

Charles Babbage, Ada Lovelace, and the Dawn of Computing

Instructor's Guide, v. 1

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Instructor's Guide

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Part 1: Introduction

Welcome to *Charles Babbage, Ada Lovelace, and the Dawn of Computing*, a Reacting to the Past role-playing game centered on Charles Babbage and Ada Lovelace, pioneers of the modern computer who lived in Great Britain in the nineteenth century.

How to teach with reacting to the past

Reacting to the Past is a series of historical role-playing games. Students are given elaborate game books which place them in moments of historical controversy and intellectual ferment. The class becomes a public body of some sort; students, in role, become particular persons from the period, often as members of a faction. Their purpose is to advance a policy agenda and achieve their victory objectives. To do so, they will undertake research and write speeches and position papers; and they will also give formal speeches, participate in informal debates and negotiations, and otherwise work to win the game. After a few preparatory lectures, the game begins and the players are in charge; the instructor serves as adviser or “gamemaster.” Outcomes sometimes differ from the actual history; a post-mortem session at the end of the game sets the record straight.

Game set-up

Before the game begins, instructors must help students to understand the historical background. During the set-up period, students will read several different kinds of material:

- The game book, which includes historical information, rules and elements of the game, and essential documents; and
- Their roles, which describes the historical figures they will play in the game.

You may also assign primary and secondary sources outside the game book (perhaps including one or more accompanying books). Some texts are recommended in the annotated bibliography that appears in the gamebook. Others may be suggested in the schedule section of this IM. If you want players to use these readings, they need to be tied in to the functioning of the game. Figure out how they tie into the game by relating them to specific roles and particular assignments. Characterize the set-up sessions as a brief introductory overview. Remind players that they should go back and reread these materials throughout the game. A second reading while in role will deepen their understanding. Remind players that players who have carefully read the materials and who know the rules of the game will invariably do better than those who rely on general impressions and uncertain recollections.

This IM provides prompts for leading discussions during these set-up sessions.

From instructor to gamemaster

Once the game begins, you become a Gamemaster (GM). During regular game sessions, this means you will often take a seat in the back of the room. While no longer in control, you may do any of the following:

- Pass notes to spur players to action;

- Announce the effects of actions taken inside the game on outside parties (e.g., neighboring countries) or the effects of outside events on game actions (e.g., a declaration of war); and
- Interrupt and redirect proceedings that have gone off track.

Much more of your work will occur outside of the classroom. Guide players by responding to their oral presentations and written work. Probably the best way you can help students is to provide nearly immediate feedback of both. Quick feedback is important because the game issues often shift rapidly.

In addition, it is quite likely that students (individually or in groups) will seek your counsel. Sometimes these consultations will involve confusion with the situation or game mechanics. Other times, they will involve students who are seeking some sort of in-game advantage. Thus, the more familiar you are with the game the better.

Student-centered classroom

Once the game begins, certain players preside over the class sessions. These presiding officers may be elected or appointed. The schedule section of this IM explains how this process works. Make sure that you have taken the necessary steps to select the first presiding officer before the game begins.

Presiding officers may act in a partisan fashion, speaking in support of particular interests, but they must observe basic standards of fairness. As a failsafe device, most Reacting games employ the “Podium Rule,” which allows a player who has not been recognized to approach the podium and wait for a chance to speak. Once at the podium, the player has the floor and must be heard.

Encourage students to avoid the colloquialisms and familiarities of today's college life. Never should the presiding officer, for example, open a session with the salutation, “Hi guys.”

Role playing

Role sheets are extremely important to players. Given their unfamiliarity with role-playing and the chaotic and unpredictable nature of many of the class sessions, they will cling to them like life preservers in a stormy sea. Encourage them to keep their role sheets close and stress their confidential nature. Role sheets contain secrets!

It is unlikely that you will be able to master the contents of all the role sheets in this game -- particularly the first time you use it. Consequently, encourage students to bring their role sheets along if they want to consult with you. Similarly, if you are corresponding with a student, pull their role sheet up on a screen so that you can consult it with ease.

Roles are often clumped into factions. This gives these players allies. In many games, one faction represents utopian theorists who seek to accommodate mankind to their intellectual visions; another faction represents social “realists” who seek to adapt these ideas to fit the obdurate shapes of human nature.

Remind faction members that in order to achieve their objectives, they will need the support of other students. They will never have the strength to prevail without allies. Consequently, collaboration and coalition-building are at the heart of every game. Along these lines, discourage them from resorting to

violence in order to achieve their objectives. (Unless that is part of the learning objectives of this particular game). Remind these faction members that every game includes roles that are undecided (or “indeterminate”) about certain issues. Similarly, encourage indeterminate roles by reminding them that they are the true kingmakers. Without their support, no faction can hope to prevail.

Liminality

Most games begin with some sort of “liminal moment.” For example, *Threshold of Democracy* begins every session of the Athenian assembly with a pig sacrifice. These are odd rituals that are not unlike the cry of “play ball” at the beginning of a baseball game. They signal that the classroom has become a different place in which the students will be interacting in strange, unusual, and delightful ways. As the game continues, students may find that their liminality deepens.

Student discomfort

This sense of being immersed in a role may be particularly challenging to students charged with promoting worldviews that are antithetical to their own beliefs. If this causes discomfort, remind them that they are merely playing roles. Also remind them to direct their criticisms at one another's roles rather than one another as persons. (For example, you may need to intervene if someone repeatedly says, “Sally's argument is ridiculous.” But encourage them to say, “Governor Winthrop's argument is ridiculous”). Similarly, remind students that it is inappropriate to trade on out-of-class relationships when asking for support within the game. (“Hey, you can't vote against me. We're both on the tennis team!”)

Remind students to always assume, when spoken to by a fellow player -- whether in class or out of class -- that that person is speaking in role. Some roles may include elements of conspiracy or deceit. Such roles will cause some students stress, so you should encourage students to talk with you if they become uncomfortable with their roles. In the vast majority of cases, you will be able to talk them through their discomfort. To encourage these students make it clear that everyone is merely playing a role.

Victory

The challenges of achieving their victory objectives highly motivate many students even if the impact on their grades is insignificant.

Assignments

In general, RTTP games require several distinct but interrelated activities:

- Reading: This standard academic work is carried on more purposefully in a Reacting course, since what students read is put to immediate use.
- Research and Writing: The exact writing requirements depend on you, but in most cases students will be writing to persuade others (particularly the indeterminates).
- Public Speaking and Debate: Expect most of your students to deliver at least one formal speech from the podium.
- Strategizing: Communication among students is a pervasive feature of Reacting games. Encourage them to continue the game outside of class. You may want facilitate this by organizing their initial faction meetings perhaps during a regular class meeting.

Some game-specific variations on these requirements are described in the Assignments section of the gamebook, but for the most part, the particular structure of these assignments is up to you. Tailor the game to fit your learning objectives by consulting the suggestions in the Assignments section of this IM.

Schedule

Similarly, this IM includes a number of sample schedules. They should help you to fit the game to a variety of formats as well as learning objectives.

Ahistorical outcomes

Every game includes the potential for ahistorical outcomes. These fall within a “plausibility corridor” of possible counterfactual outcomes that have been designed by the author. If it is important for you to retain historical verisimilitude you may want to keep this corridor narrow. You can do this by nudging players to take certain actions or through *deus ex machina* interventions. In either case, it is usually best to do this outside of regular game sessions. Otherwise, students begin to feel as if they are your puppets.

Alternatively, if your learning objectives feature leadership, writing, and speaking you may want to release these controls. As you balance between encouraging students and staying true to the history, you may find yourself in a dilemma. For example, if a weak student who rarely speaks makes a presentation that is riddled with historical errors, should you immediately correct those errors publicly, which will ensure that the class learns the correct history, or should you wait, let the mistakes go uncorrected, and build the student's confidence? Alternatively, what if an irrepressible student manages to cobble together an implausible coalition? Should you jump into the fray by forcefully reminding each faction of its purposes, or do you let it play out? This requires subtle judgment on complicated matters of content, student psychology, and pedagogy. That is to say, you must be a good teacher.

Debriefing

Every game ends with at least one session dedicated to debriefing. Comparing the historical record with student experiences is often an excellent pedagogical exercise, which helps students to understand historical causation and contingency. If nothing else, it provides you with an opportunity to set the record straight. In addition, this session allows students to exit the game. They put aside their game names, reveal their secrets, and disclose any skullduggery. Encourage them to tell all -- it is important for them to put the conflicts between their roles behind them.

Modifications

Once you are familiar with the workings of the game, feel free to modify the game as you see fit (to go out on your own, in readings, written assignments, etc.). It's your game now.

Brief introduction to the game

Charles Babbage, Ada Lovelace, and the Dawn of Computing takes place in early nineteenth-century Britain, focusing on the calculating engines designed by Charles Babbage. The central intellectual collisions in the game concern the nature of science and scientists (are they talented, wealthy amateurs, or is science a profession?) and whether and to what degree science and engineering projects should be subsidized by the government. The main question in the game is whether or not Charles Babbage should

be awarded funds from the British government for the development of his Difference Engine (an automated calculator capable of automatically creating, typesetting, and printing mathematical tables) and / or Analytical Engine (a true proto-computer), during the early to mid-1800s.

The Engines, at a minimum, would have “mechanized number,” allowing rapid, automatic, error-free production of mathematical tables to be used in navigation, astronomy, and other applications. Ada Lovelace, regarded as the world's first computer programmer, could envision applications of the Analytical Engine beyond mere mathematics, however. In the notes to her English translation of Luigi Federico Menabrea’s article *Sketch of the Analytical Engine Invented By Charles Babbage, Esq.* [Men43], Lovelace realized that the Engine could operate on symbols in an abstract manner, that it “might act upon other things besides number... the Engine might compose elaborate and scientific pieces of music of any degree of complexity or extent.” She also foresaw applications in business, drawing graphics, and more. In addition, the precision mechanical engineering work done on the engines had profound impacts on the state of engineering in the UK and around the world. The mind boggles at the prospects had an Analytical Engine ever actually been built. What would the consequences of a steam-powered, mechanical computer have been in Victorian England? One can easily get lost in the “steam-punk” possibilities of a 100-year head start in computing technology.

Players in the game may belong to one of two factions, or may be indeterminate. The pro-Babbage faction wants the government to provide funding adequate for the construction of one or both of Babbage's Engines. The anti-Babbage faction wants the opposite -- no funding for either Engine, either because they do not feel the Engines are that important, or because they do not feel the government should provide funding for such projects. Indeterminates have no set position on this issue, and are open to persuasion by the factions.

The standard version of the game covers a broad span of time, from 1828 through 1846. There are seven game sessions and three optional labs, briefly described in Table 1 below.

Table 1: Overview of game sessions

Session (year) / location	Presiding character	Theme
GS 1 (1828) / 1 Dorset Street	Babbage	Babbage's party
Lab 1	n/a	Finite differences
GS 2 (1828) / Mechanic's Institute	Lardner	Public lectures 1
Lab 2	n/a	Difference Engine
GS 3 (1828) / Royal Society	Gilbert	RS approval for DE funding PM decision
GS 4 (1830) / Royal Society	Gilbert	Celebrating the RS
Lab 3	n/a	Analytical Engine
GS 5 (1846) / Mechanic's Institute	Brunel	Public lectures 2 PM decision
GS 6 (1846) / Royal Society	Sussex	Usefulness of the AE
GS 7 (1846) / Royal Society	Sussex	Final debates re. AE funding PM decision

After a few class sessions to set up the game, you as the gamemaster will assign every student to a role in the game. As mentioned above, the roles are divided into three groups: the pro-Babbage faction, the anti-Babbage faction, and the five indeterminates who serve as Prime Minister during the game. The players have different victory objectives, which you will find in their role sheets. Be aware that some characters have victory conditions that are not tied to the performance of their faction. Basically, however, players can win by persuading the indeterminates – the PMs – to vote in favor or not in favor of funding Babbage's engines during GS 3, 6, and 7.

Learning objectives

By the end of the full version of this game, students will be able, in both written and spoken work, to do the following:

- Recognize the major men of science and politicians of Georgian and Regency Britain
- Identify the scientific, engineering, personality, and political issues that prevented Babbage's computing machines from being funded by the government and fully developed
- Identify the major components and architecture of Babbage's Difference Engine and Analytical Engine

- Use the method of finite differences and Taylor series expansions to produce approximate values for polynomials and other mathematical functions such as sine, cosine, and the natural logarithm
- Employ expanded research skills to find multiple resources that support their arguments
- Sharpen verbal expression, writing skills, and organization of ideas through the process of composing rhetorically appropriate speeches and traditional essays
- Differentiate between possible historical motivations
- Demonstrate how individual characters might react to concrete historical situations
- Devise and present logical arguments, supported by evidence
- Evaluate and appreciate classical historical and literary texts
- Analyze the relationship between fact and contingency, theory, and practice
- Criticize opposing viewpoints and defend their own
- Appraise distant cultures and transcend personal cultural constraints
- Collaborate with classmates as a member of a team
- Create community through teamwork (both inside and outside of class)
- Develop leadership skills, as members and leaders of teams

The players must also engage with questions such as:

- Should the government support scientific and engineering projects? If so, to what extent? And, must the projects have immediate perceived benefits for the government and / or society, or are pure science projects allowed?
- What societal changes were wrought by the industrial revolution?
- How did the engineering techniques developed during Babbage's computing engine projects filter out and benefit mechanical engineering practice in the UK?
- How did the nature of science, and scientists, change during the early nineteenth century?

Key concepts

Key concepts for this game include the nature of science, the societal value of science and engineering, *laissez-faire* economic thought, the expanding role of government spending, the role of women in science and in society, and the professionalization of science.

Part 2: Game setup

This section contains information to help you plan your version of the game and what you need to know before your class starts playing.

Before you start: logistics and resources

As a Reacting instructor, you should make several decisions well before the class containing the game begins, and several more before the game itself begins. There are also some logistics to consider. These issues are covered below.

Choosing a class schedule

First and foremost, you should choose a class schedule, whether to play the full version of the game, the extended version, or the compressed version. The model schedules section, below, has more information regarding these options. Make this decision based on the number of class sessions you wish to devote to the game, the amount of time you have available for each class session (i.e., 50 or 75 minutes), the number of students that will be playing the game, and the amount of time you want to devote to each speech, to open debate, and so on.

Selecting a classroom

Since students will be speaking to the class throughout the game, the classroom you use for the game should have a podium, or at least a designated location that can act as one. Ideally, the classroom you choose should be larger than you would normally require for the number of students enrolled, so that students can move around, confer in their factions, and so on. Reacting games typically become quite spirited (noisy), and so if possible a classroom that is some distance away (in time or space) from other classes would be appropriate.

Preparing the syllabus

It is easy to directly map the schedule of sessions you select on to your syllabus. It is wise to allow for three sessions of pre-game setup, and at least one session for the postmortem after the game is over. Other instructors that have played the game would be happy to share sample syllabi with you, as well; check the Facebook Reacting to the Past Faculty Lounge to contact like-minded colleagues.

Expectations for length of speeches and writing assignments

As you are preparing your syllabus, you should decide what expectations you have for the lengths of the scheduled speeches students will present, and the length for their written work. The role sheets assign formal speeches and papers, but do not give guidelines on length expectations. Base your decision on the lengths of the class periods in your game, the level of sophistication of your students (i.e., is this a first-year seminar, or a 300 / 400-level course?), your grading scheme, and so on.

Library reserves

You may wish to add books from the included Bibliography to your library's reserve list. In particular, *An Illustrated Book of Bad Arguments* [Alm13] or similar resource will be helpful for Lardner and Airy, but not required for everyone in the class.

Learning management system or other online presence

During the game, the students must read and refer to each other's papers, in both their written work and in their speeches. This is best done via a learning management system (such as Blackboard), a real-time messaging system (such as Slack), or some other electronic facility. Whatever method you choose, please make sure that only your current students have access. A publically-accessible archive of the papers from a class makes it easy for other students to plagiarize papers and speeches for their version of the game.

Preparing as gamemaster

If you have never played a Reacting to the Past game, you should! Playing a condensed version of one or more games at a Reacting workshop. Running a game is much easier if you have played it at least one time. For a schedule of upcoming Reacting workshops and institutes, including which games are being played, refer to the Reacting Consortium's Website: www.reactingsconsortiumlibrary.org. You can also see various videos of Reacting games on resources like YouTube.

To prepare for the game, you should first read through the gamebook. You may choose to skip the core texts section of the gamebook the first time through. After that, you should read this Instructor's Guide. Finally, you should read the role sheets for the roles you will be assigning.

Materials needed for the game

Before the game setup sessions take place, you should decide which student will play each role involved in your version of the game; see the role allocation table (Table 4, below) for guidance on assigning roles. Then, you should print out the appropriate role sheets (contained in the Instructor's Materials document). Distribute the role sheets to your students no later than the last day of the game setup sessions. Emphasize to your students that their role sheets are private and should not be shared with anyone else in the class.

At the end of the setup sessions, you may wish to give a faction quiz to assess the students on their retention of the pre-game reading (and also to help make sure they read the pre-game reading). A sample faction quiz is included in the handouts section of the Instructor's Materials document. The quiz is taken in groups, by faction – pro-Babbage, anti-Babbage, and the indeterminates work together for the purposes of the quiz. The faction with the highest score on the faction quiz is awarded an IP. If the indeterminates score highest on the quiz, a roll of a 10-sided die can be used to determine which indeterminate receives the IP, according to Table 2. The gamemaster should award the faction quiz IP at the beginning of GS 1. If the indeterminates won the quiz, bring a 10-sided die to class to determine the character that receives the IP.

Table 2: Awarding IP by die roll for indeterminate faction quiz victory

Die roll	IP awarded to
1 – 2	Grey
3 – 4	Peel
5 – 6	Robinson
7 – 8	Russell
9 – 10	Wellesley

Before the game begins, you should print and cut out the influence point (IP) sheets included in the Instructor's Materials document. IPs are the currency of the game, and are used to influence the decision that the PM makes regarding Babbage's engines during GS 3, GS 5, and GS 7. Certain characters begin the game with an IP, so those IPs should be distributed with their respective role sheets.

Also, you may wish to print and distribute name tags and / or name tents for each of the characters in your game. A special, "travelling" name tent could be used to indicate which of the indeterminates is currently serving as Prime Minister.

At the end of each game session, you will conduct a poll of the indeterminates; this is termed the "persuasiveness metric." The persuasiveness metric is used to determine the indeterminates opinion of who made the most persuasive presentation during the game session, and the winner receives an IP. Conduct the poll via a secret ballot. To facilitate this, you could:

- use blank slips of paper handed to each indeterminate;
- use slips of paper pre-printed with the names of those scheduled to present during the session, so the indeterminates only need to check their vote for the best presentation; or
- use an electronic polling mechanism of some sort

Likewise, at the end of GS 7, all of the players with franchise to vote (refer to the table in Part Three of the gamebook to see who has franchise) will vote on the PM who they thought made the best presentation during his PM speech. The winner of this "election" will be the winning indeterminate in the game. You will need some method of voting for this part of the game; options like those just stated for the persuasiveness metric are feasible alternatives here.

Model schedules

Three scheduling options for this game are presented in this section: standard, extended, and compressed. Because it usually takes students two or three game sessions to inhabit their roles fully, many Reacting faculty prefer the standard (ten sessions, including labs) or expanded (eleven sessions, including labs) schedules, but other curricular considerations may necessitate playing the compressed (six sessions) schedule. The three labs are optional and may be omitted if you desire.

The schedules below assume that class sessions are from sixty to seventy-five minutes in length. If your class sessions are shorter, you may wish to add some extra game sessions. For example, you may schedule two class sessions for GS 1. Also, if you have a large number of students in your class, you may wish to add more class sessions so that everyone has a chance to speak.

Standard schedule

GS 1: Babbage's Party (1828)

Location: Babbage's residence, 1 Dorset Street, London

Presiding character: Babbage

Draft schedule:

- Georgian party game

- Robinson's PM speech
 - Frend on mathematics
 - Somerville on mathematics
 - Herschel on Babbage's Difference Engine fragment
-

Lab 1: The method of finite differences

GS 2: Public lectures at the Mechanic's Institute (1828)

Location: The London Mechanic's Institute

Presiding character: Lardner

Draft schedule:

- Wellesley's PM speech
 - Sussex on *laissez-faire* economics
 - Swing on the plight of farmers and the dangers of automation
 - Lardner on the Difference Engine
 - Crosse on ???
 - Open floor for debate
-

Lab 2: The Difference Engine

GS 3: Royal Society recommendation on the Difference Engine (1828)

Location: The Royal Society of London

Presiding character: Gilbert

Draft schedule:

- Faraday introduces a resolution supporting funding the Difference Engine
 - Buckland introduces a resolution against funding the Difference Engine
 - Open debate about which resolution to pass
 - FRS voting on the resolutions
 - IP spending
 - PM decision
-

GS 4: Celebrating the Royal Society (1830)

Location: The Royal Society of London

Presiding character: Gilbert

Draft schedule:

- Grey's PM speech
- Gilbert on the Royal Society

- Babbage on the Royal Society
- Open floor for debate

Lab 3: The Analytical Engine

GS 5: Public lectures at the Mechanic's Institute (1846)

Location: The London Mechanic's Institute

Presiding character: Brunel

Draft schedule:

- Peel's PM speech
- Clement on the Difference Engine
- Brunel on the Thames Tunnel
- Lovelace on the Analytical Engine
- IP spending
- PM decision

GS 6: Royal Society discussions on usefulness of the calculating Engines (1846)

Location: The Royal Society of London

Presiding character: Sussex

Draft schedule:

- Sabine on ???
- Adams on the discovery of Neptune
- Airy on the discovery of Neptune
- Open floor for debate

GS 7: Final debates at the Royal Society (1846)

Location: The Royal Society of London

Presiding character: Sussex

Draft schedule:

- Russell's PM speech
- Open floor for debate
- IP spending
- Franchise voting for best PM speech
- PM decision

Extended schedule

The game may be extended by adding a new game session in between GS 4 and GS 5. The new game session (GS 4.5), presided by Davies Gilbert, would take place in 1830 at the Royal Society. The subject of the session would be the election of the next president for the Royal Society. The candidates for the position are John Herschel from the pro-Babbage faction and the Duke of Sussex from the anti-Babbage faction. Nominating speeches for each candidate would be required, presented by RS fellows from each faction. You, as the gamemaster, can assign characters to make the nominating speeches, or you can allow the factions to choose who nominates each candidate.

In the actual election, Babbage assumed that Herschel was guaranteed to win the position, and so he sent letters to many of his friends in the Royal that lived far from London, encouraging them to not make the trip to London for the vote. He felt their travel to London would not be necessary for Herschel to win. Herschel was not, in fact, a shoe-in for the RS presidency; without many of Babbage's friends on hand to vote for him, Sussex was elected. Simulate this by having Babbage call his faction out into the hallway to "discuss strategy" after both Herschel and Sussex have been nominated. Then, while the faction is out of the room, Gilbert can call the question, causing Sussex to be elected. As the gamemaster, you will need to meet separately with Babbage and Gilbert before GS 4.5, so that they are each aware of their extra responsibilities for the session.

Compressed schedule

The easiest way to compress the schedule for this game is to omit one or more of the optional labs.

If more must be trimmed from the game, GS 4 could be eliminated. In the standard schedule, GS 4 is ostensibly for a celebration of the Royal Society, but in reality is a stage upon which Babbage can make his surprise condemnation of the Royal, as outlined in his work *Reflections on the Decline of Science in England, and on Some of its Causes* [Bab30]. As the Royal Society is very influential in any further funding for Babbage's engines, his attack on the "social club" ethos of the Royal should be detrimental to the pro-Babbage faction's chances of receiving funding after 1828. Accordingly, if GS 4 is eliminated from the game, Babbage should distribute an abridged version of *On the Decline of Science* to the class in written form.

Roles and factions

Deciding which roles to include in the game is a function of how many students you have in the class and the characteristics of each student. Assigning roles is a major responsibility for the gamemaster. Some gamemasters carefully assign roles based on their students' strengths, weaknesses, and personalities; some assign roles randomly. There is a spectrum of options for deciding who gets which role between these two extremes.

Brief description of roles and factions

Each of the roles in the game is briefly described below. The primary speaking responsibility for each role is summarized, and any secret elements pertaining to a role are noted. Each member of the "men of science" (MOS) community has a "secret language" responsibility, described in a separate handout. The members of the MOS community are shown in Table 3.

Table 3: MOS membership

Character	MOS member?	Character	MOS member?
Adams	Y	Herschel	Y
Airy	Y	Lardner	Y
Babbage	Y	Lovelace	Y
Brunel	Y	Peel	
Buckland	Y	Robinson	
Clement	Y	Russell	
Crosse	Y	Sabine	Y
Faraday	Y	Somerville	Y
Frend		Sussex	
Gilbert	Y	Swing	
Grey		Wellesley	

Pro-Babbage faction

The pro-Babbage faction is a collection of men of science, engineers, and personal friends of Charles Babbage. This group is committed to the development of Babbage's computing engines, recognizing how important they will be. The faction members also recognize that developing the Difference Engine or the Analytical Engine will be expensive, beyond the capacity of private financing.

John Couch Adams The John Couch (pronounced “cooch”) Adams is a British astronomer and mathematician, best known for his co-discovery with Urbain Le Verrier of the planet Neptune in 1846. Adams is important to his faction, because he has an era-appropriate, concrete example of how a computing engine would be beneficial to Britain. He will make the case that his calculations regarding the location of Neptune would have been completed even sooner had one of Babbage’s engines been available. **Secret:** Adams can win the game, separately from his faction, if the Royal Society passes a resolution that he should be considered the discoverer of Neptune.

Charles Babbage FRS Charles Babbage is a British polymath -- a person whose expertise spans a significant number of different subject areas -- and the inventor of two types of calculating machines. First, Babbage invented the Difference Engine, a device capable of automatically calculating and printing certain types of mathematical tables, and then the Analytical Engine, a true proto-computer. Babbage presides over his Dorset Street party in GS 1. **Secret:** Babbage is essentially a saboteur in his own faction. He has a responsibility that is counter to his own best interests. During GS 4, he will attack the Royal Society, based on *Reflections on the Decline of Science in England, and on Some of its Causes* [Bab30]. In the extended version of the game, Babbage will also maneuver to prevent his faction leader, John Herschel, from being elected as president of the Royal Society.

Isambard Kingdom (I. K.) Brunel FRS I. K. Brunel is perhaps the most accomplished mechanical and civil engineer in Britain during the time of our game. Brunel, a close personal friend of Charles Babbage, is responsible for completing the Thames Tunnel project, for building the Great Western Railway, and for the construction of the steamship S. S. Great Western. Brunel presides over the second set of public lectures at the Mechanic’s Institute, during GS 5. In addition, Brunel speaks during GS 5 on the success

of the Thames Tunnel project, extending its success to make the case for government funding of other engineering projects, specifically, Babbage's Difference or Analytical Engines.

Joseph Clement Joseph Clement is the extremely capable toolmaker, draftsman, engineer, and industrialist hired by Charles Babbage to build his Analytical Engine. **Secret:** Clement will defect from the pro-Babbage faction in GS 5, joining the anti-Babbage faction and earning an IP for the faction. Clement will give a presentation during GS 5 detailing why he defected.

Andrew Crosse Andrew Crosse is an amateur man of science, best known for his experiments with electricity. Mary Shelly, the author of the novel *Frankenstein*, is an acquaintance, and her husband Percy Bysshe Shelley attended one of Crosse's lectures on atmospheric electricity in 1814; this may or may not have helped to influence the famous novel. Crosse makes a presentation during GS 2 on ???.

Michael Faraday Michael Faraday is an extremely influential English man of science; of all the characters in this game, his influence is the greatest in our 21st-century world. His work focuses on chemistry and electricity. Faraday makes a presentation during GS 3, introducing a resolution recommending that the government should fund work on Babbage's Difference Engine.

John Frederick William Herschel FRS John Frederick William Herschel is another British polymath, and close friend of Charles Babbage. He and Babbage, among others, formed the Analytical Society while undergraduate students at Cambridge. Herschel studied mathematics, astronomy, chemistry, botany, and more. Herschel is the leader of the pro-Babbage faction. Herschel also has a responsibility to introduce the Difference Engine fragment at Babbage's Dorset Street party during GS 1.

Dionysius Lardner FRS Dionysius Lardner is a member of the Royal Society of London and a professor at the University of London. Lardner is a scientific populist and the first scientific journalist. Lardner presides over the first set of lectures at the Mechanic's Institute during GS 2. In addition, Lardner will speak during GS 2, on the value of the Difference Engine. Lardner's speech will focus on the perceived economic benefit of the Difference Engine, specifically the harm that could occur due to errors in the navigational tables used by mariners. **Secret:** Lardner can win the game separately from his faction, if he is able to intentionally use and document at least two bad arguments (straw man, false dilemma, slippery slope, etc.) during the game, without getting caught. Lardner does not know it, but the anti-Babbage faction leader, Airy, should be especially on the alert for bad arguments.

Augusta Ada King-Noel, Countess of Lovelace Augusta Ada King-Noel, Countess of Lovelace, is the only legitimate daughter of the "mad, bad, and dangerous to know" romantic poet, Lord Byron. Lovelace is a close friend of Charles Babbage, and in 1843, she translates an article on Babbage's Analytical Engine by Luigi Federico Menabrea, and adds her own voluminous notes to the translation. The notes contain what is now considered the world's first computer program. Lovelace will make a presentation on the Analytical Engine at the second set of Mechanic's Institute lectures, during GS 5. In her speech, she will briefly explain how the machine would work, and argue why constructing the machine is vital. Her presentation will try to show the benefits of the Analytical Engine apart from mere mathematical calculation and tabulation.

Mary Somerville Mary Fairfax Greig Somerville is a Scottish polymath. She is very unusual for the time, having published several very influential papers and books. Somerville served as one of Ada Lovelace's tutors, and introduced her to Charles Babbage at one of his Dorset Street parties. Somerville will make a presentation during GS 1 on the sad state of mathematics in Great Britain, and on the recent work (by Babbage and others) that started to improve the characteristics of the discipline.

Anti-Babbage faction

The anti-Babbage faction is a collection of men of science, clergy, and political figures. This group is against the British government paying any more money for the development of Babbage's computing engines. Anti-Babbage faction members have different reasons for opposing the engines: some do not think the engines will be valuable or necessary for the advancement of science in Britain; some think the engines are potentially valuable, but do not think that projects such as this should be supported by the government; and some are generally against the increasing mechanization of British society, as it forces working people from their jobs.

George Biddell Airy FRS George Biddell Airy is an English mathematician and, as of 1835, the Astronomer Royal. Airy, holder of the Lucasian Professorship of Mathematics at Cambridge before Charles Babbage assumed the chair in 1828, is the leader of the anti-Babbage faction. Airy will make a presentation during GS 6 regarding the priority of the discovery of the planet Neptune, arguing that Adams is overstating not only his claim to be the discoverer of the planet but also how valuable a computing engine would have been to the project. **Secret:** Airy is the game's designated curmudgeon, assigned to dislike just about everyone and everything. Part of this assignment is to call out bad arguments (straw man, false dilemma, slippery slope, etc.) when they are used by other characters. In this way, he is Lardner's foe, since Lardner is assigned to make bad arguments as part of his victory conditions. Neither Airy nor Lardner know anything of these aspects of the other's roles, however.

Reverend William Buckland DD FRS The Reverend Doctor William Buckland, DD FRS, is an English clergyman, theologian, geologist, and paleontologist. Buckland published the first full account of a fossilized dinosaur, which he termed *Megalosaurus*. During GS 3, Buckland will make a speech introducing a resolution against the funding of Babbage's Difference Engine to the Royal Society. The speech will summarize all the reasons why the anti-Babbage faction believes that spending government money on the Difference Engine is unwise.

William Frend William Frend is an English unitarian clergyman, political radical, and author of the algebra textbook, *Principles of Algebra*. Frend, along with Mary Somerville, served as one of Ada Lovelace's mathematics tutors. Frend will make a speech during GS 1 where he argues against the "new" mathematics of the sort being championed by Charles Babbage and his friends. The speech will be based largely on Frend's algebra textbook, *Principles of Algebra* [Fre96], in which he endorses some very strange ideas, such as rejecting the existence or utility of negative numbers.

Davies Gilbert PRS Davies Gilbert is a British botanist, geologist, mathematician, civil servant, politician, author, and from 1827 through 1830, president of the Royal Society of London. As PRS, Gilbert will

preside over game sessions 3 and 4 (and 4.5 if the extended version of the game is being used). During GS 4, Gilbert will make a speech about the history and accomplishments of the Royal Society.

Edward Sabine FRS Edward Sabine, FRS, is an Irish military man, geologist, and astronomer. He served as the on-board astronomer on expeditions to attempt to discover the Northwest Passage under Sir John Ross in 1818 and again under Sir William Edward Parry in 1819 and 1820. Sabine will make a speech during GS 6 on ????.

Prince Augustus Frederick, Duke of Sussex, KG KT GCB FRS FRSA Prince Augustus Frederick, Duke of Sussex, is the sixth son of “mad” King George III, who reigned from 1760 until 1820. Although not a man of science, Sussex does have intellectual pursuits, chiefly in biblical studies and the Hebrew language. Sussex will serve as the president of the Royal Society after 1830 (GS 4), and in this position he will preside over the meetings at the Royal Society during GS 6 and 7. Sussex will make a speech on the principles of *laissez-faire* economic principles during GS 2.

Captain Swing Captain Swing represents the spirit and ideas of the farmers who participated in the “Swing Riots” across England in 1830 and 1831, starting fires and breaking threshing machines, protesting for increased wages, against restrictive Poor Laws, and against the increasing use of threshing machines in agriculture. Several of the threatening letters sent by the protesters were signed with the *nom de guerre* “Captain Swing.” Swing will make a presentation during GS 2 at the Mechanic’s Institute on the plight of Britain’s farmers. These issues led to the “Swing Riots” of 1830 – 1831. Swing will extrapolate from the way threshing machines put farmers out of work to draw unemployment implications regarding Babbage’s Difference Engine.

Indeterminates

In this game, the characters that will serve in the role of Prime Minister are indeterminate. That means that these characters have no pre-decided position regarding Babbage’s engines -- although each character does have some general political leanings that may inform his opinions on the subject. Each PM will make a speech when he takes office, outlining the priorities that will guide his government.

The indeterminates are polled by the GM at the end of every game session for their vote for the most persuasive presentation made during the session. The winning presenter receives an IP.

At the end of GS 3, 5, and 7, the current PM will make the decision whether to fund one of Babbage’s machines, within the constraints of the IP stacks shown in Part Three of the gamebook. Factions and / or individuals spend IPs before the PM’s decision, adding each IP to one of the stacks assigned for use during that game session. The PM also has an IP that he can spend at his discretion. The IP stack with the most IPs is the decision the PM must make. If there is a tie for the highest number of IPs in a stack, the PM can decide between the tied stacks at his discretion.

Lord Charles Grey, 2nd Earl Grey, KG PC Lord Charles Grey, 2nd Earl Grey is a Whig MP, and the namesake of Earl Grey tea. Grey will serve as PM during the game. Grey makes his PM speech at the beginning of GS 4.

Sir Robert Peel, 2nd Baronet, FRS PC Sir Robert Peel, 2nd Baronet is a Tory MP. Peel will serve as PM during the game. Peel will make his PM speech at the start of GS 5, and he makes the decision whether to fund the Difference Engine, fund the Analytical Engine, or cancel the computing engine project entirely at the end of GS 5.

Lord Frederick John Robinson, 1st Earl of Ripon, FRS PC Lord Frederick John Robinson, 1st Earl of Ripon is a Tory MP. Robinson will serve as PM during the game. Robinson makes his PM speech at the beginning of GS 1.

Lord John Russell, 1st Earl Russell, KG GCMG PC Lord John Russell, 1st Earl Russell is a Whig MP. Russell will serve as PM during the game. Russell makes his PM speech at the beginning of GS 7, and he makes the final decision to fund or not to fund the Analytical Engine at the end of GS 7.

Field Marshal Arthur Wellesley, 1st Duke of Wellington, KG GCB GCH PC Field Marshal Arthur Wellesley, 1st Duke of Wellington is the biggest hero of the French Wars and Tory MP. Wellington will serve as PM during the game. Wellesley makes his PM speech at the beginning of GS 2. At the end of GS 3, he makes the decision to fund or not to fund the Difference Engine.

Role allocation table

The role allocation table below (Table 4) indicates which characters should be included in the game, depending on class size.

Table 4: Role allocation table

Role	Class size												
	16	17	18	19	20	21	22	23	24	25	26	27	28
Adams	X	X	X	X	X	X	X	X	X	X	X	X	X
Airy	X	X	X	X	X	X	X	X	X	X	X	X	X
Babbage	X	X	X	X	X	X	X	X	X	X	X	X	X
Brunel	X	X	X	X	X	X	X	X	X	X	X	X	X
Clement	X	X	X	X	X	X	X	X	X	X	X	X	X
Buckland		X	X	X	X	X	X	X	X	X	X	X	X
Crosse							X	X	X	X	X	X	X
Faraday	X	X	X	X	X	X	X	X	X	X	X	X	X
Frend				X	X	X	X	X	X	X	X	X	X
Gilbert	X	X	X	X	X	X	X	X	X	X	X	X	X
Grey	X	X	X	X	X	X	X	X	X	X	X	X	X
Herschel	X	X	X	X	X	X	X	X	X	X	X	X	X
Lardner	X	X	X	X	X	X	X	X	X	X	X	X	X
Lovelace	X	X	X	X	X	X	X	X	X	X	X	X	X
Peel	X	X	X	X	X	X	X	X	X	X	X	X	X
Robinson	X	X	X	X	X	X	X	X	X	X	X	X	X
Russell	X	X	X	X	X	X	X	X	X	X	X	X	X
Sabine						X	X	X	X	X	X	X	X
Somerville			X	X	X	X	X	X	X	X	X	X	X
Sussex	X	X	X	X	X	X	X	X	X	X	X	X	X
Swing					X	X	X	X	X	X	X	X	X
Wellesley	X	X	X	X	X	X	X	X	X	X	X	X	X
Extra 1								X	X	X	X	X	X

Extra 2	X	X	X	X	X
Extra 3		X	X	X	X
Extra 4			X	X	X
Extra 5				X	X
Extra 6					X

Brief description of extra roles

At this point, the roles of Andrew Crosse and Edward Sabine do not have any specific responsibilities in the game. They could be included in the game, and their speeches (during GS 2 and 6, respectively) could be on topics chosen by the students playing the roles, after consultation with their factions. Crosse and Sabine will be given more concrete responsibilities during the 2017-2018 academic year.

The extra roles in Table 4 (Extra 1, Extra 2, ...) will also be added to the game during the 2017-2018 academic year. Once these roles have been added, the game will be playable by up to 28 students at a time.

Rules and procedures

Most of the rules for the game are outlined in the gamebook and the role sheets for the characters. More detail regarding the rules are listed below.

Winning the game

It is important for both the gamemaster and the students to realize that there will be multiple winners in the game. Each character has victory conditions, stated in their role sheets. Most characters win only if their faction wins: pro-Babbage faction members win if the government decides, on two out of the three opportunities, to fund Babbage's computing machines, while the anti-Babbage faction members win if the government declines to fund the machines on two of the three opportunities. Other characters have an extra way to win apart from the victory of their faction. For example, Lardner wins the game if the pro-Babbage faction wins, or if he successfully makes at least two bad arguments (straw man, slippery slope, false dilemma, etc.) without being caught by Airy or another character. Indeterminates win in a different way – by vote of the characters with franchise at the end of GS 7.

Influence points

Influence Points (IPs) are the currency of the game. Characters and factions can earn IPs in various ways, such as:

- By scoring the highest on the faction quiz at the end of the setup sessions
- By winning the party game at Babbage's party during GS 1
- By winning the persuasiveness metric vote for the most persuasive presentation during a game session
- By being identified by the gamemaster as the best presentation during a game session
- If the Royal Society passes a resolution favorable to a faction or an individual character
- When Clement defects, the anti-Babbage faction earns an IP

- By virtue of their wealth or political power, Gilbert, Sussex, Grey, Peel, Robinson, Russell, and Wellesley all begin the game with one IP each

IPs are spent at the end of GS 3, 5, and 7. Each IP spent is placed on one of the decision stacks for the game session (the stacks are visualized in Part Three of the gamebook). No one has to spend their IPs; they can be saved to be more impactful for later decisions. There is no benefit to ending the game with remaining IPs, so they should be spent no later than GS 7. During the IP spending part of GS 3, 5, and 7, individuals spend their IPs first, then factions, and finally the current PM. The decision stack with the most IPs in it is the decision the PM must make. If two or more stacks are tied for the maximum number of IPs, then the PM can decide between the tied stacks at his discretion.

Persuasiveness metric

At the end of each game session, the indeterminates vote on the most persuasive presentation of the session. Possible mechanisms for conducting the poll are listed in the logistics section, above. The winner of the persuasiveness metric vote is awarded an IP. The winner of the IP should be announced at the beginning of the next game session.

During the final game session, GS 7, the gamemaster will conduct the last persuasiveness metric poll before IP spending takes place. The gamemaster will immediately announce the winner of the poll, and award the IP to the winner.

Winning PM vote

Near the end of GS 7, all of the characters with franchise to vote (see the table in Part Three of the gamebook) vote for the PM who made the best PM speech during the game. The winner of this vote is the winning indeterminate for the game. If two or more PMs are tied for first place, then all of the tied PMs meet their victory conditions. The winning PM will not be announced until the postmortem session.

Faction defection

During GS 5, Clement defects from the pro-Babbage faction to the anti-Babbage faction. He makes a speech during the game session, outlining the reasons why he left the employ of Babbage, and his defection earns the anti-Babbage faction an IP. This defection reflects Clement's actual departure from the Difference Engine project, which dealt the enterprise a fatal blow.

From the gamebook, characters know that it is possible for a character to defect from one faction to another, and that IPs are at stake. However, they do not know who can defect. In fact, *only* Clement is allowed to defect; all of the other characters are explicitly barred from defection in their role sheets. As gamemaster, you should make sure that Clement understands that he should not reveal his intentions to defect to anyone before the event happens in GS 5. Also, you should prevent any other characters from trying to defect. If someone does try to announce a defection, you should pull them aside and remind them that their role sheet specifically prohibits their defection.

Who can speak

During the sessions that do not take place at the Royal Society (Babbage's party in GS 1, and the public lectures at the Mechanic's Institute in GS 2 and 5), any character may speak publically. During sessions

that take place at the Royal Society (GS 3, 4, 6, and 7), however, only current members of the Royal Society are allowed to speak publically from the podium. A table in Part Three of the gamebook shows who is a FRS, and when that status begins. For example, Airy was not elected FRS, and so he may not speak publically during GS 3 and 4. Lovelace and Somerville are excluded because they are women. Clement, as a working man, is also excluded. Some non-MOS characters are FRS (Peel and Robinson), while other characters that are influential MOS are not FRS (Adams and Crosse). The presiding officer for the sessions at the Royal Society (Gilbert and Sussex) should be looking out for this, and as gamemaster, you should help them enforce this rule.

The characters that cannot speak publically during Royal Society meetings may confer with their faction members and other characters; the restriction applies to asking questions of others that are speaking and publically addressing the whole body from the podium.

Podium rule

The podium rule states that any character who wishes to speak during an open discussion period should approach the podium. Once queued up at the podium, the presiding officer for the game session must allow the character to speak. The presiding officers for the game sessions, shown in Table 5 below, belong to one of the factions. Therefore, it is possible – even though their role sheets prohibit the behavior – that the presiding officer tries to ignore characters from the opposing faction when they approach the podium. As gamemaster, you cannot allow this favoritism. During the game, if you detect this behavior from the presiding officer, you should send them a note telling them to let everyone who wishes to speak. If the behavior continues, the threat or actual act of awarding IPs to the relevant factions should prevent a recurrence of this kind of behavior.

Table 5: Presiding officers, PRS, and PMs

GS	Presiding Officer	PRS	PM
1	Babbage	Gilbert	Robinson
2	Lardner	Gilbert	Wellesley
3	Gilbert	Gilbert	Wellesley
4	Gilbert	Gilbert	Grey
(4.5)	Gilbert	Gilbert	Grey
5	Brunel	Sussex	Peel
6	Sussex	Sussex	Peel
7	Sussex	Sussex	Russell

Characters are encouraged to ask questions of presenters, at the discretion of the presiding officer, but they should not make speeches to the class without approaching the podium.

Reading and writing assignments

Readings

The readings assigned for this game are voluminous, and can be difficult for students at first. The style of prose used in writing in the early 1800s United Kingdom may be initially off-putting to students. In

addition, some of the more mathematical content (functions, polynomials, finite differences, Taylor series approximations, etc.) may be especially problematical for students without a mathematical affinity. As gamemaster / instructor, you may wish to prepare students in advance for the readings. At a minimum, students should be aware that a single read-through of the core texts in the gamebook will not be sufficient to compete in the game.

The lab sessions, while optional, can help students solidify their understanding of the readings, by forcing them to work in a “hands on” manner with the material. This argues for including the labs if your syllabus allows the time to do so.

Writing assignments

As in all courses, you should clearly state at the outset the amount of writing expected of the students in the game. Most players in the game have two writing assignments. The first assignment is a written version of the speech the character is assigned to make. These papers should be posted to the document-sharing system you are using for the class before the start of the game session scheduled for the presentation.

The second assignment for most characters is actually a series of five shorter papers. In these papers, characters in the factions write a privately submit to the GM a few paragraphs on their impressions of each PM speech. Characters can use these writings to inform their vote for the winning PM at the end of GS 7.

Indeterminates have a different second writing assignment, also a series of shorter papers. They will write a few paragraphs explaining who they voted for in the persuasiveness metric portion of each game session, and why. These papers are to be submitted privately to the GM before the beginning of the next game session.

Lardner has a third writing assignment, related to his duty to intentionally make bad arguments during the debates in the game. Lardner should write a short paper detailing which bad argument techniques he employed, along with their definitions, and when each was used. This paper should be submitted privately to the gamemaster privately before the beginning of the post-mortem session.

The assignments for each character are listed in the Assignments section of their role sheet.

The need for independent research

Remind students early and often that they are expected to go beyond the materials included in their role sheets and the core texts included in the gamebook when they prepare their speeches and written work. Students should also refer to material written by other students in the game.

Grading

Grading students in a Reacting game involves several components: reading comprehension quizzes (the faction quiz given at the end of the setup phase), writing, speaking, and class participation. Feel free to evaluate your students in the manner you are most comfortable with. Advice on grading options, including sample rubrics, can be found in the Reacting Faculty Lounge Facebook group. To gain access to this faculty-only resource, contact the Reacting Consortium at reacting@barndard.edu.

Many Reacting instructors include some sort of tangible reward for students who meet their victory conditions in the game. For example, one might add a one-half grade level increase in winning students' participation scores. In a specifications grading model, winners could receive an extra "do-over" certificate, allowing them to resubmit a failed assignment from another portion of the course. Generally speaking, these rewards for winning are not terribly consequential in terms of the student's final grade in the course, but provide psychological motivation for students to become more fully engaged in the game.

Part 3: Managing the game

What follows are step-by-step guidelines on how to manage the elements in this Reacting game. Your main task as Gamemaster is to serve as guide and cheerleader. Students need to be encouraged to plunge into the proceedings, take risks, and master difficult ideas and complicated materials. You should meet with each character in the game individually, before the game starts, to make sure each person understands the expectations associated with his or her role. Encourage students to do more than the required research and seek a more in-depth understanding of their characters beyond the information provided in their role sheets.

Also be sure to grade student papers swiftly: if they're going off track, they need to be alerted as soon as possible. Generally speaking, the goal is to return graded work by the start of the next game session.

Setup sessions

The setup, or pre-game, sessions are designed to help students prepare for the game. Some recommended activities are:

1. Discuss the RTP pedagogy in general. An "Introduction to Reaction" handout is available from the faculty-only library on the Reaction Website (www.reactingsconsortiumlibrary.org). Obviously, this pedagogy may be quite different from what students have done before, and so you may try to proactively address concerns they have.
2. Do some public speaking exercises to warm students up to the type of interaction they are expected to do during a Reacting class. Lily Lamboy has created a series of two-minute videos with associated pair practicing. Links to these videos are also available on the Reacting Website.
3. Provide one or more introductory lectures / discussions on the historical context of the game (ending with the year 1828). The gamebook has a vignette that sets the scene, and excerpts from some of the primary texts involved in the game. Your pre-game lectures / discussions do not need to cover everything in depth – the students are supposed to be doing in-depth research as the game progresses. Rather, you are giving an outline and setting the context.
4. Assign roles and distribute role sheets to the students in the class. Remind students (again!) of two things:
 - a. First, each student should meet with the gamemaster individually before the beginning of GS 1, to make sure they understand what they are required to do.
 - b. Secondly, remind students that their role sheets are for their eyes only, and should not be shared with anyone else. Please do not share the role sheets electronically, to cut down on the likelihood of them becoming publically accessible on the Internet for future students playing the game.

Certain roles may also receive other handouts at this time. For example, each MOS member should receive a copy of the MOS Secret Language handout, and Babbage should receive his instructions on the GS 1 party game at this time.

5. Conduct the reading comprehension quiz. The quiz is taken in groups, by faction; for the purposes of the quiz, the indeterminates are a faction. The faction that scores the highest on the reading comprehension quiz receives an IP at the beginning of GS 1.
6. Faction meetings. It is wise to allow at least twenty minutes for the pro-Babbage and anti-Babbage factions to meet and organize. This should take place after all of the other pre-game activities, on the last class session before the game begins.

Materials to bring for every game session

Bring the following materials with you for every game session:

- Name tags with pins or lanyards, or name tents to place on desks. Students must refer to each other by character name during the game; name tags or tents help students meet this requirement, especially early in the game. It is wise to collect the tags or tents at the end of each game session so they are not lost between sessions.
- A special name tag or name tent to identify the current Prime Minister.
- This Instructor's Guide, or an abbreviated version of the schedule, so you know who is supposed to speak during each game session.
- Time cards or some other method of keeping track of the time taken for each presentation.
- Note paper and / or rubrics for tracking evaluating students during the game session.
- A smaller notepad or slips of paper for passing notes to students. On occasion you may wish to pass notes to characters in order to keep the game moving.

GS 1: Babbage's party (1828)

GS 1, Babbage's party, takes place in 1828 at Babbage's residence, 1 Dorset Street, in London. Babbage is the presiding officer for the session. Robinson is the PM.

Extra items to bring or arrange for:

- 10-sided die to determine faction quiz IP recipient, if required (see below)
- An IP certificate to award to the faction winning the pre-game faction quiz
- *I Love my Love with an A* party game handouts, one for every character except Charles Babbage
- A mechanism for recording forfeits during the party game (see below)
- A mechanism for polling the indeterminates for the GS 1 Persuasiveness Metric

If the indeterminates won the faction quiz at the end of the setup phase, bring a 10-sided die (or 10 slips of paper, numbered 1 through 10, in a hat) to determine which indeterminate receives the associated IP.

The session begins with a Georgian-era party game, adapted from the 1825 book *Winter Evening Passtimes; or, The Merry-Maker's Companion* [Rev25]. Babbage serves as the "master of the revels," i.e., he runs the game. Babbage also makes sure that everyone plays fair and that no one cheats; cheaters are assigned "forfeits." Bring copies of the game instructions handout for each player except Babbage; he should have received his version of the game instructions when the role sheets were distributed. Be

prepared to track forfeits assigned during the game, perhaps on the whiteboard or via a projected spreadsheet.

The player with the fewest number of forfeits will receive an IP at the beginning of GS 2. If more than one player is tied for the fewest number of forfeits, you should break the tie via a die roll, drawing a name from a hat, or some other randomized method.

After the revelry of *I Love my Love with an A*, the presentations scheduled for the game session take place. Babbage should call the following characters to make their presentations, in this order:

1. Robinson makes his PM speech
2. Frend speaks about his interesting view on mathematics
3. Somerville speaks about the ongoing modernization of mathematics in Britain
4. Herschel speaks about the method of finite differences and the Difference Engine fragment
Babbage displays in his home

Make sure to reserve time at the end of the game session to conduct the Persuasiveness Metric poll of the indeterminates. The indeterminates vote on who they thought made the most persuasive presentation during the game session. The winner of this Persuasiveness Metric will receive an IP at the beginning of GS 2.

Lab 1: The method of finite differences

Lab 1 teaches the students about two key mathematical concepts that were key to the Difference Engine: the method of finite differences, and the concept of Taylor Series approximations. This lab is optional.

Students may complete the lab individually, in pairs, or in factions (if in factions, the indeterminates can work together).

Extra items to bring / prepare for:

- Enough lab handouts for the number of individuals or groups that will be completing the lab
- If you wish to demonstrate / run code related to the lab, make sure the classroom computer has the required software (the Java Development Kit, Python, etc.)

There are optional programming assignments with the lab. Each of the programming assignments requires a different level of programming skill to complete; consider the background of your students when assigning these pieces. If you do not assign the programming components, you may wish to demonstrate how one would solve the problems in code.

GS 2: Public lectures at the Mechanic's Institute (1828)

GS 2, the first series of public lectures at the London Mechanic's Institute, takes place in 1828. Dionysius Lardner is the presiding officer, and Wellesley is the PM.

Extra items to bring / prepare for:

- A die or other method for breaking the tie if more than one person on the GS 1 party game (see below)
- An IP certificate to award to the winner of the GS 1 party game
- An IP certificate to award to the winner of the persuasiveness metric poll at the end of GS 1
- An IP certificate to award to the player you, as the game master, thought made the best presentation during GS 1
- A mechanism for polling the indeterminates for the GS 2 Persuasiveness Metric

If there was a tie for the fewest number of forfeits in the GS 1 party game, bring some method of breaking the tie to class at the start of GS 2. Break the tie in the presence of the students, and then award the IP to the winning character.

After all the IPs have been awarded, Lardner should take over the class and manage the following presentations:

1. Wellesley makes his PM speech
2. Sussex speaks on the benefits of *laissez faire* economic policies
3. Captain Swing speaks on the plight of Britain's agricultural workers and the dangers of automation
4. Lardner himself speaks on the Difference Engine
5. Crosse speaks; his speech is on an open topic, determined in conjunction with his pro-Babbage faction

If time remains after all of the scheduled presentations, the floor is open for debate. Lardner must use the podium rule to recognize those who wish to speak.

At the end of the game session to conduct the Persuasiveness Metric poll of the indeterminates. The indeterminates vote on who they thought made the most persuasive presentation during the game session. The winner of this Persuasiveness Metric will receive an IP at the beginning of GS 3.

Lab 2: The Difference Engine

Lab 2 teaches the students more about the workings of the Difference Engine.

Students may complete the lab individually, in pairs, or in factions (if in factions, the indeterminates can work together).

Extra items to bring / prepare for:

- Enough lab handouts for the number of individuals or groups that will be completing the lab

GS 3: Royal Society recommendation on the Difference Engine (1828)

GS 3 takes place at the Royal Society of London in 1828. During the session, the Royal will decide whether to recommend that the Treasury fund the Difference Engine or not. Davies Gilbert is the presiding officer, and Wellesley is the PM.

Extra items to bring / prepare:

- An IP certificate to award to the winner of the persuasiveness metric poll at the end of GS 2
- An IP certificate to award to the player you, as the game master, thought made the best presentation during GS 2
- A mechanism for FRS voting on the Difference Engine resolution(s), perhaps slips of paper
- An IP certificate to award to the faction favored by the RS resolution that passed
- A visualization of the IP spending stacks for GS 3, similar to those shown in the gamebook, perhaps a drawing on the whiteboard or a projected spreadsheet version
- A mechanism for polling the indeterminates for the GS 3 Persuasiveness Metric

After the IPs have been awarded, Gilbert takes over and manages the following presentations:

1. Faraday introduces a resolution supporting funding the Difference Engine
2. Buckland introduces a resolution against funding the Difference Engine

After both resolutions have been introduced, Gilbert should open up the floor to debate. He must use the podium rule to make sure that everyone who wishes to be heard receives an opportunity to speak. As game master, keep an eye on the time for the open debate, reserving enough time for the following activities.

First, after the open debate, the Fellows of the Royal Society vote on which resolution to approve (pro-Babbage or anti-Babbage). The winning faction *immediately* receives an IP.

Next, IP spending takes place. You, as the game master, should keep track of the spending with the IP spending stacks for GS 3, as shown in the gamebook. In this process, individuals, factions, and the PM “spend” their IPs by distributing them across the stacks. Individuals spend their IPs first, then factions, and finally the PM. Individuals and factions may distribute their IPs across the stacks as they see fit; the PM, however, has to place all of the IPs he intends to spend in the same stack. Each party in the spending process may spend as many or as few of the IPs they control as they choose.

Next is the PM decision regarding funding for the Difference Engine. Once the spending is complete, the stack that has the most IPs in it is the decision the Wellesley must make. If there is a tie, then the least favorable decision, from Babbage's point of view, is the one that is made.

At the end of the game session to conduct the Persuasiveness Metric poll of the indeterminates. The indeterminates vote on who they thought made the most persuasive presentation during the game session. The winner of this Persuasiveness Metric will receive an IP at the beginning of GS 4.

GS 4: Celebrating the Royal Society (1830)

GS 4.5: Presidency of the Royal Society (1830)

Lab 3: The Analytical Engine

Lab 3 teaches the students more about the workings of the Analytical Engine.

Students may complete the lab individually, in pairs, or in factions (if in factions, the indeterminates can work together).

Extra items to bring / prepare for:

- Enough lab handouts for the number of individuals or groups that will be completing the lab

GS 5: Public lectures at the Mechanic's Institute (1846)

GS 6: Royal Society discussions on the usefulness of the calculating engines (1846)

GS 7: Final debates at the Royal Society (1846)

Postmortem sessions

Part 4: Debriefing

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What happened afterward

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