



**2023**

# **IEMS 394**

# **COURSE GUIDE**

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**Northwestern** | McCORMICK SCHOOL OF  
**ENGINEERING**  
Industrial Engineering and  
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# Part I: Course Details

## 1. Introduction to IEMS 394

Welcome to IEMS 394 Client Project Challenge! Please see the Canvas site for instructor, faculty project adviser, and TA contact information, faculty project adviser assignments, and office hour schedules.

Enrollment in IEMS 394 requires advance completion of an intake survey. Prior to registration week, you will receive an email invitation if you are eligible to take IEMS 394 (i.e., you are at least in your third year, and you have completed all prerequisites). If you are eligible but do not receive such an email, contact Prof. Jill Wilson or the course instructor immediately.

This course is required for all students pursuing the BS in Industrial Engineering, with the aim of achieving the following course goals:

1. To allow you to apply the core IE methodologies you have learned.
2. To foster your capability to deal with the stress of real-world IE problems with meaningful stakes in a highly supportive environment.
3. To prepare you to be successful in your job search, and valuable to your employer, from day 1.
4. To provide measurable value to Northwestern CPC clients on an important project.

*Complete course learning objectives are provided below.*

### 1.1 Catalog Course description

*Open-ended client projects involving application of operations research techniques to complex data analysis and decision problems. Typically taken at the end of junior year or at the start of senior year. Closed to seniors in spring quarter. This course is a major requirement for Industrial Engineering.*

## 1.2 Prerequisites: What you should know before taking the course

DTC 1, 2: Design Thinking and Communication  
IEMS 202: Probability  
IEMS 303: Statistics  
IEMS 304: Statistical Learning and Data Analysis  
IEMS 313: Foundations of Optimization  
IEMS 315: Stochastic Models  
IEMS 317: Discrete Event Systems Simulation

These prerequisite courses, along with your other degree requirements, serve as a foundation for your client project. These courses have trained you in:

- **Design thinking:** Working with stakeholders to generate ideas to solve their engineering problems.
- **Probability:** Quantifying risk so you can hedge against it.
- **Statistics:** Drawing valid conclusions from data.
- **Data Analytics:** Leveraging data to make predictions and gain business advantage.
- **Optimization:** Making the best use of constrained resources to obtain the best possible KPIs.
- **Simulation:** Creating computer models of a complex enterprise to improve system performance.
- **Computing:** Implementing the tools you create in software.

## 1.3 Course learning objectives: What you should be able to do by the end of the course

1. Apply the basics of project scoping and planning.
2. Employ the basics of project scheduling and resource planning as applied to complex unstructured problem solving.
3. Be proficient in data collection, planning, and analysis in a complex real-world setting.
4. Develop a problem statement working with a client and develop a scope of work and project plan based on the available resources and project duration while still meeting the needs of the adviser and client.
5. Recognize how real-world problems allow the application of the fundamental modeling and analysis techniques of industrial engineering, including statistics, optimization, stochastics, and simulation.
6. Implement the basics of client management and, when needed, directly observe client processes through site visits.
7. Experience the complexity and ambiguity of applying IE techniques in a real-world scenario.

## 1.4 Course expectations: What we expect of you in this course

- Produce at least one high-quality solution to address your client's problem.
- Provide evidence that you have applied your core IE knowledge to the client's problem.
- Compose well-written, organized, clear, and logical reports detailing your proposed solution and its impact.
- Demonstrate effective and inclusive teamwork.

## 1.5 Materials and resources

You have access to software such as @Risk, AMPL, and Simio through the IEMS lab machines or via remote desktop. You can also choose to utilize open-source software such as R or Python. More detailed information on accessing software, the IEMS lab, or remote desktop is available on Canvas → Pages → “Tech Details.”

No textbook is required for this course. However, you are responsible for the following:

- Incidental costs and ground transportation costs to visit clients on site. These costs will be reimbursed by the client.
- Business attire. For resources to assist with this requirement, see:
  - [Career Development Fund](#)
  - [‘Cats Closet](#)

## 1.6 Grading information

- **Proposal (15%)**
  - Brief description of problem, 1-3 proposed solutions, data, and related resources.
  - Plan for completing the background research.
- **Background Research (10%)**
  - A summary and bibliography of background research on your problem.
  - Requires submission of preliminary “Sources and Sentences” assignment.
- **Midterm Review (20%)**
  - Progress update, draft report, instructor interview, and peer review.
- **Final Report (40%) & Presentation (5%)**
  - Summary of your final recommendations to the client, and their impact on your client’s enterprise.
- **Teaming Assignments (10%)**
  - Team and individual Leadership Portal Assignments
  - Team Charter Review with instructor

*Note that poor team contribution can result in a low individual grade.*

*All assignments should incorporate writing best practices to be compelling, concise, clear, organized, and logical.*

## 1.7 Course calendar

Scheduled course time will not always be used for class meetings. The class will only meet collectively on the first two days of class and on the day of your project presentation. However, you should protect the scheduled class time so that you are available to meet with your team, client, instructors, or your faculty project adviser during this time. It is permissible to meet at an alternate time, but because we have asked you to protect the scheduled course time, “we can’t find a time to meet” will not be an acceptable excuse.

You should meet with your clients at least every other week, and weekly if your client requests it. These meetings are not shown in the table below and should be scheduled in agreement with your client.

*Refer to Canvas for specific due dates.*

	MEETINGS	ASSIGNMENTS
<b>BEFORE BEGINNING IEMS 394</b>	IEMS 394 NDA Basics	Team Portal Assessment Setup / Team Behaviors (Group)
<b>WEEK 1</b>	IEMS 394 Kickoff Week (2 classes) <ul style="list-style-type: none"> <li>• Tuesday: Orientation and Team Meetings</li> <li>• Wednesday: Client Meetings</li> <li>• Sources + Sentences Writing Workshop (Friday, 1 hour)</li> </ul>	<b>Team Charter (Group)</b>
<b>WEEK 2</b>	Team/Instructor Charter Meeting (20 mins)	<b>Proposal (Group)</b>  <b>Sources + Sentences (Group)</b>
<b>WEEK 3</b>	Faculty Project Adviser Meeting Faculty Project Adviser Meeting	<b>Background Research (Group)</b>
<b>WEEK 4</b>	Writing Check-in #1 (20 mins)	Team Portal Check-in 1 (Individual)
<b>WEEK 5</b>	Faculty Project Adviser Meeting Faculty Project Adviser Meeting	<b><u>Instructor Project Review (Group):</u></b> <ul style="list-style-type: none"> <li>• Midterm Report</li> <li>• Progress Assessment</li> </ul>
<b>WEEK 6</b>	Team/Instructor Project Review Meeting (1 hour)	Team Portal Evaluation (Group and Individual)
<b>WEEK 7</b>	Faculty Project Adviser Meeting	
<b>WEEK 8</b>	Writing Check-in #2 (30 mins)	
<b>WEEK 9</b>	Faculty Project Adviser Meeting Faculty Project Adviser Meeting	
<b>WEEK 10</b>	Faculty Project Adviser Meeting	



## FINALS WEEK

Class Final Presentation

Final Presentation to the Client

Final Presentation (Group)

Final Report (Group)

Team Portal End of Project Review  
(Individual)

**RED** assignments are submitted through Canvas.

**BLUE** assignments are completed through the Team Assessment Portal and accessed through Canvas.

**BLACK** meetings are course meetings scheduled either during class time or prior to beginning IEMS 394.

**GREY** meetings are meetings with the writing instructor. Scheduling will be initiated by instructor.

**GREEN** meetings are meetings you are responsible for scheduling on your own.

\*Note: This is a typical calendar for spring quarter; fall calendar may shift slightly.

## 2. Roles and Responsibilities of Key Stakeholders

### 2.1 Students

As a student in IEMS 394, you are responsible for collaborating with your team, building relationships with your team, and contributing good work. You are also responsible for creating a professional relationship with your client so that you can represent yourself, your team, IEMS, and Northwestern in the best possible light.

It is important for you to own the work and your role in producing it. You are consultants whose job it is to provide value to the client. To some extent, this involves giving the client exactly what they ask for, however it is your job to provide value beyond this. Question assumptions and push back when clients instruct you to ignore certain aspects of the problem. Insist on explanations, though do so respectfully. In short, show your clients what Northwestern IEs are capable of! In the end, we will grade you on the quality of work you do, the value you provide, and the clarity with which you communicate these things. Lastly, remember to show your strengths and have fun!!

### 2.2 Instructors and TAs

Instructors and TAs are responsible for administering the course and making sure that the course runs smoothly. They are also responsible for grading deliverables, evaluating team performance, and providing constructive feedback. Students are encouraged to reach out to the instructors or TA for counsel or advice at any time. Office hours are posted on Canvas. See below for whom to contact with questions and for additional support:

- IEMS instructors and the TA can provide advice on project scope, teamwork, client relations, etc. They are also available to assist your team when difficulties or concerns arise with your client or faculty project adviser.
- The course writing instructor can provide advice on how to produce deliverables that best communicate your ideas. Your teams are expected to meet at least twice with the writing instructor during the quarter.

## 2.3 Faculty project adviser

Each team has a dedicated faculty project adviser. (See Canvas for your faculty project adviser assignment.) You should schedule and meet weekly with your adviser. Send a summary of your progress, next steps, and relevant questions to your faculty project adviser 24 hours in advance of each meeting. Remember that your adviser is a great resource and **CAN**:

- Give technical advice, including:
  - Referring you to models, literature, code, data sources, or methods your team may not be aware of
  - Helping surmount technical problems within the model your team has created when you are unable to resolve a problem, e.g., with software.
- Meet with the team to review progress.
- Provide feedback on a model formulated by your team, including suggesting related directions to explore.
- Provide feedback to instructors.

While your faculty project advisers can help you with many aspects of your project, they **CANNOT**:

- Meet with your client.
- Tell you what to try next.
- Help you formulate initial models or data analysis.
- Work directly on your model, data, or reports.
- Grade your project.

## 2.4 Other IE faculty

Your faculty project adviser might suggest you seek help from other faculty. If you do so, you should let your faculty project adviser know, and still keep your weekly meeting with your faculty project adviser. Before meeting with other IE faculty members, you should email them with clear and concise questions. You should keep these meetings brief and understand that you will not have time to describe to the faculty member the entirety of your project. You should not expect faculty members to solve your problem for you, and you should not shop around for the best answers from multiple faculty members.

## 3. Before Beginning IEMS 394

Course instructors will use your intake-survey responses to form a team for each project. Each project team will be designed to represent diverse skills that meet the needs of that project. You will receive an email from the course instructor three to four weeks before the start of the course with the names of your teammates and detailed information about your project. It is important to be on the lookout for this email.

### 3.1 Tasks to complete BEFORE beginning IEMS 394

*These tasks should be completed two to four weeks before the quarter begins. View instructor communications for specific dates.*

- **Contact the instructors right away** if for any reason you will not enroll in IEMS 394 next quarter. Teammates will be counting on you otherwise.
- **Review** your project description and NDA. Make note of any questions you want to ask the client.
- **Attend the virtual session with NU Law on understanding NDAs.**
- **Communicate with your team** about who will complete the tasks below. If you are reading this and none of your teammates has yet done so, take the initiative and begin the conversation.
- **Create a recurring Zoom meeting** that you can use for all your client meetings. Add all your teammates as alternate hosts on the meeting.
- **Email your client** to introduce yourselves and share the Zoom link for your future meetings. Copy your instructors on this message. You will not need to copy the instructors on future client communications.
- **Conduct some preliminary research** (literature survey) on the problem stated and learn something of the application described by the client. Each team member should find and read at least one different and relevant article related to your project.
- **Review the Team Behaviors, Team Charter, and Proposal assignments.** Those will be due within the first week to ten days of the course.
- **Communicate with your team** about elements of the team charter important to you to include.

### 3.2 Team Center for Leadership Assignments

The Team Center for Leadership Assignments consists of team and individual exercises that appear within the course's Canvas site. By clicking on each assignment, you will be taken to a tool within Canvas in which you complete the appropriate exercise by the due date.

You will need to complete the first exercise (Team Behaviors) as a group. One person from your group will fill out the first exercise on behalf of everyone, but you all need to be present to discuss how you will implement each of the Team Behaviors listed. Please note that parts of other exercises require you to meet and converse with your team as well. Thus, be sure to complete these exercises during and/or after your existing team meetings.

If you run into any errors while completing the Team Assignments, please first refresh the page or click on the assignment a second time. If the problem persists, email [lead@northwestern.edu](mailto:lead@northwestern.edu) and describe the issue you are experiencing.

### 3.3 Calendar events

*These tasks should be completed before the beginning of the quarter and the week the quarter begins. View instructor communications for specific dates.*

- **Virtual session with NU Law on understanding NDAs.** The NU Law session is typically scheduled two weeks before the start of the quarter.
  - **[Strongly recommended]** There will be a virtual session with NU law centered around understanding NDAs in the context of your project. The session will cover what you should look for in an NDA and the framework for how to review an NDA. It will also give you the chance to ask questions. These sessions cannot be recorded and so attendance is strongly recommended for all students, especially those required to sign an NDA. This is **strongly recommended** for all students, but especially for those of you who are required to sign NDAs to access data or other client materials. Refer to section 4 for more information about NDAs.
  - If you are taking IEMS 394 in the Fall, the NDA session usually takes place a week or two before the quarter starts. If you are taking IEMS 394 in the Spring, the NDA session typically occurs during finals week of winter quarter. \*This session is intended as general information and is not intended to replace legal consultation.
- **Kickoff Events during the first week of class.**
  - **[Required]** All-class meeting with instructors to review course expectations. Part of this class session will be reserved for your team to plan for your first client meeting.
  - **[Required]** Team meetings with client representatives. Faculty project advisers who are available will also join at the start for introductions. If your client is attending remotely, use the recurring Zoom meeting you shared with them.
  - **[Strongly Recommended]** Sources & Sentences Writing Workshop. The course writing instructor will share useful writing strategies to help make your reports, clear, concise, and compelling and will discuss approaches to help you begin work on your background research.

## 4. Non-disclosure Agreements (NDAs)

If your team is required to complete a Non-Disclosure Agreement (NDA), it will be included with your project description in an email from your instructors.

### 4.1 What is an NDA?

An NDA is sometimes referred to as a confidentiality agreement. It is a legally binding contract that acknowledges and establishes a confidential relationship between parties. When signing an NDA, you are agreeing that any sensitive information you have access to will remain private and will not be shared to any other parties. NDAs are common in many business settings and negotiations. Additionally, employees are often required to sign NDAs to protect an employer's confidential business information. If you break an NDA, you are subject to the consequences laid out in the contract.

For more information on NDAs, see the following references\*:

*\*Disclaimer: This should not be interpreted as legal advice.*

- [The Key Elements of Non-Disclosure Agreements](#)
- [Non-Disclosure Agreements \(NDAs\)](#)
- [What to know about signing an NDA at work](#)

Treat an NDA as the binding legal document that it is. Also be aware that faculty do not sign NDAs, so sanitize communications with your adviser and instructors accordingly.

## 5. Kickoff Week

The purpose of Kickoff Week is to provide you with a solid jumping off point to ensure a successful start to your project. There are three events during the first week of classes, also called “Kickoff Week.” Please see below for details of each event:

- **During the first day of class**, the Student Kickoff Event will take place. Instructors will lay the groundwork for IEMS 394 and give an orientation addressing the course administration, goals, learning objectives, and expectations. After the Kickoff Event you will have a clear understanding of the purpose of the course, how IEMS 394 is organized, the resources you have access to during your project, and what is expected of you this quarter. You will also have the opportunity to ask questions. You will then have time to collaborate with your team to prepare for your first client meeting and to develop your team charter.
- **During the second class**, you will meet with your client directly. Come prepared with questions for your client and having conducted preliminary research. Use this time with your client to gather the information—including data—you need to get started on your project work and to finalize any required NDAs. Business attire is encouraged, regardless of whether you will meet your client in person or remotely.
  - You will also be given time during the second class to meet directly with your faculty project adviser. In this time, you will be able to establish and clarify your relationship with your adviser including meeting times, avenues of communication, expectations, etc.
- **During the third class**, the writing instructor will host an optional writing workshop to discuss general writing best practices and help you prepare your background research assignment. You are strongly encouraged to attend.

### 5.1 Kickoff Week Checklist

To make the most of your time during these meetings, see the Kickoff Week Checklist below.

#### *With your team:*

- Decide how you will communicate.
- Decide how you will share files.
- Complete the Leadership Portal Team Behaviors exercise (see Canvas) and [Team Charter](#).
- Make a plan for completing the [Project Proposal](#).
- Develop a list of questions for your first client meeting.

#### *With your faculty project adviser:*

- Schedule weekly meetings, with the first no later than Week 2.
- Determine when faculty project adviser wants to receive weekly updates (typically 24 hours in advance of the weekly meeting).

### *With your client:*

- Agree on project scope, objectives, and timeline:
  - First, ask your client any preliminary or clarifying questions on the project.
  - Then, ask more thorough questions so that you can frame an objective that aims to solve the root of the problem your client is facing.
- Sign and return NDA if applicable.
- Schedule your next virtual meeting
  - Do **not** record Zoom sessions.
- **Finalize** acquisition of data.
- Determine an environment for sharing files, data, and communications:
  - Be mindful of the subject line in emails.
  - Do not need to copy instructors in client email communication.
- Ask about expectations for email response time.
- Discuss any software requirements or expectations.

## 6. Working with your Team

In IEMS 394 you will be working with a team for the entire quarter; therefore, it is crucial to form relationships with your team members and to create a positive team dynamic. Before beginning your project, watch the video linked below for more information on how to develop a high-functioning team:

[Introduction to Teaming](#) (18 mins)

Additionally, your team will be creating a [Team Charter](#) that outlines the roles, responsibilities, expectations, and plan for conflict resolution within your team.

### 6.1 Getting started with your team

You will work with your team throughout the entire quarter, so it is important to organize yourselves; decide:

- Roles and responsibilities (e.g., project manager, editor, archivist, client liaison).
- Regular meeting times (minimum of 2x per week), and protect those times.
  - If you are meeting virtually, do not schedule Zoom meetings through Canvas. If your team plans to meet virtually, also review [Best Practices for Virtual Teams](#).
- Modes of communication and work sharing.
- Overall project timeline. Refer to Canvas for additional information.
- How you will hold each other accountable.

***\*Note: If you indicated on the intake survey a willingness to handle expenses or reimbursements, please self-identify to your group***

While working with your team make sure to use **inclusive practices**:

- Listen to and respect each team member's ideas.
- Give the benefit of the doubt; assume everyone's intentions are good.
- Assume everyone is as smart and capable as you.
- Be as flexible as possible with your time.
- Be understanding of how others' circumstances may differ from your own. Work hard to contribute and give others the chance to do the same.
- Give, and be open to receiving, constructive feedback.

And avoid **exclusive practices**:

- Impromptu meetings of most—but not all—members of the team.
- Scheduling meeting times that always exclude the same person.
- Interrupting or talking over other team members.
- Using lots of jargon that others do not understand.
- Playing to stereotypes.

## 6.2 Common sources of conflict

When working with a team, conflict may arise. Listed below are some common sources of team conflict experienced in IEMS 394 and some suggestions on how to avoid or resolve them:

### *Uncommunicated or assumed expectations*

A teammate can become frustrated if they feel another teammate is not meeting expectations. It is normal to have expectations for how we will be treated in a group-project environment or on how work will be accomplished. However, it is important to stop and ask: *Is my teammate aware of the expectation?* Often the answer is no! Make sure to state your expectations as a group clearly. Do not assume that others hold the same expectations as you. You can address this by making expectations explicit in your Team Charter, where teammates can refer to them when necessary, and by stating your expectations clearly and directly in team communications.

### *Differing interpretations of expectations*

Even when teams communicate their expectations, they can be interpreted differently. For example, what does “on time” mean? For one group member that can mean within 5 minutes of the scheduled time, for another teammate it can be exactly at the scheduled time, and for the third teammate it can mean 5 minutes early. Make sure to clarify what “on time” means for your group.

The same can be said of response times. What is an acceptable response time to an email or group chat? For some students, an appropriate response time is within a few minutes, for others it may be within a few hours. Make sure to agree upon an appropriate response time for your team.

### *Not feeling heard or valued*

Project satisfaction and contribution are strongly tied to feeling valued as part of the team. Do your part to ensure that all team members feel valued and are contributing equally. If a teammate doesn't feel valued, they might hesitate to voice their opinions and make contributions to the project. According to a Forbes [survey on the benefits of feeling heard](#), “highly engaged employees are three times more likely to say they feel heard at their workplace (92%) than highly disengaged employees (just 30%).” To have a highly engaged team, you can:

- Encourage full participation in meetings.
- Take time to hear and consider all ideas and find the benefit in each.
- Frequently ask all teammates for feedback and ideas.
- Offer positive reinforcement to teammates.
- Discover and play to each teammate's strengths.
- Recognize that each teammate is equally capable of contributing to the work.

## *Delegating work and designating roles*

Conflict may arise when there is disagreement or confusion surrounding who is in charge. Create a system within your team for appointing a team leader or project manager who is responsible for delegating tasks. Teams may choose to have members rotate between roles, but make sure that each team member always has an assigned role with clear responsibilities. The following are some ways to ensure that roles and tasks are designated and delegated clearly:

- In your Team Charter, clearly list the responsibilities of each role within the team.
  - Make sure to clarify: Who gets the final say on specific project decisions?
- Create a spreadsheet that tracks each week's delegation and designation of roles and assignments.
- Start each meeting by stating what you expect to get done in the allotted time.
- End each meeting by stating what you expect each team member to complete by the time of the next meeting.
- Create an agenda for each meeting that details each team member's responsibilities.

## **6.3 Conflict Resolutions**

### *Consider, in advance, how you will hold people accountable*

Often times people wait until there is a conflict to decide how to resolve it. This can lead to team members feeling targeted or feeling like the disagreement or resolution is personal. It is important to create a plan, in advance, for how your team will handle conflict. This way, there is an objective procedure for handling these situations. This plan should be included in your Team Charter so that when issues arise you can refer to the document you created together as a team. Your plan for conflict resolution should consider things like who makes the decision, or how a decision will be made, when your team struggles to achieve consensus, or how conflict will be brought to the attention of the team.

### *Develop team chemistry*

Success depends on everyone working well together. Therefore, get to know your team outside the scope of the project and take time to build social connections! Having strong relationships among team members will help to increase commitment to peaceful conflict resolution (and will make team meetings more fun).

## **6.4 Team Charter Assignment<sup>1</sup>**

1. Before beginning the Team Charter, watch the following video: [Team Contracting](#) (6 mins)
2. Complete the Team Behaviors exercise in the Leadership Portal. This exercise is meant to get you thinking about your expectations for the team and what things may be important to include in the Team Charter.
3. Using the Team Charter guidance, develop a Team Charter with an eye towards avoiding typical teaming problems that often arise.
  - a. Note that you will need to reflect on the questions provided before coming together as a team.
  - b. You will be best served by a detailed and explicit charter that outlines team norms and behaviors around processes and procedures (e.g., team communication).
  - c. Please also see **Appendix A: Team Charter Example**. Note that this example does not include a statement of each member's skills, which we are asking you to include.

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<sup>1</sup> Much of this section has benefitted from the advice and contribution of Professor Gail Berger.



4. By Week 2, you will receive a meeting schedule for a Team Charter Review Meeting with your instructor. **All** team members are required to attend this 20-minute meeting. This provides an opportunity to connect with you directly and ensure every team is off to a strong start.

## 6.5 Developing a Team Charter

The Team Charter sets out your collective agreement about how you'll work together, your standard(s) for excellence, and how you'll respond to gaps in individual and team performance. While there is no set formula for team charters, your draft will typically answer the following questions<sup>2</sup>:

- What is our mission? What will success look like?
- What specific objectives do we need to reach to achieve success? And by when? What are our key milestones and deadlines, and how will we ensure we meet them?
- What roles do we need, and who will fill those roles?
- What resources (people, time, financial, equipment, and processes) do we need?
- What skills does each individual bring to the project and how will we make best use of those skills?
- What's the context of our work together? Who called us together and what do we know about that person's (or group's) expectations?
- Who has authority to make what decisions? What decisions can individuals make? What decisions can be made by smaller work teams? What decisions do we make together?
- What value do we place on conflict? How will we resolve conflict when it occurs?
- How will we know when we've achieved genuine agreement?

Consider the following prompts:

1. Reflect individually about your skills. What skills will you bring to the project? What skills do you hope to further develop through this project? Think about broader professional skills in addition to those specific to engineering and analysis.
2. Reflect individually on possible answers to the questions above. What kinds of practices are likely to support your team's success?
3. Discuss as a team the skills that each individual member will bring to the project, and what skills they hope to develop. Include this information in your Team Charter.
4. Work together as a team to write your Team Charter and submit it as a PDF file in Canvas.
5. One of the instructors will schedule a follow-up conversation to discuss your Team Charter. The primary purpose here will be to ensure that your team is well positioned to function effectively and complete a successful project. They may ask additional questions such as:
  - What is your greatest strength as a team?
  - What are your greatest challenges as a team?
  - What behaviors and attitudes will help you collaborate?

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<sup>2</sup> These questions are adapted from *Design Thinking and Communication: Principles and Practice* (2018 edition), C. Yarnoff, et al.

## 6.6 Using the Team Charter

After developing the team charter, make sure to use it throughout the project. See below for best practices<sup>3</sup>:

- Great team charters set specific expectations for quality and responsibility. For example, many students would agree with the statements “we want a high grade” or “we want an ‘A’.” Similarly, you might agree that “everyone should come to each team meeting prepared to contribute.” Great, those are goals. However, they do not specify how these goals will be measured along the way. How will you evaluate the quality of your work? Will you evaluate your work upon submission to the team or when you meet for discussion?
- We encourage you to make changes to your charter as you learn about habits that aid or impede your team’s effectiveness. It is essential that your entire team meet together to make these changes. Often, teams find it useful to review the charter on a regular basis, typically after the first two weeks and then at least once each month thereafter.
- Return to the charter periodically, and especially when conflicts arise. Revisiting your shared expectations is a good step toward resolving them.
- While teamwork is an essential part of any great team, it must be complemented with effective project management. A simple project planning tool is to document “What, When & Who”:
  - What work needs to be done?
  - When does the work need to be done?
  - Who is responsible for making sure the work gets done?

## 7. Working with your Client

IEMS 394 is an opportunity for you to impress your client. Aim to demonstrate both your technical AND interpersonal skills. This course can lead to potential job offers or can provide a meaningful client work experience that you can incorporate into future job interviews. Additionally, while working with your client, remember that you are not only representing yourself and your team, but also the IEMS Department and Northwestern as an organization. Keep your communication and relationship with your client professional and consistent.

### 7.1 Communicating with clients

Remember the following when communicating with clients and project scoping:

- Clients often mistake “problems” for “objectives.” You should work toward an **objective**.
  - “We do a poor job of delivering on time.” ← *problem*
  - “We would like no order to be more than two days late.” ← *objective*
- Clients mistake things they have **never done** for things they **cannot do**.
  - Figure out what the real constraints are.
- Clients often fail to distinguish constraints and objectives.
  - Some constraints are “hard”, e.g., nonnegativity or flow-in equals flow-out.
  - Other issues stated as constraints are really aspirational, i.e., “soft” constraints. Even “satisfy demand” may need a shortfall variable that accounts for, and appropriately penalizes unmet demand.

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<sup>3</sup> Taken from “Teamwork Group Charter Exercises, Center for Leadership, provided August 28, 2020; and from *Leadership Theory: Facilitator’s Guide for Cultivating Critical Perspectives*, 6B: Team Leadership Through a Critical Lens p. 274-289, J. Dugan, et al.

- Clients often think they know what is causing the problem.
  - Maybe, maybe not. **Question everything.**
- Clients often do not know what a **model can and cannot do.**
  - Models are not magic.
  - Models can be useful without being perfect.
  - Models almost always require some calibration (e.g., to data).
  - Models can be descriptive, predictive, or prescriptive.

### *Additional suggestions*

- Appoint one team member as liaison to the client, i.e., the client should have a single point-of-contact with your team.
- Under commit and over perform—always better to exceed expectations.
- Make clear to clients what you need and when you need it.
- Never share work with the client until it has been reviewed by the team.
- Do not let schedule conflicts delay client meetings; meet the client with a partial team if needed.

## **7.2 Delivering your results**

Discuss with your clients when and how they would like to receive the final results from your project. At a minimum, you will want to deliver a copy of your final report and schedule a separate presentation. You can include any NDA-protected information that you could not share with your instructors, and your presentation can go into greater detail about your solution and recommendations.

Take care to make your presentation appropriate to the technical capabilities of the clients. Unless your client asks otherwise, focus on insights, recommendations, and impacts, rather than on technical details.

Finally, work with your client to arrange delivery of any datasets or software solutions that you cleaned, organized, or developed on their behalf. Make sure to thank them for the opportunity!

## **8. What to do if...**

### **8.1 Your group is struggling to identify an IE project based on what the client has given you**

Try to look past the specifics of what the client is asking of your team and focus on discovering the root of the problem your client is facing. Question everything. Your client might not understand where their problem is coming from or what their “real problem” is. Once you have reached the root of the problem, if you are still struggling to develop an IE project, consult your faculty project adviser, instructors, and TA.

### **8.2 Your group is struggling to agree on the project scope with a client**

If your team is struggling to agree on a project scope with a client, you can prepare an abbreviated project proposal. Include 2-3 possible project descriptions and solutions. Within the proposal define the problem you plan to address, what methods you will use to address it, and how the solution would impact or benefit the client. These proposals should demonstrate the type of work that IEs can do and the amount of work the team can feasibly complete within the quarter. Have your adviser review the proposal before sending it to the client. In your client meeting, discuss the

project proposals and have the client choose the project scope they find to be the most beneficial to them. Said another way, your client may believe that their problem is very complicated because there are many details. Your job is to assess “which differences make a difference.” Develop simple mental models of the situation to understand what features your simple mental model fails to capture. Based on the assumptions you make such exercises can help produce the desired 2-3 proposals.

### **8.3 Your client is unresponsive**

If you have reached out to your client and have not received a response, inform the instructors. If necessary, the instructors will contact the client and resolve the communication issues. In the meantime, work on background research or other aspects of the project that do not require additional information from your client.

### **8.4 There is a conflict within your team**

When a conflict arises within your team address it openly, honestly, and early. You may have to refer to your Team Charter to clarify team expectations, roles, and responsibilities. You can also review the Common Sources of Conflict for more information on avoiding conflict within your team.

When discussing a conflict within your team remember to always speak from your own experiences and only use “I” statements. Treat every teammate with respect and listen to what each teammate has to say!

If the conflict cannot be resolved, consult with the instructors right away. Do not allow team conflict to interfere with the progress of your project. Above all, do not involve your client in the conflict.

### **8.5 A team member is not contributing equally**

If a teammate is not contributing, first make sure that the teammate feels valued and heard. Then seek to understand the reasons the teammate is not contributing, and whether they are within the teammate’s control. Encourage involvement from the team member by asking them for feedback, ideas, and opinions. Additionally, make sure your team is clearly and evenly distributing work. If a team member repeatedly fails to complete their assigned tasks, consult with the instructors.

### **8.6 Your group has limited access to data or there is no data**

If your team is not provided with data from the client, you may need to find proxy data. Find a data source that is similar to the data you would ideally have from your client. When developing your midterm and final reports make sure to discuss the limitations of proxy data in the relevant sections of your report. Within your report, you may also want to include a list of data the client should begin collecting and the ways in which they can begin to collect it. If you are struggling to find proxy data, you can ask the instructors, TA, or your faculty project adviser for advice on where to start.

### **8.7 Your group is having trouble reaching your faculty project adviser**

If you have reached out to your adviser and not received a response, inform the instructors. If necessary, the instructors will contact the adviser and resolve the communication issues.

# Part II: Deliverables

## 9. Overview of Project Deliverables

### Proposal (15%)

#### *Group Submission*

The project proposal frames the client's problem and describes 1-3 proposed solutions, including the potential challenges of each proposition. The proposal will also explain the data and software required for the proposed work. The purpose of the project proposal is to ensure that your team creates a clear plan of action and can get started on the project promptly.

### Sources and Sentences

#### *Group Submission*

This assignment is a preliminary step toward carrying out and synthesizing the research necessary to develop informed solutions to your client's problem. The Sources and Sentences write-up will be graded as part of the Background Research and will include a preliminary discussion of four to five sources (one per team member) relevant to your project.

### Background Research (10%)

#### *Group Submission*

Background research places the work you are doing for your client within a broader context and establishes connections between your problem and related problems solved by others. Sources can include textbooks, journal and trade publication articles, Web pages and videos. Your background research should describe what you learned from these sources that is relevant to your problem, **not** provide a general literature review.

- You will submit your background research in its entirety (10%) in Week 3. This document will build upon your "Sources and Sentences" write-up submitted in week 2. The instructors will provide feedback on form and content.
- The key insights of your Background Research will inform your Midterm and Final Reports.

### Midterm Review (20%)

#### *Group Submission*

The Midterm Review consists of several related deliverables designed to ensure timely and appropriate progress. It also gives your team the chance to receive feedback and guidance from the instructors.

- The **Progress Assessment** asks you to indicate your level of progress on elements of the work. You should think about your progress in terms of the technical work completed, not in terms of the writing you have done. You will also answer some questions designed to guide a productive discussion with the instructors in your Midterm Review Meeting.
- The **Midterm Report** is a progress report on your project to-date using the format and guidelines for final reports. Think of this as an early draft of the final report. The Midterm Report should include: an introduction section, a supporting analysis section with a nearly complete data and software section, a list of data analyses created or planned, and descriptions or formulations of candidate models. You should also articulate what the next steps are in the project and what success looks like for your project.

## Final Report (40%)

### *Group Submission*

The Final Report includes an executive summary, introduction, solution, supporting analysis, future development, bibliography, and necessary appendices. The report is meant to describe your client's problem and the insights you developed during your investigation, the solution you formulated, and the data analysis and modeling you conducted to formulate the solution.

## Final Presentation (5%)

### *Group Submission*

The final presentation is a video recording of at most 5 minutes, which will be viewed by the instructors and other teams, as well as some clients and IEMS faculty. The presentation will be followed immediately by approximately 5 minutes of live questions from the instructors to the team. This is like an executive summary of your project that emphasizes the results and implications of your solution.

## Teaming Assignments (10%)

### *Group and Individual Submission*

Teaming assignments are due throughout the quarter. Teaming assignments are both group and individual submissions. As a group you will complete the initial Team Behaviors assignment, before the first day of class, and the midterm review. Individually, you will complete a check-in assignment during week 4, an individual midterm evaluation, and a final end-of-project review. In the teaming assignments you will formulate expectations for your teams and evaluate your team's progress and how effectively you work together. The assignments also allow you to give and receive anonymous feedback to and from your teammates as well as share information about your team with the instructors.

# 10. Project Proposal

Develop a 4-page project proposal that frames your client problem and proposes an initial plan for carrying it out. You should do so with an eye towards what is achievable within the course timeline, and what is valuable for the client.

## 10.1 Developing a Project Proposal

Critical first steps:

1. Establish **objectives** (there are almost always more than one) and how they can be measured.
2. (Literally) **sketch** the problem.
  - What is inside versus outside the box? How does the inside interact w/ the outside?
  - What are the flows, the links, the relationships, or the information sources?
3. Think **first** about how to **model** the system, not how to **solve** the problem. Understand what the client does **now**, or how the client would solve the problem without you, before thinking about the approach you propose.
4. Decide if **uncertainty** is a dominant or secondary issue.

Additionally, consider what types of modeling frameworks are relevant to your project:

- **Mathematical program:** When objectives can be clearly and quantitatively expressed as a function of things you can change.
- **Stochastic process:** When uncertainty is an inherent part of the system, and they want to do well despite the uncertainty.
- **Statistical model:** When you have data and want to infer what matters or predict the outcome of future cases.

- **Simulation model:** When uncertainty is an inherent part of a system whose performance is determined by complex interactions, and you want to know the consequences of changes.
- *Of course, there is no perfect mapping, and models can be used in combination, but this may be viewed as a starting point for guiding your approach.*

## 10.2 Guidelines for Project Proposal

Must follow the format below:

- No more than 4 pages, single-spaced, 11-point type, no cover page.
- Must include a graphic that displays visually your current understanding of the problem.
- *Successful proposals are concise and focus on the critical points.*

### CPC Proposal

**Client:** <client's organization name here>

**Key Client Contact:** <contact name here>

**Team members:** <your team member names here>

**Date:**

### Problem (1 page)

Briefly describe the problem as *you understand it*. Be sure to state concisely why this is a problem for the client, why it is important, and in what way a solution to it would deliver value. Also provide relevant context on your client's industry or the specific problem. Include your graphic here (see examples next page). Do **not** describe solutions. Remember to define industry-specific terms when you first use them. Even if the definitions are obvious to you, omitting them may prevent your reader from fully understanding the problem or your recommended solutions. Consider this problem statement an early draft of the introduction for your midterm and final reports.

### Proposed Solution Approaches (1-2 pages)

Propose 1-3 approaches for creating a solution. A "proposed solution" includes one or more data-independent models; a statement of the anticipated challenges; a proposal for how the model will be analyzed; and a statement as to what sort of solution the model will deliver.

Make sure to ask yourself and clearly address the following questions:

- What are the goals?
- How will the client's problem be solved without your help?
- How will you know when you have succeeded?
- What are the hard and soft constraints in the problem and how will your proposed solution handle them?
- What are the engineering standards, laws, or regulations that will impact your solution? How will you handle these regulations in our proposed solution?

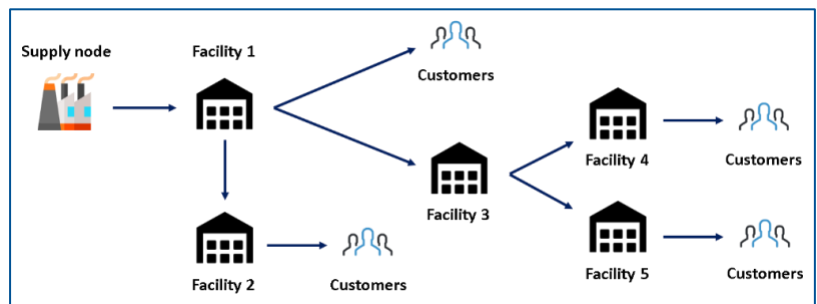
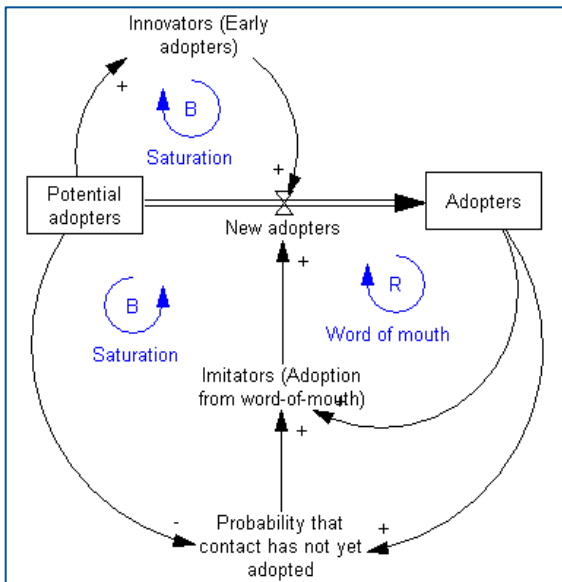
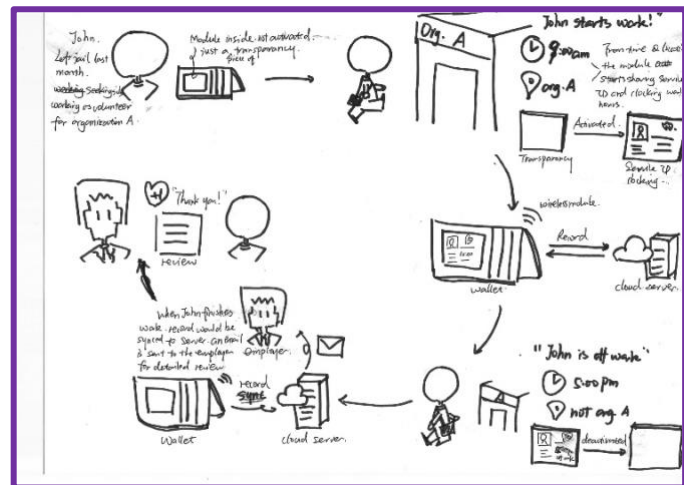
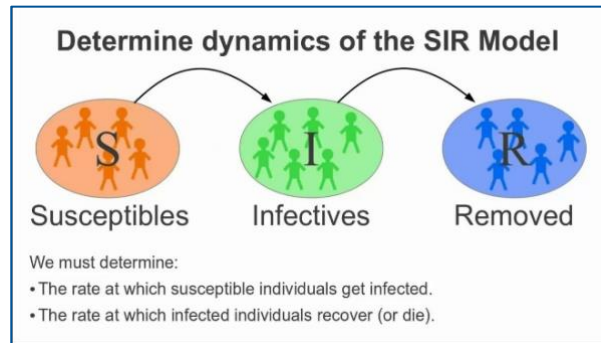
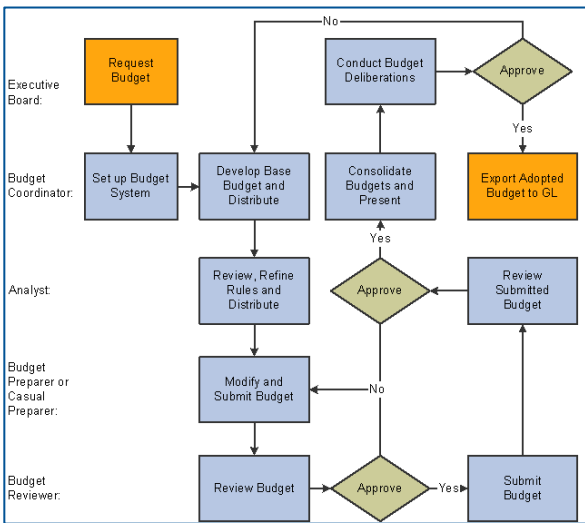
*Example of Proposed Solution Approaches: We propose creating an optimization model reflecting two objectives: maximizing customer satisfaction and minimizing cost. To handle these competing objectives, we will initially treat customer satisfaction as a constraint measured in terms of time until their appointment is scheduled and treat cost as an objective to be minimized. This model needs to encompass sequencing constraints, staffing constraints, and warehouse space constraints. Incorporating demand uncertainty into this formulation will be a challenge. Success in this approach will yield a weekly schedule as to which customers' orders will be processed on which days, along with a projection of how much overtime might be needed. We believe that a proof-of-concept model will be small enough to be solvable within Excel, but that a full solution might require that the client obtain an industrial strength solver, for which we will provide recommendations. We will assess the performance of our model's solutions by benchmarking it relative to simple heuristic that aims to mimic the client's current approach.*

**Data, Resources and Risks (1 page)**

Describe the data that your proposal requires, including what is currently available and what needs to be obtained. For data that need to be obtained, state your plan for obtaining it. Describe any other resources (e.g., software) that you need to obtain or learn. Give a project timeline, your assessment of risks that would prevent successful completion of the project, and how you propose to mitigate those risks.

**Graphics:**

Your graphic should describe your understanding of the system and associated problem at a high level, indicating what aspects of the problem that your solution will need to encompass, the basic flows of people, parts, information, etc., and data inputs. You may also indicate aspects of the problem about which you are currently unsure and need additional information. Your graphic may be hand drawn if done *neatly*, though this should be a last resort. Some example graphics are shown below:





## 10.3 Common Issues

Past experience has revealed the following list of common areas for Project Proposal improvement. Many of these issues also apply to the Midterm and Final Reports, and of course to projects you take on once you leave NU.

1. In any proposal or report it is important to establish one or more **quantifiable objectives in conjunction with the client**. Nearly all problems will have “decision variables” (things that can be controlled) and constraints on them; these should be clearly identified.
2. Model, data, and tool (e.g., Simio, R, Python) are **distinct** entities. A proposal should first define a data- and tool-independent model, then the data needed to populate that model can be described, and finally the tool used to solve the model should be chosen. The tool is the **least important** aspect of these three at the proposal stage.
3. Distinguish between **descriptive, predictive, and prescriptive** models, and which is needed for your problem. Statistical machine learning models have little value for situations that are entirely outside of the existing data but can be used to infer key parameters, make predictions, or identify important factors for situations described by existing data. Simulation models can be used to mimic current operations of a system, to assess the performance of alternative operations policies or system design, or to assess system performance of a new system. Mathematical optimization models (e.g., linear, nonlinear, and integer programs) can be used to optimize system design or operations, incorporating one or more objectives and constraints.
4. It is important to decide if **dynamic behavior matters**; do not use tools like systems simulation or queueing theory that emphasize time dynamics for a static assignment/allocation problem.
5. Avoid statements that you cannot justify with data, analysis, or quantitatively and qualitatively justified intuition.
6. It is always important to state how you anticipate evaluating or testing the quality of your solution.
7. The purpose of the graphic is to lay out what is “inside the box” (will be modeled in detail) and “outside the box” (will be ignored or modeled simply); describe the critical flows and data sources; and highlight the key problems/bottlenecks. Your proposal or report should refer to your graphic, and the graphic should be easily readable.

## 10.4 Rubric for Project Proposal

CPC Proposal <span style="float: right;">✎ 🔍 🗑</span>		
Criteria	Ratings	Pts
<p>Description of client problem</p> <p>Clearly-stated identification of the problem with a discussion of why the problem is a problem, the value of a solution, and relevant context.</p>	This area will be used by the assessor to leave comments related to this criterion.	25 pts
<p>Proposed solutions</p> <p>Multiple relevant models with trade-offs fully described.</p>	This area will be used by the assessor to leave comments related to this criterion.	25 pts
<p>Data resources</p> <p>Description of required data. List of available and unavailable data, a plan for obtaining unavailable data, and a plan for what to do if data cannot be obtained.</p>	This area will be used by the assessor to leave comments related to this criterion.	20 pts
<p>Other resources</p> <p>A prioritized list of resource needs with alternatives and sources.</p>	This area will be used by the assessor to leave comments related to this criterion.	10 pts
<p>Project timeline and risks to completion.</p>	This area will be used by the assessor to leave comments related to this criterion.	10 pts
<p>Proposal document</p> <p>Follows all guidelines, is well-written and organized, and is without errors.</p>	This area will be used by the assessor to leave comments related to this criterion.	10 pts
		Total Points: 100

## 10.5 Levels of Competency for Project Proposal

	<b>Marginal</b>	<b>Acceptable</b>	<b>Exemplary</b>
<b>Description of client problem</b>	Limited description of the client's problem.	Identification of client's problem with relevant graphic.	Identification of client's problem with compelling graphic, clear statement why it is a problem and the value of a solution.
<b>Proposed solutions</b>	One or more models with debatable relevance proposed.	One or more relevant models proposed.	Multiple relevant models with trade-offs fully described.
<b>Data resources</b>	Incomplete data list, including only possible data and/or needed data.	List of available and unavailable data with limited plan for obtaining unavailable data.	List of available and unavailable data, a plan for obtaining unavailable data, and a plan for what to do if data cannot be obtained.
<b>Other resources</b>	List of possible resource needs.	Prioritized list of resource needs and sources.	Prioritized list of resource needs with alternatives and sources.
<b>Project timeline and risks to completion</b>	Incomplete timeline with limited list of risks.	Complete project timeline with list of risks to completion.	Complete project timeline with prioritized and annotated list of risks to completion.
<b>Proposal document</b>	Does not follow all guidelines.	Follows all guidelines, well organized and well written.	Follows all guidelines, well organized and written, compelling discussion, and without errors.

# 11. Background Research

## 11.1 Background Research Guidelines

### Motivation

Industrial engineers use mathematical, statistical, and computer models to address complex operations problems. In your coursework the focus has been on **tools** (programming, data structures, optimization, probability and stochastic processes, statistics and statistical learning, simulation) with some exposure to **applications** that apply those tools (e.g., IEMS 307, 341, 373, 381, 382, 383, 385).

When you address a real problem, as in IEMS 394 and on the job, it is important to learn from the success of others who have addressed similar problems: What model formulations have proved valuable on related problems? What tools were used? What difficulties were encountered? *In your IEMS 394 project we expect you to reach beyond the training from your coursework to relevant references in the literature.*

### Requirements

IEMS 394 requires that you find, summarize, and create a bibliography of background research relevant to your problem. The entirety of your Background Research will be submitted as a stand-alone deliverable. The key insights of your background research will also inform the Introduction sections of both your Midterm and Final Reports.

Background research sources include textbooks, journal and trade publication articles, Web pages and videos. *Your background research should discuss what you learned from these sources that is relevant to your problem, **not** provide a general literature review. It is critical that you evaluate and document how the “assumptions” in related work do or do not conform to your problem.*

You will develop and synthesize the research informing your proposed solution through a series of scaffolded deliverables:

- **Sources and Sentences:** a brief bibliographic write-up (week 2)
- **Background Research:** a two-page essay and bibliography discussing the entirety of your research findings (week 3). Your complete Background Research will be included as an appendix to your Final Report.
- **Background Research Discussion:** a concise, one-paragraph distillation of the key insights from your research, which you will include in the “Introduction” sections of your Midterm and Final Reports

### Sources and Sentences

To support the completion of your background research, you will submit a brief “Sources and Sentences” write-up in week 2. For this assignment, you will list **four to five** sources (one per team member) relevant to your project. For each source, you should draft three sentences identifying the following:

- The main takeaway
- Information learned that was not stated in the abstract
- Relevance to your project

The “Sources and Sentences” assignment will be graded as part of the Background Research.

As you develop your Background Research it could be productive to keep the above three-sentence annotation in mind as a useful framework to evaluate sources you find after submitting the initial “Sources and Sentences” assignment.

## Background Research

### CPC Background Research

**Client:** <client's organization name here>

**Key Client Contact:** <contact name here>

**Team members:** <your team member names here>

**Date:**

Your background research should take the form of a two-page essay that summarizes research findings relevant to your project and places your work and its key questions in the context of similar applications. Your essay should showcase that you have identified relevant sources and include a clear discussion of:

- what you learned that is relevant to your problem
- the importance of the information learned
- any assumptions made in the research and how these assumptions might impact applicability

You might begin with a revised and streamlined statement of your client problem from your Project Proposal. From there, you should work to synthesize the information you find in your sources.

Do not draft a sequential discussion of your sources. Rather, imagine that your sources are in conversation with each other and with the questions pertinent to your project. Sometimes your sources will agree and support each other, other times you will find disagreement and refutations. Your job is to enter the conversation and situate your project's questions and nuances within it.

You can find examples of background research on Canvas → Files → Sample Reports. Note that while these example reports have background research within the report, you will submit background research as a separate deliverable.

Your Background Research is due in week 3, though you should aim to have it completed as early as possible.

The key insights of your Background Research relevant to your proposed solution will be included in a one-paragraph summary in the "Introduction" sections of your Midterm and Final Reports. The entirety of your Background Research will be included as an appendix to your Final Report.

## Research tools

While a starting point may be to just “Google” your problem, there are more refined searches that can more quickly find relevant material.

- Google Scholar (<https://scholar.google.com/>) finds journal articles and books and allows you to see what sources cited them. It also makes it easy to copy and paste the citation into your report. If you VPN to Northwestern first, then you will often get access to the book or journal through Northwestern subscriptions.
- The *INFORMS Journal on Applied Analytics* (<https://pubsonline.informs.org/journal/inte>) publishes only application papers, written in a format that will be easy for you to understand. The papers published in this journal also have good examples of background research for applied problems.
- The [libguide](#) provides guidance on conducting background research, access to databases relevant for IE problems, and an opportunity to sign up for a research consultation with a Northwestern librarian. You are strongly encouraged to take advantage of this resource—especially the consultation.
- The *INFORMS Analytics Magazine* (<https://pubsonline.informs.org/magazine/analytics>) has nice high-level articles on applications of IE tools in many domains.

## 11.2 Tips for Background Research

*Do not summarize, connect each source to your project, and keep it brief.*

Do not summarize entire articles in your Background Research. Instead, pull out the information from the resource that is directly relevant to your project. Only highlight things you have learned that will inform your project. Include *why* the information is important to your project and *how* it has impacted or will impact your project decisions, connecting each source back to your project.

*Do your research early.*

Complete your background research early. You may have to wait for data from clients or take some time to decide on a project scope; however, the background research can begin almost immediately. Focus on the research early so that you can dive into the model, data, analysis, and report for the remainder of the quarter.

Additionally, researching sources that address similar problems is more helpful before you have developed your project idea, because you can use insights from your background research to fuel your brainstorming process. That said, be careful to avoid becoming “anchored” in the approaches of others, especially if key aspects of your project differ.

*Choosing sources*




We assume you have knowledge of IEMS classes, so this is not research. The goal is to find textbooks, technical reports, and journal articles that address similar problems using quantitative modeling and analysis and summarize these as input to framing your model and your approach. Background research may also include data sources that you uncover that inform your project. If you need help, look at the references in your sources’ bibliographies or papers that cite your source (reverse-citation search).

## Citations

Sources from the literature—whether journal articles, trade publications, textbooks, etc.—should be grouped, and discussed relative to your problem. For example: ‘Ankenman & Nocedal (2002), Wang & Wilson (2022), and Morton et al. (1999) work on problems similar to ours. [Now detail how they are similar in specific ways A, B, and C.]’

If you cite a textbook, do not cite the full textbook. Rather, point to the relevant section or chapter and explain its relevance. Write something like Morton et al. (1999) if the reference has three or more authors.

### 11.2.1 Rubric for Background Research

Background Research   		
Criteria	Ratings	Pts
<b>Appropriate Sources</b> Sources are relevant and sufficient to address problem context. Incorporates and builds upon completed "Sources and Sentences" assignment.	This area will be used by the assessor to leave comments related to this criterion.	15 pts
<b>Assumptions and Insights</b> For key sources, writing addresses:  a.) what you learned that is relevant to your problem b.) evaluation of any assumptions made and how they might impact applicability.	This area will be used by the assessor to leave comments related to this criterion.	10 pts
<b>Analysis &amp; Synthesis</b> Sources are analyzed and synthesized topically (rather than sequentially). Clear discussion of the importance of the information learned.	This area will be used by the assessor to leave comments related to this criterion.	15 pts
<b>Document</b> Document is professional, clear and compellingly written, free of errors, and is at most 2 pages (excluding bibliography). Sources are cited and listed appropriately.	This area will be used by the assessor to leave comments related to this criterion.	10 pts
		<b>Total Points: 50</b>

# 12. Midterm Review

Your midterm review will consist of four components:

- **Midterm Report:** An early draft of your final report that provides detailed information on your progress.
- **Progress Assessment:** A shorter summary and evaluation of your progress to-date that will form the basis of a conversation with your instructors.
- **Instructor Project Review Meeting:** A face-to-face conversation with instructors to review your progress, share successes, and discuss challenges to successful project completion.
- **Peer Project Feedback:** Questions and suggestions for another project team based on the information presented in their Progress Assessment and the Instructor Project Review.

## 12.1 Midterm Report

Prepare a progress report on your project to date using the format and guidelines for final reports (Refer to Section 13.1 Guidelines for Final Report). Think of this as an early draft of the final report. The Midterm Report should include:

- **A complete Introduction section**, including a one-paragraph summary of the most relevant insights from your Background Research (~1-2 pages)
- **A Supporting Analysis section**, which describes as fully as possible both your planned and completed analysis (~3-4 pages). The section should include:
  - Supporting Analysis I: A nearly complete Data and Software section. Software may be a list of potential software solutions that are yet to be fully investigated.
  - Supporting Analysis II: A Modeling and Analysis section that should include a list of data analysis completed and planned. More than one candidate model may be described and **formulated**.
- **A Next Steps and Vision for Success section** (~1 page)
  - Discuss potential solutions and their impacts.
  - Explain what success looks like for your project, where you would like to end, and how you plan to get there.

### 12.1.1 Common Issues




Past experience has revealed the common areas of improvement listed below for the Midterm Report; many will also apply to the Final Report.

- **Introduction:** In this section, you should not only describe the client's problem, but also summarize the key facts and insights you have gleaned from studying the problem. All graphics, here and elsewhere, should be of high quality (hand drawn is no longer acceptable at this stage).
- **Supporting Analysis:** We have a strong preference for formal modeling formulations (e.g., a regression model, mathematical program, stochastic process) using mathematics, even if not yet complete. Make sure all terms in the model are carefully defined. Link your model to your data sources. Simulations should include a "box-and-arrow" diagram describing the model flow.



- **General issues with respect to report structure and content:**
  - A report is not a narrative of what you did and in what order. Focus on problem, solution, and supporting analysis.
  - Be concise and get to the point.
  - Focus on what is important, and disregard what is peripheral. One of the key attributes that you as an IE bring to a problem is the ability to figure out what matters.
  - Do *not* tell the story of what you did in the project in chronological order, and do not describe things you tried that did not work unless they are important to understanding what you did do.

## 12.1.2 Rubric for Midterm Report

CPC Midterm Report   		
Criteria	Ratings	Pts
<p><b>Introduction</b></p> <p>Clearly-stated description of the client's problem, possibly including graphics, that summarizes key facts and insights you learned in your research and analysis. Also includes a summary of your background research. For full credit this section should be complete.</p>	This area will be used by the assessor to leave comments related to this criterion.	20 pts
<p><b>Supporting Analysis I - Data and Software Resources</b></p> <p>Summarizes data sources and software that you are using and anticipate using. Full credit requires substantial completed work.</p>	This area will be used by the assessor to leave comments related to this criterion.	20 pts
<p><b>Supporting Analysis II - Modeling and Analysis</b></p> <p>Describes data analysis and mathematical, computer, or statistical models that have been created, and any additional models or refinements you plan to use. Full credit requires substantial completed work. Also includes challenges you see to completing the project.</p>	This area will be used by the assessor to leave comments related to this criterion.	20 pts
<p><b>Next Steps and Vision for Success</b></p> <p>Describes potential solutions and their impacts. Explains what success looks like for this project, where you would like to end, and how you plan to get there.</p>	This area will be used by the assessor to leave comments related to this criterion.	5 pts
<p><b>Report Document</b></p> <p>Report is prepared in the correct format, is free of grammatical and spelling errors, is well-written, organized, clear, and logical. Report incorporates feedback and discussion items from writing check-in #1.</p>	This area will be used by the assessor to leave comments related to this criterion.	10 pts
		<b>Total Points: 75</b>

## 12.2 Progress Assessment

The Progress Assessment is a separate document from your Midterm Report which will help you prepare for the Instructor Midterm Review Meeting. The Assessment is a brief summary of your Midterm Report that will provide key information to guide your face-to-face conversation with the instructors. Course instructors will review your Progress Assessment carefully and provide substantial feedback in advance of your Final Report. Your Progress Assessment will certainly draw information from your draft midterm report, but it is not only a summary of that document. The Assessment must be organized as follows and must be at most two pages long.

1. Provide a *brief* summary (one paragraph) of the problem that you have been asked to address.
2. For each of the following, provide *concise* answers based on your work so far, and describe the work you propose to complete. You will have the opportunity to elaborate if needed in the Instructor Project Review Meeting. Also give an estimate of the percentage of work completed in each area (0-100%). Note that **we expect substantial overall progress** on these items, even if some are more advanced than others.
  - **Data collection:** What data sources do you have? What crucial data are missing, and what are your plans to acquire it?
  - **Modeling and analysis:** What data analysis will you conduct? What mathematical, computer, or statistical models will you create in order to make an actionable decision recommendation?
  - **Software:** What software packages will you use to conduct data analysis, or create your models?
3. What is your biggest accomplishment, or most meaningful success, so far?
4. What are the biggest obstacles to your success, and what do you need to overcome them?
5. Given the work you propose to complete:
  - What impact do you think accomplishing it will have for your client?
  - What is your recourse plan if you are not able to accomplish key goals that remain?
  - What questions do you have for the instructors?

You should provide the substance of Item 1 (problem summary) and Item 2 (Data/modeling & analysis/software) to your client for feedback and buy-in. This could be done in writing with a request for feedback, via Zoom in a conversation with a slide-based summary, or through your preferred means of communication with your client. Be sure to plan ahead so that you receive timely feedback.

## 12.3 Instructor Project Review Meeting


The Instructor Project Review Meeting will also be part of your Midterm Review grade. This is a collaborative meeting designed to ensure your continued project success. Your instructors will review your Progress Assessment and discuss your work, providing suggestions and guidance for overcoming potential project challenges. Each team member is expected to be present and actively participate in this discussion. You will also participate in the Instructor Project Review Meeting for a partner team.

Before this meeting you should:

1. Prepare a brief presentation (2-3 minutes) of your project progress so far, and any questions you want to be sure to discuss with the instructors.
2. Read the Progress Assessment provided to you from your partner team.
3. Develop a list of questions and suggestions for your partner team to consider. You can add to this throughout the review discussion. At the end of the discussion, you will submit this to the instructors, who will review it and share with your partner team.

Five points appear in the Midterm Review rubric to reflect how well your team responds to instructor questions and comments. Remaining points will be allocated in a separate assignment to reflect each individual's contributions. Meetings will last no more than 30 minutes per team.

## 12.3.1 Instructor Project Review Meeting Rubric

CPC Instructor Project Review Meeting  			
Criteria	Ratings		Pts
<b>Progress Assessment</b> Includes a brief summary of the midterm report to prepare for the team/instructor meeting.	15 pts Full Marks	0 pts No Marks	15 pts
<b>Project Review Meeting</b> Full engagement in question and answer session with instructors. Submission of thoughtful questions and suggestions for peer team.	5 pts Full Marks	0 pts No Marks	5 pts
			Total Points: 20

## 13. Final Report

The purpose of the final report is to evaluate and communicate how the project was executed to various stakeholders. Clients need to understand the proposed solution and impact, and instructors need to assess your understanding of the problem and the IE models developed to solve the problem. Consider your client the primary audience for the body of the final report; you will include appendices to help the instructors evaluate the technical aspects of your solutions. Prepare your Final Report following the “Guidelines for Final Reports” section.

See example reports on the course Canvas page → files → “Example Reports”.

*\*Note: The examples provided on Canvas have a Background Research section within the final report. The complete Background Research section is now a separate deliverable and should not be included in your Final Report document. As with your Midterm Reports, your Final Reports should include a one-paragraph summary of the key insights from your background research in the “Introduction.”*

### 13.1 Guidelines for Final Reports

- Your report must follow the format below, including the section headings. Additional subsections may be added as needed.
- Your report must be at most 10 pages, single-spaced, 11-point type, plus a cover page.
- Your report should include appendices that document data, models, sensitivity analyses, etc. that are important for the instructors and may be useful for the client but the report itself *must be self-contained and fully understandable without reading the appendices*.
- Incorporate feedback that you received on your proposal, background research, progress assessment, and midterm report. Think about that feedback broadly, as opposed to it simply applying to a single line of a single document.

- For both your final presentation and your final report, focus on presenting your problem and your solution, **not** your process. Examples of "your process" might include: the means by which you iteratively obtained data from your client; the timing with which you learned certain revelations about your problem; the fact that you were new to the problem domain and needed to do background reading; the fact that it took a lot of time to perform certain tasks; the order in which your team performed certain tasks; etc.
- Remember that the final report is a significant component of your course grade. You want to ensure that your writing effectively communicates the client's problem; your solution, its limitations and impact; and your supporting analysis.

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## **COVER PAGE (1 page)**

### **CPC {Midterm, Final} Report**

**Client:** <client's organization name here>

**Key Client Contact:** <contact name here>

**Team members:** <your team member names here>

**Date:**

### **Executive Summary (1 page)**

- One paragraph summarizing the problem.
- One paragraph summarizing your proposed solution.
- One paragraph describing what will be delivered to the client.

### **Introduction (~1-2 pages)**

- Discuss the client's problem, possibly including graphics.
- Summarize key facts and insights that you learned as part of your research and analysis, including a one-paragraph summary of the most relevant insights from your Background Research.

### **Solution (~2-3 pages)**

- Describe the solution you are recommending to the client, how it works and why each component is important.
- Summarize data sources and software used to form your recommendation. Refer to the Data and Software appendix for additional details.
- Include a brief description of any statistical or computer models that you are delivering to the client and why they were selected for this problem. While this section may describe the data analysis, specific details about the models should be included in the Modeling and Analysis appendix. Refer to that appendix as needed in this section.
- Address how the solution can be maintained and updated by the client in the future, if appropriate.

### **Limitations and future development (~1 page)**

- Discuss limitations of your assumptions and/or the solution.
- Explain risks the client should be aware of when applying the solution.
- Describe any future developments to the models and proposed solution. Consider the implementation phase of the solution.

### **Conclusion (~ 1 page)**

- Describe impacts of the solution. These may include both economic and non-economic impacts. The latter could involve social good; equity; robustness or reliability with respect to uncertainty; risk aversion; efficiency; simplicity; novel insights; etc.
- Thank the client and other stakeholders that you worked on in this project. These may include individuals that you interviewed or discussed the process or data analysis to help your understanding of the problem and solution.

### **Appendices**

The appendices should include the supporting analysis and can be divided into three main appendices. Depending on your project, there may be other appendices that might be helpful to include. Yet be judicious in what you append, focusing on the methods and models that informed the final solution you are presenting to the client.

- *Final background research*
  - Include the final graded assignment.
- *Supporting analysis I – Data and software*
  - Include additional details of the data and software used to form your recommendation not included in the solution section.
- *Supporting analysis II - Modeling and analysis*
  - Describe data analysis and the mathematical, computer, and/or statistical models you developed and how they were used to arrive at your recommendation.

## 13.2 Rubric for Final Report

CPC Final Report   		
Criteria	Ratings	Pts
<p>Executive Summary</p> <p>Summary of the problem, your proposed solution, and what will be delivered to the client.</p>	This area will be used by the assessor to leave comments related to this criterion.	10 pts
<p>Introduction</p> <p>Clearly-stated description of the client's problem, possibly including graphics, that summarizes key facts and insights you learned in your research and analysis. Also includes a summary of your background research.</p>	This area will be used by the assessor to leave comments related to this criterion.	15 pts
<p>Solution</p> <p>Description of an actionable decision-support solution that you are recommending to the client. This section should focus on the solution and accompanying analysis, not the supporting model or data.</p>	This area will be used by the assessor to leave comments related to this criterion.	15 pts
<p>Limitations and Future Development</p> <p>Discussion of limitations of the solution or risks of which the client should be aware, and how the solution can be maintained and updated by the client in the future.</p>	This area will be used by the assessor to leave comments related to this criterion.	5 pts
<p>Conclusion</p> <p>Discussion of solution impacts. These may include both economic and non-economic impacts. Thank the client and other stakeholders that you worked on in this project.</p>	This area will be used by the assessor to leave comments related to this criterion.	5 pts
<p>Appendix: Background Research</p> <p>Include the final graded background research assignment .</p>	This area will be used by the assessor to leave comments related to this criterion.	0 pts
<p>Appendix: Supporting Analysis I - Data and Software</p> <p>Description of data and software that documents and summarizes the data sources and software that you used to form your recommendation.</p>	This area will be used by the assessor to leave comments related to this criterion.	20 pts
<p>Appendix: Supporting Analysis II - Models and Analysis</p> <p>Description of models and analyses that provides details of data analysis and mathematical, computer, or statistical models that you created to inform your recommended solution.</p>	This area will be used by the assessor to leave comments related to this criterion.	20 pts
<p>Final Report Document</p> <p>Report is prepared in the correct format, is free of grammatical and spelling errors, is well-written, organized, clear, and logical. Report incorporates feedback and discussion items from writing check-in #2.</p>	This area will be used by the assessor to leave comments related to this criterion.	10 pts
		<b>Total Points: 100</b>

# 14. Final Presentation

## 14.1 Guidelines for Final Presentation

The final presentation is a video recording of at most 5 minutes, which will be viewed by the instructors and other teams, followed immediately by approximately 5 minutes of live questions from the instructors to the team. This is the final presentation to your **instructors**. You should schedule a separate presentation to your client, which may include confidential data.

All teams are expected to attend class on the date of final presentations. See Canvas for details. Presentation order will be by random draw, first playing the video and then taking live questions. The instructors will play your video from their computers. Here are some guidelines for the instructor final presentation:

- Think of this as an Executive Summary that emphasizes results, implications, and potential impact. Your audience is the course instructors, so you can be technical. Use graphics and/or animation as needed to enhance your presentation.
- Emphasize your models, results, and deliverables; only a brief review of the client's problem is required. Do *not* tell the story of what you did in the project in chronological order, and do not describe things you tried that did not work unless they are central to understanding what you did do.
- Be prepared to answer questions in the live session. For full credit, all team members must participate in the recording, including speaking, and answering questions live. An easy way to record your presentation is as a Zoom meeting, which you then export as an .mp4 file and upload to Canvas. Be mindful of how the presenter in such a video can obstruct graphics or other material on a slide. Do a test recording first.
- Remember that you represent yourself, IEMS, and Northwestern to all stakeholders. Clients and IEMS faculty will be invited to attend, so professional dress and behavior is expected.

## 14.2 Rubric for Final Presentation

CPC Final Presentation		
Criteria	Ratings	Pts
Clearly articulates the problem, as well as suitability and shortcomings of data	This area will be used by the assessor to leave comments related to this criterion.	10 pts
Provides clear justification for team's approach to the problem	This area will be used by the assessor to leave comments related to this criterion.	10 pts
Clearly articulates recommendations, risks, and impact for the client	This area will be used by the assessor to leave comments related to this criterion.	10 pts
Demonstrates clear evidence of contributions from all team members	This area will be used by the assessor to leave comments related to this criterion.	10 pts
Handles questions thoughtfully, directly, and confidently.	This area will be used by the assessor to leave comments related to this criterion.	10 pts
		Total Points: 50



# Appendix A: Team Charter Example

*This is a Team Charter developed by an IEMS 394 team from a previous quarter. Some information has been removed to maintain confidentiality. You should not copy this directly! This only provides an example of the kinds of details your team may want to specify.*

## Team Charter

**Mission Statement:** Our ultimate mission is to meet the expectations of our instructors and ourselves while also satisfying our client.

- **Instructors:** Our instructors offer positive feedback throughout the project, on both quality and time management.
- **Ourselves:** We will gain growth and strength in analytical and communication skills, as reflected by an A at the end of the semester.
- **Client:** We will seek to communicate with our client as frequently as possible in order to ensure our understanding of the project.

## Performance Goals

1. Everything we turn in will be tidy and well-organized. Neither our instructors nor our advisers should have difficulty finding what they asked for.
2. We will honor the due dates we discuss and present in ClickUp.
3. Our project folder should be well-maintained, as all files should be easy to find and navigable.

## Team Standards

1. Each group member should be treated with proper respect and should be able to give their input on all important decisions.
2. Group members should be on time for each meeting and should make every effort to come to all meetings. Absences will be addressed at the next meeting. There will be a five-minute grace period for tardiness.
3. Official meetings should specifically focus on accomplishing as much as possible. Separate meetings can be planned for the purpose of team bonding.
4. We will always be professional with our client.

## Protocol

### Communication

- We will respond to emails from our client, adviser, and instructor within 24 hours (48 on weekends)
- We will use email regarding important project decisions to communicate with each group member. We will also use text messages to keep all project members updated on dates and meetings.
- In-team communication will be responded to in a timely manner (less than 24 hours)
- Written deliverables will be posted on Google Docs
- In the event of any conflicts or disputes, we will take time to openly discuss and solve the issue. We will speak with respect and honesty.

### Meetings

- We will attempt to have all four group members meet in person at least once a week (outside of class) to discuss issues and future plans. "Community meetings" can occur before general meeting.
- We will communicate with our client for clarification when problems arise.
- We will set an estimate for the length of meeting time and stay close to it.
- Ideally, we will meet on **Sundays at 11 am**, and our weekly meetings with Professor Perry will be announced at a later date.

### Planning

- We will keep ClickUp updated every week.
- Deadlines should be addressed at every meeting to make certain that all group members are staying on track.
- All meetings should be planned with at least 24 hours' notice.

### *Conflict resolution*

- We should treat each other with respect, and we should target the idea, not the person.
- We will use “I” statements when discussing any problems.
- We will refer to the Team Charter to re-focus on our goals and commitments to each other.
- Everyone should have the opportunity to express their opinions and be required to update team members on progress at each Community Meeting, and the team should vote on the best resolution.

### **Roles and Responsibilities**

- We will operate with a rotating leadership style, where every week one member of the team becomes the “point person” regarding organization, responsibilities, questions, communication, and team functionality. This person will lead the meetings throughout the week and check with members to ensure that progress is being made.
- Every member should view the ClickUp Site to remain aware of their own and other members’ responsibilities
- Every member should finish their assigned work before the deadline shown ClickUp. In case of emergencies or other issues, the person should notify other members about unfinished work by 9pm on that specific day.