which are themselves highly cited).

C.2.7) Successors
For each paper being annotated cite the one or two most important successor papers (those papers that cite the entry and which are themselves highly cited or for which you can furnish alternative evidence of their importance).

C.2.8) Bibliographic Data
Complete citations to these ~10 + (including all pre-cursor and successor papers), following EIC rules for adequacy of data field entries for each citation. For each of these bibliography entries, make certain to incorporate an explicit (live) online link (e.g. a doi number) or provide evidence that none exists.

Wikipedia Contribution

C.2.9) Identification of Wikipedia Stub
Find an existing “stub” in the Wikipedia that comes closest to your topic area.

C.2.10) Leading Paragraph
Write a leading paragraph for a Wikipedia entry that relates the stub topic to the area you have researched. Incorporate the motivation for interest to the general Wikipedia readership by summarizing the position presented in C.2.1)

C.2.11) Review of Literature
Write a second paragraph for the Wikipedia entry that summarizes the contributions of the papers cited in C.2.2) – C.2.4)

C.2.12) Wikipedia Submission
2.3. Technical Writing

C.3) Problem Formulation  (G= 0.1)

Overview

This is the opportunity for the group to gather together its individual members’ various directions of curiosity or insight about legged machine mobility and its biological counterparts and pull out a central hypothesis – an idea about how to improve performance that can be experimentally tested. The need to test the hypothesis and the value of the improvement must be documented against what your group has learned about the larger scientific literature in the course of the Literature Review (assignments C.1 & C.2).

This written material is a sober, neutral problem formulation. In contrast, you will use it as the foundation for the oral mid-term presentation, C.4 that will take the form of a project proposal – a “pitch.” This written problem statement and hypothesis for performance improvements will also be largely recycled to become the introductory section of your eventual class report C.7 – C.10.

Structure of the Problem Statement Essay

**C.3.1) Desired Capability**

Given the problem domain identified in C.2.1), which of the open problems identified in C.2.5) will the group focus on. That is, state clearly what missing robotic capability or general behavior your group’s question will address. Justify the importance or value of achieving it.

**C.3.2) Present Unavailability**
Contrast the contributions of the robotics literature identified in C.2.2) to the target problem(s) of interest to the group. Use this prior body of work to justify your claim that your proposed problem(s) of study have not yet been solved.

**C.3.3) Desirability of Bioinspiration**

Use the literature identified in C.3.3) to argue that a bioinspired solution to this problem may be possible and could lead to desirable advances in robot behavior. Explain why your group cannot simply find an existing mathematical technique or engineering design method, learn how to use it (assuming you were given the necessary time and instruction to do so) and apply that to the proposed problem with good likelihood of success.

Ingredients of the Hypothesis

**C.3.4) The Idea**

What specific additional design step or change in existing design will add (or help lead to adding) the desired capability?

**C.3.5) Refutability**

What measurement or analytical method can be applied to test whether or not the proposed design step has the desired effect?

**C.3.6) Necessary Means**

What methods, procedures, or tests available to your group will be used to refute or support the hypothesis?

Submission to Class Wiki

Mandatory Consultation with EIC-Fellow: 2/5 – 2/26
Submission of Draft to Class Wiki: 2/28
Scoring of Mechanics (EIC fellow scores structure and written clarity of C.3.1 – C.3.6)
Scored Draft emailed back: 3/20

**C.5) Written Reviews of Project Proposals (I=0.1)**

Overview

After listening to the class mid-term oral presentations, C.4, and reading carefully one of the group problem formulation documents, C.3, that will be assigned to you, you will write an individual anonymous review of the proposal. You will put yourself in the position of a potential sponsor who must decide to allocate funds to one out of ten of the proposals encountered. You will try to give the “proposers” sufficiently good feedback on the strengths and weaknesses of their proposals as to help them create a winning version in their next round.

Structure of Review

**C.5.1) Short Paragraph Summary**
Very briefly paraphrase the authors’ proposal and arguments sufficiently to convince them you have considered their ideas seriously enough to deserve their attention.

C.5.2) Paragraph Appraisal of Technical Content
Comment on the importance of the proposed problem and the value of the desired capability or behavior. Assess the magnitude of the gap between the desired and presently available (state-of-the-art) capabilities as evidenced by the authors’ cited literature. Assess the relevance and likely availability of a biologically inspired solution.

C.5.3) Paragraph Appraisal of Proposal Mechanics
Two sentences on quality and interest of written proposal statement C.3. Two sentences on quality, interest and production values of oral slides. One sentence on quality of oral presentation and the listener’s experience.

C.5.4) Specific Critical Remarks: Written Statement
Use the rubric of the problem formulation (C.3.1 – C.3.6) to identify the weaker points in the project proposal. Identify steps the reviewed group could take to improve these.

C.5.5) Specific Critical Remarks: Oral Presentation
Use the rubric of the mid-term project proposal (C.4.1 – C.4.7) to identify the weaker points in the group oral presentation. Identify steps the group as a whole could take to improve these.

C.5.6) Paragraph of Overall Appraisal
Identify the best aspect(s) of the proposal and suggest how this could be further improved.
What parts of the written and oral presentation were most interesting or convincing. How might the presentation have been made stronger still?
Identify any problematic aspects of the proposal and justify your concerns.

Submission to Class Blackboard Site
Submission of Written Review to Class Blackboard: 3/20
Grading for accuracy, creativity, helpfulness (Course Instructor grades individuals)
Blind reviews (along with instructor’s grade) posted to Class Wiki and linked to original statement and oral presentation materials: 3/27

C.6) Experimental Methods and Setup (G=0.1)
Overview
Your group will now reconvene, consider the critique of the anonymous peer reviewers and the instructors’ reactions to your written problem statement (C.3) and oral project (C.4) proposals, to improve the proposed problem statement. You will also survey the various
laboratory tools and methods you have learned about in the warmup exercises and determine what empirical work is actually within the realm of possibility for the next few weeks of work. These greater insights and instrumental experiences now form the basis for a careful “statement of work”: exactly what empirical will you perform with the robot? How will you analyze the data that you collect?

Revised Hypothesis

C.6.1) Restatement of Original Hypothesis
Provide a brief summary review of the ideas presented in C.3.4) – C.3.6).

C.6.2) Revisions Resulting from Lab/Course Experience
Which aspects of the lab warmup exercises are most relevant to the experiments you propose to now pursue independently? Which aspects of the class lectures are most relevant to the questions at hand? What have you learned about the literature, lab equipment, design infrastructure and measurement equipment that modifies your ideas about what should be studied or what you can likely accomplish in the brief period available in the lab the remaining weeks of the semester?

Experimental Methods

C.6.3) Details of Setup
What equipment, supplies, materials, and instrumentation will be required to perform this experiment? What code will you need to write and how will it be allocated to the group members and then coordinated?

C.6.4) Sources of Means
Compare the setup you would like to the setup available to you as part of the class laboratory. What aspects of the already available setup present the greatest hurdles and what other sources of equipment, supplies or instrumentation would be better. Where could one procure these, how long would it take, and what budget would be required.

C.6.5) Operational Plan
Present a detailed plan with timetable of experimentation incorporating clear assignments of responsibilities (and deadlines) to individual group members. Incorporate in the schedule of operations some number of “rendezvous” junctures (group meetings) where discrepancies between planned and actual operations can be assessed and handled.

Data Analysis

C.6.6) Resulting Data Base
Describe in detail the data that will result from the completed experiments and detail the data structures and physical storage media that will be used to keep the data intact and easily available.
C.6.7) Data Processing
Review and revise the procedures and tests anticipated in C.3.5 and C.3.6. Describe in detail the computational procedures you will apply to the data to realize these tests (or superior versions of them that you now can better devise).
This step might be purely a careful statistical analysis (need to show sources of methodology and nature of data cleaning and scripting tools required to do so). It might instead take the form of a comparative simulation with rudimentary data cleaning sufficient to allow comparison to experimental outcomes. One or the other aspect of applied mathematics must be represented in the computational step of your methods and setup proposal.

C.6.8) Operational Plan
Present a detailed plan with timetable of data processing and analysis incorporating clear assignments of responsibilities (and deadlines) to individual group members. Once again, incorporate in the schedule of operations some number of “rendezvous” junctures (group meetings) where discrepancies between planned and actual operations can be assessed and handled.

Submission to Class Wiki
Mandatory Consultation with EIC-Fellow: 3/20 – 3/27
Mandatory Consultation with Lab Instructor: 3/25
Submission of Draft to Class Wiki: 3/27
Scoring of Mechanics (EIC fellow scores structure and written clarity of C.6.1 – C.6.8)
Scored Draft emailed back: 4/3

C.7) Draft Technical Report (G=0.1)
Overview
Your group is now ready to anticipate how the complete report will turn out by writing up an initial prospective draft. The draft incorporates all the past feedback you have received from past reviews and critiques (C.2, C.3, C.6) and corrects the anticipated methods and instrumentation, C.6, with the real versions actually implemented in your lab work. Moreover, the draft incorporates a sample of the analytical methods applied to preview data (possibly “invented” – with plainly visible disclaimers marking apart the practice data from what you will submit subsequently after your experimental work has finished).

Final Draft of Prior Written Materials

C.7.1) Revised Problem Statement
Rewritten version of C.3) taking into account the feedback from EIC-Fellow. Rebut or address and respond appropriately to the written reviews of the original proposal.

C.7.2) Revised Literature Review
Rewritten version of C.2) taking into account the feedback from EIC-Fellow.

**C.7.3) Revised Experimental Methods and Setup**
Rewritten version of C.6) taking into account the feedback from Class TA and the growing experience base from the lab work.

Initial Draft of Experimental Results

**C.7.4) Status Report of Progress**
Update on C.6.3) – C.6.5).

**C.7.5) Draft of Results Section of Technical Report**
Update on C.6.6 – C.6.8).

Submission to Class Wiki
Submission of Draft to Class Wiki: 4/8
Draft graded by combination of course instructors
Graded Draft emailed back: 4/15

**C.10) Final Technical Report (G=0.2)**

Overview
This is it: the compilation of all earlier draft materials (C.3, C.6, C.7) with the actual results of physical experiments and data analysis and a clear statement of conclusions and future work.

Final Draft of earlier components

**C.10.1) Introduction, Literature Review, Problem Statement, Experimental Design**
Final version of C.7.1) – C.7.5) How well does the report respond to and integrate prior suggestions by fellows and instructors?

**C.10.2) Analysis**
Quality and completeness of mathematical modeling or statistical data analysis.

Conclusions

**C.10.3) What is the meaning of these results?**
Summarize what you have learned personally and assess what possible contribution to the literature you have made.

**C.10.4) What would be the next step of work?**
Describe a follow study (or more than one) that is motivated by the present conclusions and that you believe would likely make a new contribution to the literature. What additional resources (beyond time) would be required to carry this out?

Submission to Class Wiki
Submission of Final Report to Class Wiki: 4/29
Report graded by lab and lecture course instructors

C.11) Written Reviews (I=0.1)

Overview
Each class participant will be assigned an individual group’s written and oral final products. You must determine whether those results are compelling enough to warrant publication. If so, then you must state why. If not, then articulate in a constructive manner what is wrong and what would need to be improved before these materials are worth sharing in a more public venue?

Structure of Review

C.11.1) Paragraph Synopsis of Context
A brief (typically, one paragraph) summary of the overall problem statement, motivation, and intended aims of the project is written carefully enough to convince the subject of the review that the reviewer has in fact understood the report’s larger context and place in the literature.

C.11.2) Two Paragraph Appraisal of Results
A brief (typically one paragraph) summary of the claimed results and conclusions. A second (typically longer paragraph) summarizing the accuracy and importance of results. Includes at least sentences addressing whether the claimed results and conclusions are truly justified by the evidence presented. At least two sentences addressing whether the claimed results and conclusions are interesting enough that dissemination to a broad audience is warranted – this opinion must be justified by an explanation why.

C.11.3) Specific Critical Remarks: Written Statement
Identify the best aspect(s) of the report and suggest how they could be further improved. Identify any problematic aspects of the proposal and justify your concerns.

C.11.4) Specific Critical Remarks: Oral Presentation
Identify the best aspect(s) of the oral presentation and suggest how they could be further improved. Identify any problematic aspects of the presentatip and justify your concerns.

Submission to Class Wiki
Submission of Written Review to Class Wiki and Class Blackboard site: 5/1
C.12) Collegial Evaluations (G=0.1)

Overview
How did you perform as an individual within your group? How did each of your group members perform?

Evaluations

C.12.1) Self
Give yourself a grade for your contribution to the group’s work. Justify your assessment with reference to specific accomplishments and contributions.

C.12.2) Collaborators
Assign a grade to each of your group members for their contributions to the group’s work. Justify your assessment with reference to specific accomplishments and contributions.

Submission to Class Wiki
Submission of Written Review to Class Blackboard site: 5/1

2.4. Oral Presentations

C.4) Mid-Term Project Proposal (G=0.1)

Overview
You have identified a scientific problem to work on in C.3. You must now convince the potential sponsor (your class peers) to “fund” you to go ahead and carry out the investigation of the hypothesis you have laid out. This is a “pitch” – an attempt to persuade – but you are pitching to a very sophisticated group of reviewers (your peers) and so your arguments will have to be scientifically convincing. You need to develop a slide show that captures the excitement and social value of the project while keeping enough of the factual scientific motivation in sight that there is no question about the intellectual probity of the ideas.

Submission of Slides to Class Wiki (C.4.a; G=0.05)

C.4.1) Content
All elements of the written problem formulation, C.3.1) – C.3.6), are laid out in telegraphic form on main slides. Supporting details for each element, C.3.1) – C.3.6), are provided on additional slides meant to be used during presentation only when/if audience questions lead to them.

C.4.2) Structure
“Telegraphic” form means bullets with minimal number of words or symbols needed to remind speaker (and cue audience) of a particular idea or concept. The bullets’ outline structure must mirror or represent in some clear manner the logical structure of the ideas.
C.4.3) Notes and Timing Cues
Main slides are organized to keep presentation on focus in allotted time. Speaking notes are prepared that remind presenters what communications goals they have for each slide and how much time will be required for each of the bullets on the slide to achieve each communication goal.

Oral Class Presentation (C.4.b; G=0.05)

C.4.4) Content
Presentation leads audience through brief account of all elements of the written problem formulation, C.3.1) – C.3.6).

C.4.5) Audience Interaction
Questions are solicited, acknowledged and either handled by reference to appropriate detail slide or judiciously deflected as requiring more detail than audience needs to understand the content of the problem statement.

C.4.6) Timing
Presentation fills the time allotted and no more

C.4.7) Division of Labor
All members of the group participate in some manner and their individual contributions to the group effort are clear to the audience.

Submission of Slides to Class Wiki
Mandatory Consultation with EIC-Fellow: 2/12 – 3/4
Submission of Draft to Class Wiki: 3/4
Scoring of Mechanics (EIC fellow scores points C.4.1 – C.4.3)
Scored Draft emailed back: 3/20

Oral Mid-Term Class Presentations
March 6

C.8) Final Project Presentation Materials (G=0.1)
Overview
You have learned a tremendous amount of new material. You have worked extraordinarily hard to get a physical device to perform some new feat. You have made wonderful new discoveries. Your peers are really interested only in the discoveries and only incidentally care about how much work you had to do or how much you learned in order to make the discoveries. You have a very brief time period (10 min) to get them excited about the discoveries. If you do not provide enough supporting technical detail they will assume you are impostors; if you try to dive deeply down into all the technical details your peers will fall asleep. What 10 min worth of nuggets will rivet attention yet demonstrate your technical
depth? This needs to be transferred over to a slide show that can be delivered live to a live audience.

Mechanics and Structure

C.8.1) Prior Criteria
Quality of slides relative to criteria C.4.1) – C.4.3)

C.8.2) Visualization of Quantitative Results
Is there an animation or some visualization aid to help the audience understand and interpret dynamical simulation data? Are there visually clear and carefully, accurately composed graphics to present statistical data analyses?

Technical Content

C.8.3) “Bottom Line” Results
Does the presentation supply the audience with a clear understanding of what was accomplished or learned?

C.8.4) “Next Steps” Understanding
Does the presentation advance a clear proposal about what an audience member might do if he or she were interested to pursue work of this kind?

Submission Class Wiki
Due 4/15

C.9) Final Project Presentation (G=0.1)

Overview
Good scientific presentations combine elements of theater with elements of preaching and, most importantly, teaching.

Mechanics and Structure

C.9.1) Prior Criteria
Quality of presentation relative to criteria C.4.4) – C.4.7)

C.9.2) Explication of Quantitative Results
How well were the visualization aids integrated into the oral presentation? Did they increase or decrease the audience’s focus on and understanding of the results?

Technical Content

C.9.3) “Bottom Line” Results
Does audience come away from the presentation with a clear understanding of what was accomplished or learned?

**C.9.4) “Next Steps” Understanding**

Does audience come away from the presentation with a strong idea about what is needed to pursue work of this kind?

Final Class Presentation
4/22-24