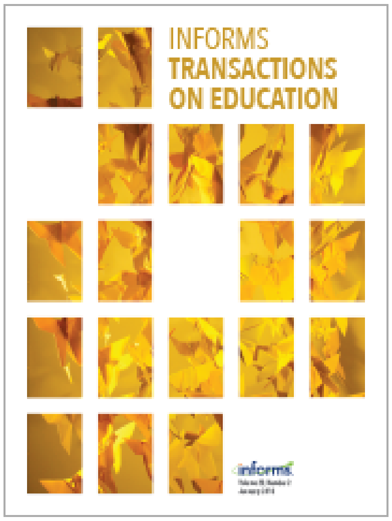


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Case Article

# Louisiana Branch Lines

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**Abstract.** Louisiana Branch Lines is a struggling Southeast U.S. railroad in just four cities and 12 markets. Their marketing, operations, and finance performance is poor and their departments disjointed. In this customizable, nine-part case, instructors can choose to focus on basic problem structuring and descriptive and predictive statistics, optimization model building, simulation of solutions, or the integration of all of the above. It is based on a real-world case.

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**Supplemental Material:** Data are available at https://doi.org/10.1287/ited.2021.0258ca. The Teaching Note is available at https://www.informs.org/Publications/Subscribe/Access-Restricted-Materials.

**Keywords:** cases • developing analytical skills • developing communication skills • developing critical thinking skills • spreadsheet modeling

## Summary Description

The Louisiana Branch Lines (LBL) case is a multiple-week, multiple-assignment integrative case. It allows a unique look at incremental, separable, but closely related problems. It is based on the published work of Gorman (2001, 2002, 2005) and related to Gorman et al. (2010) and Gorman et al. (2011). It is loosely based on my actual experience at BNSF Railway, where pricing, equipment distribution, customer service, and finance were often treated largely independently from an organizational perspective; but they needed to be integrated in order to achieve desired performance levels. A modeling perspective demonstrates the need for integration and helps overcome organizational resistance. It also represents the challenge in "selling" analytical results to domain experts (in this case, marketing and sales) and the importance of an integrated view of network-based operations.

Though the case is rail based, the same concepts apply to any mode of point-to-point freight transportation (truck, sea, air) and even one-way rentals. (The learning here is less relevant to hub-and-spoke networks.) The concept of network balance and reverse logistics applies well beyond rail; students can be reminded that this is not a "rail case" but rather a network business case. In fact, most rail concepts, such as train schedules, yards, and the like, are abstracted away and are largely irrelevant to the case.

As the case is designed, the first week or two are introductory—question and answer sessions, preliminary descriptive data analysis (parts 0 and 1), and predictive analysis (part 2). The optimization problems (parts 3, 4, 5) are presented incrementally; in part 3, a strictly marketing perspective is applied to the pricing decision in a quadratic optimization problem across 12 markets (individually or in tandem; they are independent if one ignores equipment constraints). Part 4 is a straightforward transportation problem repositioning empty equipment from surplus to deficit locations. In part 5, the integration of the two models reveals that the scope of each model individually is inadequate to achieve maximal profits. As such, it gives the students a flavor of the uncertain scope and incremental nature of many analytical projects. Further, it gives the students a chance to see a very advanced analytical project develop in manageable steps. In the final stages (parts 7 and 8), uncertainty of model parameters is introduced, both from the objective function basis and from the decision variable basis.

The optional, introductory stages (0 and 1) are problem framing and basic financial descriptive statistics. The core of this project is stage 2, estimation of demand, and stages 3 through 5, solving problems with different framing and objectives and the importance of their integration. For courses that include stochasticity and simulation, students can use Monte Carlo simulation to simulate the objective function value robustness of their proposed solutions (part 6—data tables) or, alternatively, solve the model repeatedly against a range of demand conditions, finding a range of optimal decision variable values (part 7—Visual Basic macro programming).

Finally, for more basic courses optimization, the instructor can focus solely on stages 2–5. The instructor would provide solutions to earlier stages (e.g., provide key financial statistics (part 1) and regression estimates of demand curves (part 2)), encouraging students to step into an advanced problem with more guidance (e.g., start at phase 2 or 3), while perhaps alluding to more advanced perspectives.

Though the cases are tool independent, they have been offered entirely using Excel for all stages and all solution files are provided in Excel.

The primary pedagogical value is seeing an effective integration of analytical methods, the importance of scoping, and a realistic case of a multiphase project as is often experienced in business.

## Overall Case Objectives

Students conducting this case will

- Utilize a suite of analytical tools, including descriptive and predictive statistics, linear and nonlinear optimization, risk analysis simulation, and stochastic optimization.
- Understand the importance of balance and reverse logistics and network economics (in this case, rail).
- Develop a better understanding of the vagaries of real-world decision making, including determining data requirements, describing methodologies, and defining assumptions.
- Glean insights into decision-making conflict across various areas of the organization (in this case, marketing, operations, and finance).
- Get a sense for a real-world, iterative project for which a series of steps and methodologies result in a positive outcome for an organization.
- Work on a simplified version of a project that has been demonstrated as successful with a real-world, multibillion dollar company that saved hundreds of millions of dollars (Gorman 2001).
- Learn how to clearly, concisely, and accurately describe analytical models and their results.

## Literature Review

This case is relatively unique as it applies multiple tool skills over multiple weeks to a real-world (published) problem. To my knowledge, most cases are based on fictitious entities and problems that are "realistic" and constructed for application by a single tool.

Students often learn analytical techniques in a "stove pipe," that is, they think the methods are entirely separate and are not usually used in concert. Cases are then developed with specific tools in mind. An example of such a case-based course is given in Frances and Terekhov (2019), which describes the course schedule with a different case, and different tool, each week. As such, students are fed optimization problems, statistical problems, and simulation problems in isolation and without any consideration for how the problem may be viewed, or solutions improved, by applying different lenses.

Though such courses are certainly laudable, I wanted to provide an in-depth experience for my case-based course. In my experience, the single-tool project is decidedly not the case in practice, as I often integrate a number of methods in my approach to most practical problems. For examples, see Ahire (2007), Gorman (2010a and 2021), all of which combine three or more different analytical tools in the approach to the problem

However, there are relatively few cases that integrate a number of analytical techniques in a single problem. One example of a similar approach is found in Shumsky (2009), which uses statistics, simulation, and optimization in the application of yield management to a fictitious airline. Gorman (2012) applies statistics, optimization, and simulation in the analysis of a simple game called "Pass the Pigs." Both of these cases roll out incremental analyses on the same problem, expanding the tools used and the depth of understanding of the solution. I found this paucity of articles in the literature for integrated analytical techniques in the classroom to be unsatisfactory.

I teach a number of courses that cover multiple areas of analytics. They are case study courses and capstone courses that require students to identify the best method to apply in each case. However, as I moved from week to week in the semester for the case study course, it felt somewhat disjointed: put one problem away and begin another, never considering opportunities to extend the analysis of the problem at hand. In the capstone course, students often focused on a single method in their approach, not allowing for the possibility of using multiple methods, ostensibly because in their course work, a single tool was always applied to get "the answer." Gorman (2010b, 2011) discusses the challenges of students converting their textbook methods to work with real-world problems and the pedagogical value to students from applying an array of methods in the context of a single project. I wanted to use cases that integrate different analytical tools as necessary to better approximate field-based learning experiences and real-world projects (Gorman 2017).

I have also found relatively few cases that were based on published research of a real application; this case mirrors the BNSF pricing problem (Gorman 2001). Further, I note a dearth of cases in the literature on freight transportation in general and particularly in rail. The idea came to mind that if students were able to view a real-world problem through multiple lenses, they would better understand that a broader view and array of tools leads to higher-quality solutions. Further, if the case was motivated by an actual published application (which is also rare to my knowledge), students would have a more integrated view and be motivated by the fact that just such a method was used in practice. This is the motivation for my case and my contribution to the case literature.

## Solutions

The accompanying solution files contains incremental analysis on each of the phases of the analysis. Simulation files (phases 6 and 7) are separated from the first five phases, as random numbers inhibit solver speed and a Visual Basic macro is required for part 7.

Each segment solution "report out" (phases 1–7) is written independently; but in some class coverages (as described in the teaching notes), it makes more sense to combine them into a single report out.

Note that though the solutions are valid, alternative solutions may be justifiable; as mentioned above, this case is not about getting "the" answer but rather a reasonable one.

## Implementation Experience

This case has been offered to five MBA classes and one junior-level undergraduate class that covers optimization and simulation. I conducted a survey specific to the extended case of the undergraduate class and three of the MBA classes. I collected quantitative and qualitative feedback from all six classes in the form of course evaluations.

The survey responses were on a seven-point Likert scale from Disagree Strongly (1) to Agree Strongly (7). The questions were of two types: learning and difficulty. The questions were asked of each part and for the case study as a whole. Undergraduates only completed through part 6 and were not asked questions of parts 7 and 8 or the case overall.

The results are shown in Table 1. Undergraduates appreciated the learning in the case less and generally found it more difficult than MBA students, though only in 3 of the 12 questions in common were the means significantly different at the 95% level or above. Generally, both sets of students valued the learning of the case more than they found it difficult; however, part 6 (simulation) was more difficult for undergrads

**Table 1.** Responses to Quantitative Survey Questions

| Difficulty/learning of each part | Undergraduate | | | MBA | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | St dev | *N* | Mean | St dev | *N* | Mean | St dev | *N* |
| Difficulty—part 0 | 3.69 | 1.78 | 16 | 3.58 | 1.64 | 19 | 3.63 | 1.68 | 35 |
| Difficulty—part 1 | 4.40 | 1.50 | 15 | 3.42 | 1.35 | 19 | 3.85 | 1.48 | 34 |
| Difficulty—part 2 | 3.56 | 1.93 | 16 | 3.33 | 1.64 | 18 | 3.44 | 1.76 | 34 |
| Difficulty—part 3 | 5.00 | 1.71 | 16 | 5.00 | 1.68 | 18 | 5.00 | 1.67 | 34 |
| Difficulty—part 4 | 4.88 | 1.93 | 16 | 5.63 | 1.67 | 19 | 5.29 | 1.81 | 35 |
| Difficulty—part 5 | 5.19* | 1.38 | 16 | 6.05* | 0.71 | 19 | 5.66 | 1.14 | 35 |
| Difficulty—part 6 | 5.31 | 1.78 | 16 | 4.16 | 1.68 | 19 | 4.69 | 1.79 | 35 |
| Difficulty—part 7 | | | | 4.71 | 1.93 | 17 | 4.71 | 1.93 | 17 |
| Difficulty—part 8 | | | | 4.29 | 1.76 | 17 | 4.29 | 1.76 | 17 |
| Difficulty—overall | | | | 6.12 | 1.45 | 17 | 6.12 | 1.45 | 17 |
| Difficulty average | 4.58 | | | 4.46 | | | 4.51 | | |
| Learning—part 0 | 5.25 | 1.65 | 16 | 5.68 | 1.29 | 19 | 5.49 | 1.46 | 35 |
| Learning—part 1 | 5.06 | 1.61 | 16 | 5.58 | 0.77 | 19 | 5.34 | 1.24 | 35 |
| Learning—part 2 | 5.81 | 1.33 | 16 | 6.16 | 0.83 | 19 | 6.00 | 1.08 | 35 |
| Learning—part 3 | 5.12** | 1.50 | 16 | 6.16** | 0.76 | 19 | 5.69 | 1.25 | 35 |
| Learning—part 4 | 5.40 | 0.99 | 15 | 5.26 | 1.88 | 19 | 5.32 | 1.53 | 34 |
| Learning—part 5 | 5.00 | 1.63 | 16 | 5.21 | 1.55 | 19 | 5.11 | 1.57 | 35 |
| Learning—part 6 | 4.44** | 1.86 | 16 | 6.05** | 0.97 | 19 | 5.31 | 1.64 | 35 |
| Learning—part 7 | | | | 5.94 | 1.25 | 17 | 5.94 | 1.25 | 17 |
| Learning—part 8 | | | | 6.18 | 1.01 | 17 | 6.18 | 1.01 | 17 |
| Learning—overall | | | | 6.24 | 0.75 | 17 | 6.24 | 0.75 | 17 |
| Learning average | 5.08 | | | 5.80 | | | 5.60 | | |

*Notes*. Significantly different means undergrad and MBA students denoted with * for 95% confidence interval and ** for 99%. Std dev, standard deviation.

**Table 2.** Common Two-Word Phrases in Open Comments to Each Part of the Case

| Part 0 | | Part 1 | | Part 2 | | Part 3 | | Part 4 | |
|---|---|---|---|---|---|---|---|---|---|
| 5 | A good | 2 | Was difficult | 4 | To see | 3 | Was easy | 3 | We needed |
| 4 | Was hard | 2 | Very helpful | 2 | To understand | 3 | Easy to | 3 | Had to |
| 4 | Good questions | 2 | To understand | 2 | The easiest | 3 | Difficult for | 2 | Most difficult |
| 3 | To learn | 2 | To know | 2 | See the | 2 | Very easy | 2 | I struggled |
| 3 | Real world | 2 | Real world | | | 2 | Useful to | 2 | I needed |
| 3 | Learn how | | | | | 2 | Real world | 2 | I didn't |
| 3 | Ask good | | | | | 2 | Little difficult | 2 | Difficult part |
| 2 | Was difficult | | | | | 2 | Liked this | 2 | Didn't understand |
| 2 | I enjoyed | | | | | 2 | Difficult to | 2 | A good |
| **Part 5** | | **Part 6** | | **Part 7** | | **Part 8** | | **Overall** | |
| 3 | Was difficult | 4 | How to | 4 | To learn | 3 | I understand | 4 | I learned |
| 3 | Difficult because | 4 | Able to | 3 | Had to | 2 | Very useful | 3 | Real world |
| 2 | Was hard | 3 | Understand the | 2 | Was hard | 2 | Ultimately what | 2 | Very difficult |
| 2 | To think | 2 | Was able | 2 | The code | 2 | Everything together | 2 | Very challenging |
| 2 | Think through | 2 | I realized | 2 | The analysis | | | 2 | Understanding of |
| 2 | I didn't | | | 2 | Made sense | | | 2 | To grasp |
| 2 | Difficult for | | | | | | | 2 | Open ended |
| 2 | Critical thinking | | | | | | | 2 | Critical thinking |
| | | | | | | | | 2 | And apply |

than it was valuable for learning. Both groups of students found part 2 (regression of demand curves) to be most valuable with relatively low difficulty. When asked to rate the project overall, MBA students described it as more difficult and a better learning experience than the straight average of the individual part responses. (Undergrads were not asked this question.)

**Table 3.** Examples of Literals Taken from Open-Ended Questions in the Survey

| MBA | | Undergrad | |
|---|---|---|---|
| Supporting | Detracting | Supporting | Detracting |
| This course was very challenging, but I learned a good deal and am grateful for the experience. | I think … more instruction could be provided to help guide students through the expectations. | This was a good real world example of the usefulness of solver. | It was hard to narrow it down to a problem statement because the problem seemed so broad. |
| This case was very useful, and difficult at times. It may just be because I have no prior experience with complex real-world problems like this or I had no knowledge of the railway industry. I learned a lot, not as much technically, but with my mind I find myself able to think my way through problems a lot easier now. | The way we did it I was always rushing to write something up fast and didn't have time to review my results. Also, I considered dropping this class because you left us lost to much and it was very frustrating. | This section of LBL allowed me to experience a more "real world" experience. I think it is beneficial for students to be able to ask for the data they need rather than having everything already in front of them. It forces you to think through the problem! | Without having a good understanding or background on the industry, it was somewhat difficult to come up with good questions. |
| The way this course was setup was my favorite so far of my entire MBA program. I really like the concept of working one case from beginning to end. | Would of preferred to exercise the methodology in more smaller cases. | Once we saw how we needed to redirect the existing market imbalance, I really did pick up on how and why we needed to do this part. | I felt like it was hard to know how to navigate through the data on our own. This was such a large scale project in an intro level decision making class. It almost felt like this was a case study for grad students. |

Qualitative (open-ended questions based on each of the parts above) responses were mixed. In general, some students suggested that a lack of clear requirements and confusion about how to approach each part were a hindrance. On the other hand, other students suggested that the real-world and vague nature of the case was an asset to seeing how to apply analytical tools. Instructors need be aware of student comprehension and ability to work in an uncertain environment in order to strike a balance between the risk of frustration and the satisfaction of getting through a difficult case.

The summary of the observations above might be that the case is better suited for MBA-level students as they are more likely to thrive in a less structured setting and value it. Perhaps providing more straightforward guidance to undergraduates is a good strategy to reduce student frustration and improve perception of the case. MBA students are probably better equipped to deal with project uncertainty largely as a part of their work experience.

Table 2 presents common two-word phrases in the general, open comments of the survey that express some sort of sentiment or opinion of the part of the case. Generally, there was a mix of "enjoyed" and "learned" with "difficult" and "had to." Generally, and subjectively, parts 0–2 and part 8 were best received. Parts 3, 4, and 5 had the most challenging or negative sentiment phrases. Parts 6 and 7 expressed more understanding and synthesis. Overall, students expressed learning in a difficult and real-world problem, as one would hope in a case.

The full comments in Table 3 capture some of the major themes in supporting and detracting statements on the case. As can be seen, MBA students had fairly more positive things to say about the challenge presented in the case.

## Final Remarks

Integrated, multiple-phase cases that are based on an actual implementation are rare. However, they present an opportunity for students to think in depth about a problem, applying multiple analytical techniques, and develop incremental solutions. This case is based on a real-world example at BNSF railway (Gorman 2001) and demonstrates to students the power of relatively simple analytical techniques in understanding a problem. Though difficult and highly unstructured, it helps more advanced undergraduate and MBA students have a sense for what it takes to apply analytical techniques in the real world. Students also gain experience in writing up analytical results in a clear, concise, and nontechnical way.

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