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Atlas managerial accounting case: Examining joint products in the international scrap metal recycling industry

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ABSTRACT

The purpose of the Atlas managerial accounting case is to apply managerial accounting, economic, and international business concepts. Atlas Scrap Metal produces the joint products of steel and mixed non-ferrous material, which includes the non-ferrous metals of aluminum, copper and zinc. Atlas currently sells containers of the mixed non-ferrous material to other processors to be sorted into pure metals. The processors bid on the containers of mixed non-ferrous material based on local spot prices for the sorted non-ferrous metals, as well as on their sorting costs, which vary geographically depending on local labor and automation costs. The case requires an analysis of the costs and revenues that are relevant to the company's decision to continue to sell mixed non-ferrous material to other processors, or to vertically integrate and process the non-ferrous metals inhouse. You are required to support the recommendations quantitatively with calculated contribution margins and by considering a revenue sensitivity analysis on commodity prices for the non-ferrous metals. The Atlas case was inspired by Adam Minter, 2013 book, *Junkyard Planet.*

1. Atlas managerial accounting case

1.1. Introduction

In late spring 2018, Alex Gonzales looked across the piles of scrap at her family's business, Atlas Scrap Metal in Richmond, California. Alex knew the scrap metal industry might not seem very glamorous to some, but she was proud of the business. "This could all be dumped in a landfill and new metals would have to be mined and extracted. We're not just running a business; we're helping ensure the earth's resources are used sustainably." Alex had recently graduated with degrees in accounting and sustainability and would be starting as a business analyst with an international recycler in the fall. She had agreed to spend the summer between graduation and her start date working to help the family's scrap business by analyzing the company's products.

Atlas Scrap Metal recovers and sells steel from scrapped car hulks. The process of reclaiming steel provides Atlas with another product, mixed non-ferrous material, which includes waste, but also includes the valuable non-ferrous metals of aluminum, copper and zinc. The non-ferrous commodity metals are used to support manufacturing and construction. Rather than process the mixed non-ferrous material inhouse, Atlas sells the mixed non-ferrous material by the container load to other recyclers for further processing. Atlas Scrap Metal process approximately 3600 cars per month with each car yielding

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approximately 1 metric ton (MT) of steel and 0.145 MT of mixed non-ferrous material. Last year, Atlas sold 43,200 MT of steel and 310 containers, or 6,820 MT, of mixed non-ferrous material.

Alex wandered through the loading yard, which was packed with containers filled with mixed non-ferrous material bound for the Port of Oakland, the large container port 15 miles away. The containers would soon be bound for an incoming container ship from China. The containers would then be loaded as cargo for the ship's return trip across the sea, and eventually be delivered to Chinese buyers who would process the material further into pure, sellable metals. Alex had spent the past few weeks reviewing the company's recent business transactions. She notices the most recent sale of a container of mixed non-ferrous material had a price of $20,000. She believes that this sale provides significant contribution for Atlas.

Alex knew the scrapyard had been doing exceedingly well lately given the high demand for metals. She logged onto scrapmonster.com and compiled the current spot prices for aluminum, copper and zinc, shown in Table 1 (Scrap Monster, 2014). She glanced down at last year's income statement, shown in Table 2, and was intrigued by the growing revenue Atlas was earning from mixed non-ferrous material. Alex wondered whether Atlas should continue to sell the containers of mixed non-ferrous material to the highest bidders. Maybe it was time for Atlas to consider vertically integrating and processing the mixed material into pure aluminum, copper and zinc. Would expanding processing capabilities increase Atlas' profits she wondered?

Alex enters her father's office eager to share her expansion idea. "Dad – did you realize the last container of mixed non-ferrous material sold for $20,000? If other processors are willing to pay $20,000 for a container of mixed non-ferrous materials, the recoverable non-ferrous metals must be really valuable. I looked at the spot prices for aluminum, copper and zinc and it seems like we're leaving a lot of money on the table. Why doesn't Atlas reclaim these metals and sell them? Isn't there some way we could get into this business and increase our profits?"

Her father replies, "Metal prices have been excellent lately, but it isn't always the case. Alexis, you know metals are commodities and commodity prices can be volatile. Look at the prices over the long term." Her father pulls up the *St. Louis Federal Reserve Economic Research Division* website (https://fred.stlouisfed.org) to show her the steel price index since 1982, shown in Fig. 1, and the last ten years of non-ferrous metal prices, shown in Fig. 2. Then he continues; "Right now, all scrapyards are benefiting from higher prices because of the rapid expansion and growth in China and other developing countries. However, prices haven't always been so good – you don't remember it, but the financial bust in 2008 nearly put us under. And 2016, while not as bad, was still a tough year. And now I'm hearing that new tariffs and import restrictions on recyclable materials in China could have a negative impact on scrap metal exports from the U.S. We need to make sure that we don't overcommit resources to an unsustainable line of business."

Alex responds "I think we should look at it dad – these prices are just incredible! I don't want us to miss out on opportunities."

"If you want to look into it Alexis, there is a lot of research to be done," says her father. "There are two approaches scrapyards around the world take to reclaim non-ferrous metals. One is labor intensive, where trained employees hand sort the metals from the waste. The other method, which is used by some of our North American customers, is more capital intensive, involving specialized equipment to automate the sorting process. Atlas would have to lease the equipment. Both reclamation methods are costly and require scale. Furthermore, I'm still worried about the issue of commodity prices. Expanding the workforce with our current warehouse space is a commitment to people. Expanding with automation, is a huge capital commitment, that would tie us up for years of additional committed costs. If commodity prices for the metals fall, I'm afraid we'd be in the red. Once you look at all the numbers, I think you'll see where the risks are."

Undeterred, Alex replies: "I'll look into it dad. Data and analysis will help us to make the right decision."

1.2. Scrap metal as a product

For most consumers, the purchase of a new car or appliance includes a plan to dispose of the old model. A functioning used car might be sold, traded into the dealer, or donated to charity. But an inoperable car – one that cannot be repaired at a reasonable price – ends up in a scrapyard. Because there is value to recover, this scrapped car can be transformed into products that are bought and sold around the world. Atlas Scrap Metal recovers steel and mixed non-ferrous material, which contains aluminum, copper and zinc, from salvaged automobiles.

The U.S. is the largest generator and exporter of scrap metal. About half of domestic metal production in the U.S. comes from scrap, and about a third of U.S. scrap metal is exported to other countries. Steel is used in the construction of skyscrapers, bridges and automobiles. Non-ferrous metals, such as aluminum and copper are used in wiring and electronic applications. In the past decade, China has been the largest export market for U.S. scrap metal due to its high economic growth and corresponding infrastructure development (Kalyani, 2016). Future demand for scrap metal is likely to come from places where infrastructure development is strong (BIR, 2019). In addition, increased regulation of mining operations is likely to increase the value of scrap metal prices (Kalyani, 2016).

Metals are an undifferentiated commodity with prices set by global economic forces. While strong and growing, the secondary materials market for mixed non-ferrous scrap material is not as well-developed as pure commodity metal markets. As the cost of mined metals and the associated environmental impact of harvesting these virgin materials has increased, revenue from secondary (recycled) materials has increased. Compared to creating steel from raw materials, recycling metal uses 74% less energy and 40% less water; and produces 58% less carbon dioxide emissions with fewer water and air pollutants and essentially no waste (BIR, 2019).

Table 1
Price of non-ferrous metals per metric ton (USD/MT).

Price per metric ton (MT)	North America	China	India
Aluminum	$1,786	$2,040	$1,920
Copper	$6,107	$7,408	$6,592
Zinc	$1,565	$2,024	$2,176

Table 2
Atlas scrap metal income statement.

	Steel	Mixed metals	Consolidated
Revenue	$32,919,959	$6,199,213	$39,119,172
Reclamation costs	32,684,817	68,190	32,753,007
Gross profit	235,142	6,131,023	6,366,165
Operating expenses:			
Depreciation & amortization			400,000
Selling, general & administrative			1,300,000
Operating income			4,666,165
Tax expense			1,633,157
Net income			$3,033,008

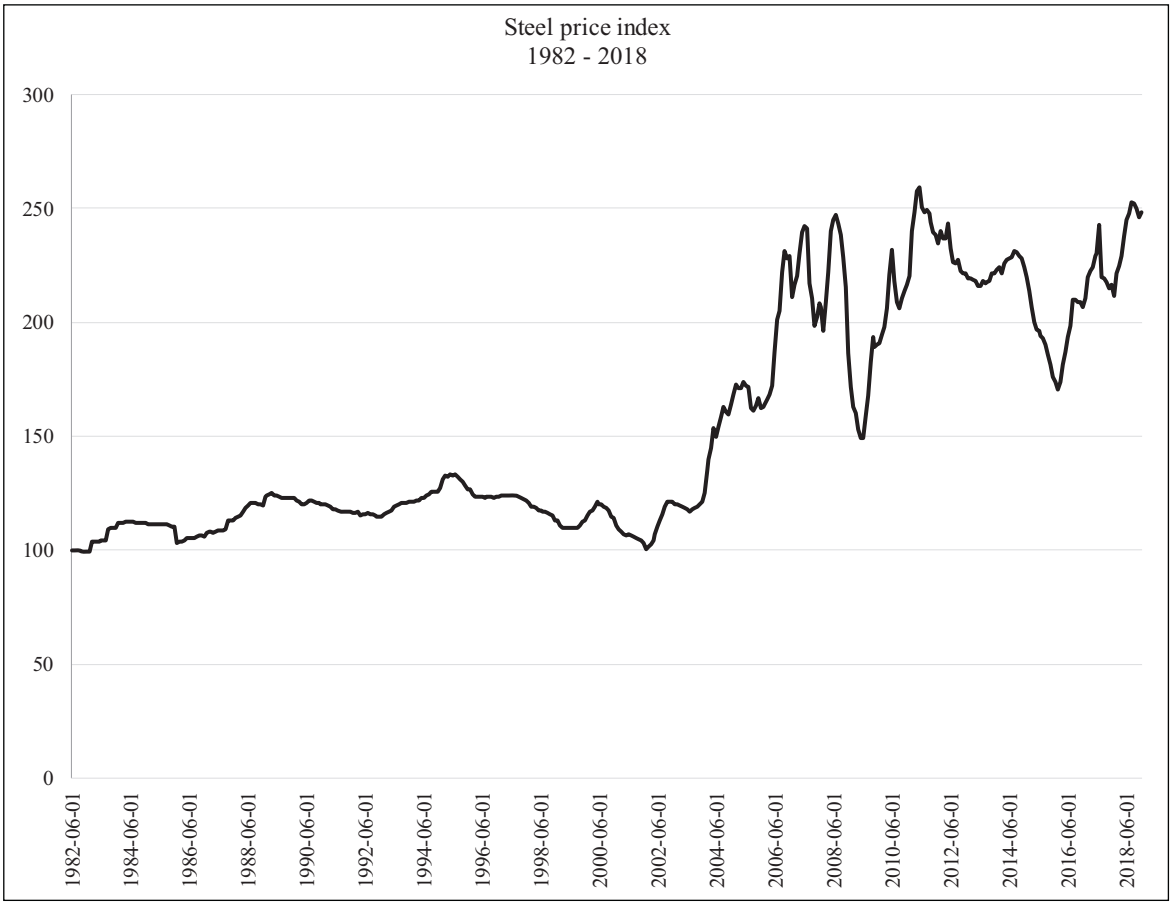

Fig. 1. Steel price index, 1982–2018.

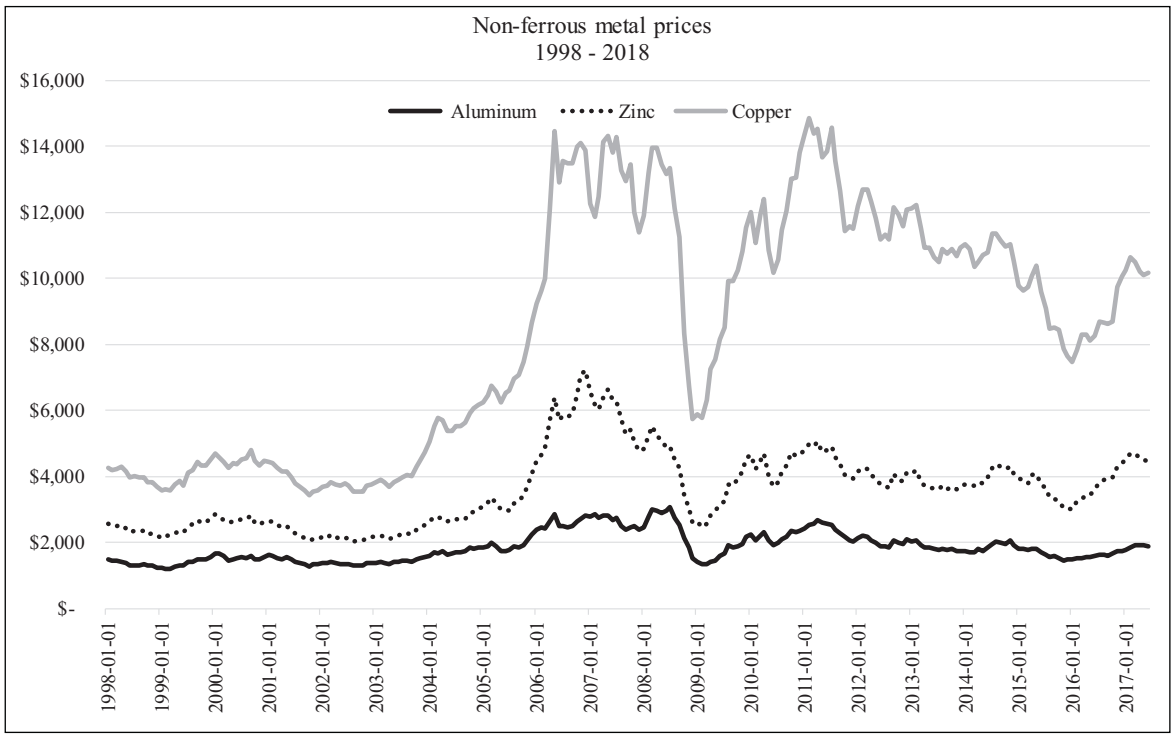

Fig. 2. Non-ferrous metal prices per MT, 1998 – 2018.

1.3. An overview of Atlas' operations and costs for processing scrap

Atlas' revenue arises from the sale of recovered steel and non-ferrous mixed material. The process of recovering steel from scrapped automobiles is highly equipment-intensive at Atlas. The equipment at Atlas is overseen by a small workforce comprised of skilled machine operators and sorters. The scrapyard operator removes all fluids and hazardous material from the car. The operator then strips the car of any components that can be readily sold for reuse by auto repair shops and restorers, including wheels, some interior fixtures, and under-the-hood components. Atlas sells these recovered components to a local parts dealer. The revenue from salvaged components is immaterial and is considered cost reduction rather than revenue. The remainder of the scrapped car, called the "hulk," is crushed and becomes raw material for Atlas.

An automobile hulk consists of steel, and non-ferrous materials including aluminum, copper and zinc, along with waste that is comprised of glass, foam, fibers, and plastics. At Atlas, automobile hulks are processed into steel and mixed non-ferrous material in a three-staged process. This process is shown in Fig. 3. At each stage of the process, waste is produced and disposed of responsibly. Waste disposal is included as indirect overhead costs for Atlas.

In the first stage, car hulks are loaded onto a platform using a crane and pushed into a shredder. The purpose of the shredder is to chew the hulks into manageable pieces that are three to four inches in size. The crane and shredder operators work in tandem to ensure the shredder works near capacity without exceeding its operating tolerance. In the second stage, a conveyor belt carries the shredded material under a rotating magnetic drum where the steel is picked up by the drum and deposited onto a belt that will carry it to the third stage where it is forged and smelted into steel ingots that are ready for sale. The material not picked up by the magnetic drum is shredded non-ferrous material and includes shredded bits of zinc, copper, aluminum, upholstery, dashboards and anything in the car that wasn't steel. This material continues down a separate belt, to its third stage, where it is baled and loaded into a container at an incremental cost of $10 per bale.

International buyers bid on the containers of mixed non-ferrous material from Atlas, based on reliable estimates of the contents of each container load. The buyers separate the waste from the metals and then sort the metals into their pure forms. Atlas has sold containers of its mixed non-ferrous material to processors in North America, China, and recently, India.

The costs incurred in extracting the metals from the salvaged cars to produce one metric ton (MT) of steel ingots and 0.145 MT of non-ferrous mixed material are shown in Table 3.

Direct material costs are the net cost of the car hulk. This direct materials cost consists of the cost of the purchased scrapped cars, net of the revenue from the re-sold components. Labor costs consist of hourly wages and benefits for the shredder operators, forge operators, crane operator, belt operator and other supporting workers. Overhead costs consist of half depreciation and occupancy costs, which are fixed at the plant level. Occupancy costs includes leasing costs, office staff salaries, property taxes, marketing and the owner's salary. The other half of overhead costs are comprised of indirect mate-

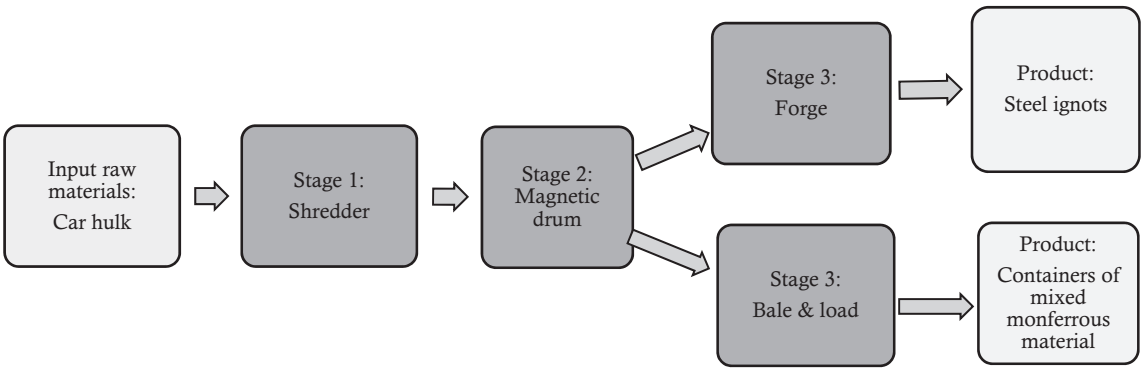

Fig. 3. Atlas' metal reclamation process.

Table 3
Costs of processing scrap cars (per MT of steel produced).

Direct materials cost	$140
Direct labor cost	$155
Overhead cost	$400

rials, wearing parts, indirect labor costs for the scrapyard shift managers, and machine maintenance costs. The price of recovered steel varies widely, depending on current market conditions. The bulk of the steel extracted by Atlas is currently sold for industrial uses in the local region. Prices for steel had recently been $700 per MT.

1.4. The market for non-ferrous metals

The automobile recycling process at Atlas produces the joint products of steel and non-ferrous mixed material. Atlas sells the non-ferrous mixed material to other processors that have the capability to reclaim the valuable non-ferrous metals. The value of the recovered non-ferrous mixed material depends on its composition (measured in yield as a percent of total weight) and on commodity prices. A typical yield from the non-ferrous mixed material at Atlas is approximately, 60% aluminum, 10% copper, 5% zinc, and 25% waste. The demand for non-ferrous mixed material comes from processors around the world. These processors buy the non-ferrous mixed material from sellers such as Atlas and extract and sort the metals for sale. Normally, non-ferrous mixed material is sold and purchased by the container load. A container carries approximately 22MT of non-ferrous mixed material. Buyers purchase containers of mixed non-ferrous material by bidding on the containers.

The price the buyer is willing to pay Atlas for a container of mixed non-ferrous materials depends on several factors. Most important are the expected commodity market values of the separated metals, the cost of shipping the container to the processing plant, and the cost of processing the non-ferrous mixed material into pure metals. The value of each metal varies by country, depending on the demand generated from growth in manufacturing and construction, and the local supplies of metals that are available.

The cost of shipping depends on the shipping mode and distance. North American customers ship containers by rail, whereas overseas customers use container ships. To make mixed non-ferrous scrap material useful, it needs to be sorted and refined using labor or automated equipment. The cost of processing non-ferrous mixed material into salable metals varies widely and depends on the processing technique employed to sort the metals. Most competitive processors in the United States and Canada employ the automated floatation process to separate the metals. These operations require significant capital investment. Where wage levels are lower, processors use hand sorting, relying on highly trained human sorters to do the separation. Separated metals are then forged into regular unit sizes and shapes for sale.

Atlas is currently entertaining bids on containers of non-ferrous mixed material with three processors, one in the United States, one in China, and one in India. Container prices for the non-ferrous mixed material are negotiated for each sale, Atlas has no long-term contracts. Processors base their bids on the revenue they can achieve from sale of the sorted metals and the cost functions they face. Each processor uses different methods and thus faces different operating costs. The US processor utilizes an automated separation process. The Chinese and Indian processors use hand sorting. The subsequent refining and grading process is similar in each plant but is somewhat faster in the US plant because of automation. Alex uses industry data to estimate processing costs. The cost estimates for processing a container of non-ferrous mixed material to finished salable metals by processor is shown in Table 4.

Table 4
Processing costs by plant per container load (USD/22MT).

	US plant	Chinese plant	Indian plant
Raw materials before freight cost	negotiated	negotiated	negotiated
Inbound freight cost	$2,500	$700	$2,250
Direct labor cost	400	200	60
Overhead costs:			
Allocated depreciation and occupancy costs	7,200	1,500	300
Indirect overhead	900	720	900

Raw materials cost is the amount the buyer agrees to pay Atlas for the container of non-ferrous mixed material. The price processors are willing to pay for a container depends on their expectations for the future prices for the pure metals. Inbound freight cost is the cost of shipping the container to the buyer's plant, including taxes and import duties. Inbound freight cost for the US processor consists of the cost of loading, rail shipping, unloading, and truck delivery. For the other two processors, the containers travel by ship rather than rail, and are unloaded and delivered by trucks from the port of entry.

Direct labor cost for the US processor consists of the wages and benefits of machine operators. Direct labor cost for the Chinese and Indian processors includes mainly the wages paid to hand sorters and wages of forge operators. Overhead costs for all the processors consist of depreciation and occupancy costs, which are fixed at the plant level, and variable indirect costs such as waste disposal fees and indirect labor.

1.5. Atlas' processing options

Fig. 4 depicts the process Atlas could use to further process the mixed non-ferrous material after the steel split-off point. The reclamation could be achieved with either labor intensive hand sorting or through an automated process. The automated process would use a series of liquid baths to "float" the lighter waste away from the heavier metals. An eddy-current separator would then use rotating magnetic fields to sort the metals into their pure forms of aluminum, copper and zinc.

Alex understands her father's hesitation to committing to the additional costs required to process the non-ferrous mixed material. She starts her analysis by considering the costs associated with sorting the metals by hand, as her father is likely to be skeptical of committing to the automated sorting option. Alex knows the process of hand sorting is time consuming and takes experienced personnel. While Atlas management has that expertise from years of dealing with mixed metal buyers, it would require additional trained operating personnel to complete the exacting work of hand sorting the non-ferrous metals. Identifying and separating the aluminum, copper and zinc from one MT of mixed metal would cost approximately $975 in additional direct labor costs alone. The sorting station would be located directly after the shredding belt, thus avoiding the bailing step. Sorted product would proceed along separate conveyors to bins for final processing and grading. Alex prepared estimates of the conversion cost of processing the non-ferrous mixed material into pure metals for sale in Table 5.

Direct labor in the final processing stage includes hourly wages and benefits for machine operators. Overhead costs consist of $18 of allocated fixed depreciation and occupancy costs, and $10 for incremental indirect materials, such as wearing parts and machine oil, and indirect labor.

Alex knows that one benefit of the labor-intensive sorting approach would be that it is more flexible relative to the capital investment in machinery required to implement the automated sorting process. A capital lease for sorting equipment would significantly increase the company's annual fixed expenses. Alex knows her father is unlikely to support such a large capital commitment. But she also knows her father is not likely to look favorably on viewing any of his employees, either those currently employed or those that would be hired for the sorting, as expendable. Alex realizes that processing the non-ferrous mixed material further would be a major undertaking for Atlas, but that it could increase the company's profitability if implemented correctly. She decides to look at the numbers like her father suggested so she could make a well-reasoned recommendation.

2. Case requirements

2.1. Discussion questions

Write out a brief answer to each of the case discussion questions to prepare for the in-class discussion.

1. In two to three sentences, describe the company's products, customers, and operations. Briefly summarize the options available to Atlas for the non-ferrous mixed material. What are the internal and external risks faced by the company? Do you recommend that Atlas continue to sell the mixed non-ferrous material? Or, do you recommend Atlas vertically integrate and process the non-ferrous mixed material further? Use the calculations and analysis from the questions below to support your recommendations.
2. Calculate and critique steel profitability metrics. Specifically:

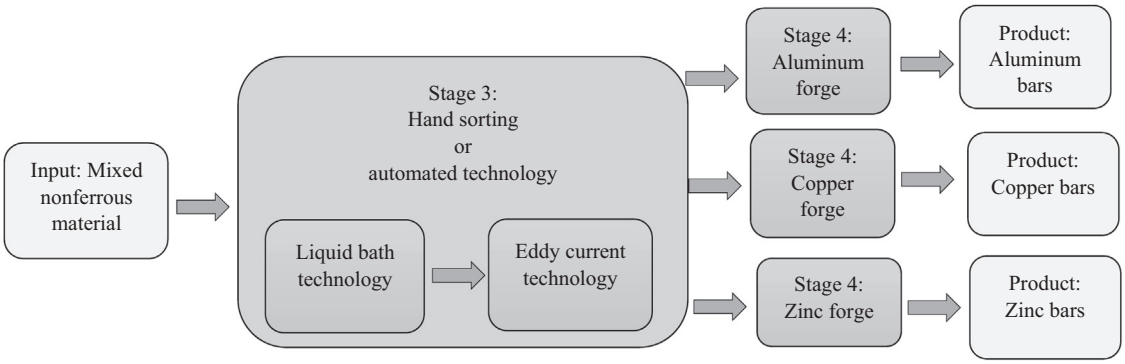

Fig. 4. Reclamation process for aluminum, copper and zinc after the split-off point.

Table 5
Atlas' expected costs of separating and processing one MT of mixed metal for sale.

Costs of hand separating and processing 1 MT of metals for sale	
Direct labor – hand sorting	$975
Direct labor – final processing and grading	20
Overhead cost	28

a. Determine the gross profit Atlas earns producing and selling one MT of steel if the entire processing cost described in Table 3 is attributed to steel production.
b. Determine the contribution margin of one MT of steel.
c. What insights can the computations offer regarding the profitability of steel extraction from automobiles? Do the calculations provide management with information to facilitate decision making on the sale of steel and the mixed metals? Explain.

3. Define the alternatives Atlas is considering for the disposition of non-ferrous mixed material. Describe, without calculating, the costs and revenues associated with each alternative.
4. Analyze Atlas' option for continuing to sell the non-ferrous mixed material to international processors. Assume each container is filled with 22 bales of non-ferrous mixed material and that the distribution of metals in the container reflects the percentages given in the case.

a. First, assume Atlas sells the containers of non-ferrous mixed material at the recent bid price of $20,000 per container load. Calculate the contribution for Atlas from the sale of a container of non-ferrous mixed material from the steel split-off point.
b. Calculate the contribution margin by container for each potential buyer/processor. Continue to assume the buyers pay Atlas $20,000 for the container of non-ferrous mixed material and then process the material into saleable metals.
c. What factors do you think influence the differences in processing costs and profits among the potential buyers of non-ferrous mixed material? Would you anticipate any changes in these factors in the future? Why or why not?
d. Now, ignore the pricing assumption (i.e. ignore the $20,000 price per container) and determine the maximum amount each buyer would be willing to pay for a container of non-ferrous mixed material. Assume the buyers have adequate capacity to process the non-ferrous mixed material. (Hint: This is the maximum price the buyer can pay for a container of non-ferrous mixed material and still earn a non-negative contribution margin.) Based on these calculations, which processor is likely to offer Atlas the highest bid?
e. Suppose Alex's dad is correct about non-ferrous metal prices falling in the future. What would each of the other processors be willing to pay for the containers assuming the processors' revenues from the sorted mixed metals were to fall by half? (Hint: Repeat requirement 4.d. by cutting the non-ferrous metals prices in Table 1 in half).

5. Analyze Atlas' option of vertical integration assuming Atlas were to process the non-ferrous mixed material into pure metals using hand sorting. Assume the sorting costs shown in Table 5 and that Atlas would sell the sorted metals domestically to North American buyers.

a. Assume the spot prices shown in Table 1. Calculate the opportunity cost of selling a container of non-ferrous mixed material by calculating Atlas's expected contribution from processing the non-ferrous mixed material further. Discuss factors that could cause this opportunity cost to increase or to decrease.
b. Given the choice set Atlas faces and your calculations, what is the minimum price Atlas should accept from any buyer for a container of non-ferrous mixed material under current market conditions? Do you think Atlas will be able to find a mutually agreeable price with any of its potential buyers given current metals prices? Why or why not?

6. Analyze Atlas' option of vertical integration assuming Atlas were to process the non-ferrous mixed material into pure metals using automation. Assume Atlas could lease the equipment required for the automated sorting by entering a multiyear equipment lease.
   a. What factors should Atlas focus on in deciding whether to take on the fixed costs of the equipment leases? What are the risks with automation?
   b. Assume that Atlas would incur direct labor costs of $400 per container and $900 of variable overhead per container load to process the mixed metals with automation. Also assume that Atlas will continue to recover 310 containers of mixed metals annually. What total annual fixed cost related to automation would make Atlas indifferent between the labor-intensive hand sorting and automation options for sorting the mixed metals?
7. Compare the annual contribution for continuing to sell the non-ferrous mixed metal as is with the hand sorting and automated recovery options. Specifically:
   a. Compile a comparison of the contribution of each of the three options side by side under current market conditions using the prices in Table 1. Assume volume of 310 containers of non-ferrous mixed material. Assume the expansion into automation requires a five-year lease (focus on the first year and ignore subsequent years to simplify the analysis), as well as other fixed costs, which total $6 million of committed costs per year.
   b. Perform a sensitivity analysis on volume; assuming volume falls to 250 containers.
   c. Perform a sensitivity analysis on metal prices; assuming the prices in Table 1 fall by 25%, fall by 50%, increase by 25% and increase by 50%. The template shown in Table 6 can be used to organize the analysis.
   d. How do you think container prices of mixed non-ferrous material would react to the price shifts in the end markets for metals discussed in part c?
   e. What conclusions can Alex draw from the sensitivity analysis?
8. The Merriam Webster dictionary defines sustainability as "being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged" (Dictionary, 2019). Similarly, the Bruntland Report for the World Commission on Environment and Development describes sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). How does Atlas contribute to sustainability?

2.2. Written report requirements

Prepare a report (two to four pages single spaced) for the Atlas management team recommending a strategy. The report should include the following sections:

- **Executive summary**: The executive summary should provide a clear recommendation for the company on whether to sell or process further the mixed non-ferrous material. The executive summary should also include a preview of the analysis supporting the recommendation(s). The executive summary should be one paragraph.
- **Company overview:** Describe the steel and mixed metal reclamation business (i.e. discuss the company's products, customers, and operations), to help the management team better understand Atlas' current position in the industry.
- **Opportunities and risks:** Discuss the most important opportunities and risks that will contribute to the company's success to help the management team better understand Atlas' options.
- **Recommendations and conclusion:** Make a recommendation to the management team on the sell or process further decision. That is, let the management team know which of the following strategies to pursue with respect to mixed metals:
  - o Continue to sell containers of the mixed non-ferrous material. Explain your reasoning and identify the most likely buyers in the short and long run.
  - o Process the mixed non-ferrous material in-house using skilled labor. Explain your reasoning.
  - o Process the mixed non-ferrous material inhouse by leasing automated sorting technology. Explain your reasoning.
- **Discussion questions:** The discussion questions will guide your analysis and should be submitted as an appendix to the write up (note the discussion questions are not included in the pages guideline).

3. Teaching note

3.1. Overview of Atlas managerial accounting case

Atlas Scrap Metal case is based on the recent book *Junkyard Planet*, by Adam Minter. Minter's book depicts the development and operation of the worldwide scrap and reuse business, and its role in the development of greener design, resource use, and waste practices. The case depicts a scrap-metal recovery business that recycles cars generating the joint products of steel and non-ferrous mixed metals.

The case provides students with an opportunity to use quantitative analysis to evaluate a specific decision. The case guides students through the analysis of the costs and revenues relevant to the profitable sale of mixed non-ferrous material, which is a joint product with the company's primary product of reclaimed steel. Modeled as a "sell-or-process-further" decision, the case requires students to analyze the decision to sell the mixed non-ferrous material as is, or to process the mixed

Table 6
Template for sensitivity analysis.

Current market conditions & volume of 310 containers	Sell-as-is	Hand-sorting	Automation
Revenue - current prices			
Variable costs			
Annual fixed costs of automation			
Contribution			
Current market conditions & volume of 250 containers	**Sell-as-is**	**Hand-sorting**	**Automation**
Revenue - current prices			
Variable costs			
Annual fixed costs of automation			
Contribution			
Sensitivity - market prices fall by 25%	**Sell-as-is**	**Hand-sorting**	**Automation**
Revenue - fall by half			
Variable costs			
Annual fixed costs of automation			
Contribution			
Sensitivity - market prices fall by 50%	**Sell-as-is**	**Hand-sorting**	**Automation**
Revenue - fall by half			
Variable costs			
Annual fixed costs of automation			
Contribution			
Sensitivity - market prices increase by 25%	**Sell-as-is**	**Hand-sorting**	**Automation**
Revenue - fall by half			
Variable costs			
Annual fixed costs of automation			
Contribution			
Sensitivity - market prices increase by 50%	**Sell-as-is**	**Hand-sorting**	**Automation**
Revenue - fall by half			
Variable costs			
Annual fixed costs of automation			
Contribution			

metal further by separating the metals of aluminum, copper and zinc from the waste. Students examine comparable prices for copper, aluminum, and zinc from markets in three countries, along with processing costs from potential customers in North America, China and India. Using this information, along with information about the internal costs at Atlas, students estimate buyer reservation prices for the mixed metals and compare them with the potential profit from further processing the mixed metals using either labor-intensive-hand sorting or an automated-sorting process. Since revenues are highly dependent on volatile commodity prices, a sensitivity analysis is required.

The case addresses the need for managerial accounting cases that allow students to apply relevant analysis in a decision-making context for joint products. Apostolou, Dorminey, Hassell, & Rebele (2015–2017), Apostolou, Dorminey, Hassell, & Rebele (2018), Apostolou, Dorminey, Hassell, & Hickey (2019) review the accounting literature annually and classify cases by topic. We reviewed the cases classified for use in managerial accounting courses between 2010 and 2017. The learning objectives of most of the managerial accounting cases we reviewed included analyzing costing calculations (e.g. Zahller, 2017; Braun, 2013), variance analysis (e.g. Mudde & Sopariwala, 2014) and CVP analysis (e.g. Samuels and Sawers, 2016). Our review found a lack of cases for performing differential analysis and evaluating relevant information for joint products.

There were a few cases that stood out as similar to the Atlas managerial accounting case. Canace and Juras (2011) authored an international case on capital budgeting decisions relating to a joint venture. The Canace and Juras (2011) case is similar to the Atlas case, as it requires students to consider macroeconomic and international factors in its decision to pursue a joint venture. However, the Canace and Juras (2011) case focuses on valuation and budgeting making the two cases distinct. Recently, Ayres and Stanfield (2019) developed a cased on joint costing, which develops a cost system by estimating and applying overhead allocation rates for joint products. The Atlas managerial accounting case differs from Ayres and Stanfield (2019) by focusing on the strategic decision to sell or process further a joint product after the split-off point.

There is a companion case published in this same issue, Atlas international business case: Examining globalization and economic indicators for the scrap metal recycling industry, that can be used by accounting instructors to more deeply

explore the international economic and business environment faced by Atlas. It is not necessary to teach both cases together, as they have been written in a way to be taught independently or complementarily. The Atlas international business case requires students to research data on global wages, shipping rates, trade balances, exchange rates, commodity prices and scrap prices. Often revenues and costs are given in accounting case analyses. Researching this data allows students to grasp the global forces that influence recyclers' different revenue and cost functions, which are reflected in the Atlas managerial accounting case. The Atlas international business case provides accounting instructors with an opportunity to bring international themes into their accounting courses. The companion Atlas case could be taught prior to the Atlas managerial accounting case to provide context for the revenue and cost assumptions provided in this case.

There is increasing interest in sustainability across college campuses (Calder & Dautremont-Smith, 2009). The Apostolou et al. reviews (2015–2019) only identified two resources as relating to sustainability. One paper, authored by Bouten and Hoozée (2015), is an instructional resource introducing students to the concept of sustainability reporting. Another paper on sustainability, authored by Hazelton and Haigh (2010), describes how the authors incorporated sustainability themes into a graduate accounting course. The Atlas cases complement the existing instructional resources introducing sustainability concepts.

3.2. Case learning objectives and implementation guidance

The purpose of the case is to develop a basic understanding of how global economic forces influence the for-profit recycling industry. Specifically, the case enables students to:

1. Examine how global economic forces influence the for-profit recycling industry and provide an opportunity to discuss commodity price volatility, globalization and sustainability.
2. Apply the tools of managerial accounting and differential analysis to evaluate alternative business options related to the sell-or-process-further decision.
3. Calculate contribution and gross margin for both the buyer and seller of the mixed metals to compare cost functions faced in different geographical regions. Calculate opportunity costs and consider the tradeoffs between labor and automated sorting.
4. Develop professional competencies communicating technical analysis to a management audience.

The case was written for an introductory managerial accounting course; however it could be implemented in an upper-level course on cost accounting. The case can be implemented after relevant cost and differential analysis have been covered. The instructors implementing the case discussed the case in-class after students had prepared responses to the discussion questions. A written report was due approximately a week later. Fig. 5 shows a teaching plan for the in-class discussion, which outlines discussion topics and approximate time spent in-class on the topic.

3.3. Case efficacy: student learning and feedback

The case was piloted in an undergraduate managerial accounting course.[1] The course is a required business course traditionally taken by students majoring in business during the spring of their sophomore years. The case was piloted by two different instructors over four semesters.

The first implementation of the case required students to read Ch. 5 of Minter's book, *Junkyard Planet*, to provide general background on the recycling industry, and on the shipping phenomenon known as the "Backhaul." A backhaul occurs when shipping rates are significantly lower for the return trip due to trade imbalances. Following the first implementation and based on instructor experience with the case and informal feedback from students, the case narrative was revised slightly to incorporate additional background information on the industry so that the case can be implemented without requiring students to read excerpts from the book *Junkyard Planet*.[2] The case efficacy was then tested through a survey in five introductory managerial accounting courses in subsequent semesters.[3]

Prior accounting education researchers have used student surveys to assess the usefulness of pedagogical resources (e.g., Matherly & Burney, 2013; Grimm, 2015; Blazovich, Huston, & Huston, 2014). The survey included questions to assess students' understanding of concepts covered in the case (e.g. factors relevant for calculating contribution), as well as students' perceptions of their learning, and their opinions on the case. Survey questions are provided in Appendix A. The survey had an 85% percent participation rate. Student survey responses for the case were generally positive and provided evidence of

[1] All the instructors who piloted the case are also authors of the case.

[2] The companion case, Atlas international business case, and its teaching note, present data on the scrap metal recycling industry, which summarize many of the significant economic issues discussed in Minter's book. Thus, if instructors wish to cover these topics in more depth, the international business case can be assigned as a background case prior to assigning the managerial accounting case.

[3] The case narrative was stable over the three-semester period in which survey data was conducted. Following suggestions by the reviewers, additional discussion questions related to automation (discussion question 6) and metal price volatility (discussion questions 4.e., 5.c. and 7) were added to the case in the most recent semester as in-class discussion questions. We chose to keep the survey questions stable rather than add additional questions to maintain comparability of the survey results.

Discussion topic	Approximate time	Activity
Overview of the Scrap Metal Recycling Industry and Atlas	15 min	Discuss and describe the operations at Atlas and place the company in the value chain. Identify the opportunities and risks faced by Atlas. Show videos on scrap process: • *Car recycling process*, Recycle Aid video shows the overall process of automobile recycling; http://www.recycleaid.co.uk/car-and-vehicle-recycling/1221/ • *Schnitzer Recycling* process video shows a scrap metal shredder and separation process in operation; http://www.schnitzersteel.com/metals_recycling_process.aspx
Contribution and gross profit for steel	10 min	Calculate contribution and gross margin for steel. Discuss how overhead allocation impacts gross margin.
Contribution margin of domestic and international processors for mixed metals	30 min	Calculate the contribution margins for each processor. Discuss why the cost functions (labor, shipping, etc.) differ. Discuss why the revenue for the recovered metals varies due to local stage of development, supply and demand. Identify most-likely trading partner given current market conditions.
Atlas' options to sell or process-further	30 min	Discuss and calculate opportunity costs. Compare labor-intensive hand sorting and automation cost structures. Discuss commodity revenue risk.
Conclusion	10 min	Discuss final recommendations, role of the data, how economic data is volatile, and that the decision will likely need to be revisited as economic conditions change.

Fig. 5. Teaching plan for Atlas managerial accounting case.

achieving the learning objectives. Students reported spending an average (median) of 4.9 (4) hours preparing the case with a low of one hour and a high of 17 hours.[4]

The survey attempted to measure students' understanding of managerial accounting concepts by asking students to identify factors that are relevant for calculating contribution margin, for determining the highest price a buyer is willing to pay for direct materials, and for determining whether or not to process a product further. These results are summarized in Table 7 (N = 139). Students scored well on the question related to calculating contribution margin. Product revenue was correctly identified as a relevant factor for calculating contribution margin by 95% of students, and variable costs including direct materials, variable manufacturing, direct labor, and variable selling costs were correctly identified as relevant factors by 52%, 74%, 59% and 83% of survey respondents respectively. Fixed salaries for staff and common advertising costs were correctly identified as irrelevant factors by 88% and 91% of survey respondents.

Students were asked to identify relevant factors for determining the highest amount a buyer is willing to pay for direct materials. The buyer's revenue for the finished product, the buyer's variable costs including direct labor and shipping were identified as relevant factors by 71%, 82% and 72% of survey respondents. The seller's production costs and depreciation were correctly identified as irrelevant by 67% and 48% of students. Students were less clear on whether or not the seller's production costs were relevant or irrelevant. In the future, this could be a point that could be better emphasized in the case discussion.

Students were asked to identify relevant factors for determining whether to sell a joint product as is or to process it further. The revenue for the unprocessed product, the revenue for the processed product, and the additional processing costs were correctly identified as relevant factors by 74%, 79% and 76% of survey respondents. The depreciation and allocated overhead were correctly identified as irrelevant by 74% and 72% of students. Students were less clear that the revenue from the original product, the joint processing costs and the contribution of the original product were irrelevant, with only 40%, 52%

[4] One student reported spending 30 hours preparing the case and two students reported spending zero hours on the case. These observations were considered outliers and were removed.

Table 7
Students correctly identifying relevant and irrelevant factors in the analysis.

	% Correctly identified as		
Factors for calculating contribution margin:	relevant	or	irrelevant
Product revenue	95%		
Fixed salaries for staff	15%		88%
Direct materials costs	52%		
Variable manufacturing cost	74%		
Direct labor costs	59%		
Common advertising costs for multiple products			91%
Variable selling costs	82%		
Factors for determining the highest amount a buyer is willing to pay for direct materials:	relevant	or	irrelevant
The buyer's revenue for the finished product	71%		
The buyer's labor costs for processing the direct materials	82%		
The buyer's depreciation & amortization on equipment used to process the direct materials			67%
The seller's cost to produce the direct materials for the buyer			48%
The cost of shipping the direct materials from the seller to the buyer	72%		
The seller's depreciation expense			87%
Factors for the decision to sell product Y as is or process product Y further to product Z:	relevant	or	irrelevant
Revenue from the original manufactured product (product X)			40%
Revenue from the by-product as is (product Y)	74%		
Revenue from the processed by-product (product Z)	79%		
Joint costs of producing products X and Y prior to the split-off point			52%
Costs of additional processing to convert product Y to product Z after the split-off point	76%		
Depreciation and amortization of the processing equipment			74%
Contribution margin of joint-product (product X) prior to the split-off			58%
Allocated fixed manufacturing overhead			72%

and 58% of students correctly identifying these factors as irrelevant. In the future, this could better be emphasized better in the case discussion.

Through the survey, students rated the case's usefulness for increasing their understanding of the following concepts: (1) determining contribution margin, (2) applying contribution analysis in a decision context, (3) determining relevant costs and revenues in a decision-making context and (4) determining a range of acceptable prices for both a buyer and a seller. The survey used a 5-point scale, where one indicated the case was "extremely useful," three denoted the course project was "moderately useful," and five indicated the case was "not useful at all" for increasing their understanding of the concept. Between 83% and 85% of the students perceived the case as at least moderately useful for developing their understanding of these concepts. These results are summarized in Table 8.

The survey also asked students to describe the most interesting aspect of the Atlas case. Themes that emerged were that students thought it was interesting to make the decision and that students liked how the case integrated the course concepts and applied those concepts to a realistic scenario. Representative responses included the following:

- "I thought seeing all the concepts being applied to a real-life situation was pretty interesting. It helped show how these concepts can be used in real life."
- "I enjoyed having a real application for the accounting we have learned. We had to apply all concepts from beginning to end, which I felt was beneficial."
- "I thought it was really interesting to be able to make all the calculations and be able to make a recommendation for Atlas. It was neat to be able to see the whole process through and have the evidence to back up for your recommendation."
- "It was just interesting to actually go through a problem that we could apply to a real life situation. It just felt like the analysis that we were doing would be something we might do in the future."
- "The most interesting part was trying to fit all of the pieces of the case together in order to provide an analysis of the business and what route the business should take."

Students were also asked to provide suggestions for improving the case. Students suggested that more structure for the assignment such as intermediate deadlines for the groups would have been helpful. A few students also expressed difficulty with working in teams and suggested implementing a peer review process. Given that the case was piloted in an introductory course, more guidance on how to approach cases and group work is likely warranted.

Appendix B provides a grading rubric that can be used by instructors evaluating written reports. Recommended solutions for the discussion questions and an Excel file containing the calculations can be obtained by contacting the corresponding author (sdgrimm@stthomas.edu).

Table 8
Students' perceptions of the case and their learning.

	Usefulness scale:				
Concept	Extremely		Moderately		Not
Determining contribution margin	13%	36%	35%	14%	2%
Applying contribution analysis in a decision context	17%	39%	27%	15%	2%
Determining relevant revenues and costs in a decision context	17%	35%	33%	13%	2%
Determining a range of acceptable prices for a buyer & seller	19%	30%	35%	14%	2%

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Appendix A. Survey instrument

1. Do you consent to participating in this survey?
   Yes or No.
2. In calculating contribution margin of a product the following factors are relevant:
   - Product revenue
   - Variable selling costs
   - Fixed salaries
   - Direct material costs
   - Variable manufacturing overhead
   - Direct labor costs
   - Common advertising costs for multiple products
3. In determining the highest amount a potential buyer is willing to pay for direct materials, the following factors are relevant (select all that apply):
   - The buyer's contribution margin for its finished product
   - The buyer's revenue for the finished product
   - The buyer's labor costs for processing the direct materials
   - The buyer's depreciation and amortization on equipment used to process the direct materials
   - The seller's cost to produce the direct materials for the buyer
   - The cost of shipping the direct materials from the seller to the buyer
4. A company is in the business of manufacturing product X. A by-product of the manufacturing process is Product Y. Product Y can either be sold as is, or processed further in to Product Z. The company is determining whether or not to sell the by-product as is or to process it further. Identify which of the following factors are relevant to the company's decision (select all that apply):
   - Revenue from the original manufactured product (Product X)
   - Revenue from the by-product as is (Product Y)
   - Revenue from the processed by-product (Product Z)
   - Joint costs of producing Products X and Y prior to the split-off point
   - Costs of additional processing to convert Product Y to Product Z after the split-off point
   - Depreciation and amortization of the processing equipment
   - Contribution margin of joint-product (Product X) prior to the split-off point
   - Allocated Fixed manufacturing overhead
5. To what degree did this case help you to understand the following concepts (select all that apply):
   - Determining contribution margin
   - Applying contribution analysis in a decision context
   - Determining relevant costs and benefits in decision making
   - Determining a range of acceptable prices for a buyer and a seller in a transaction
6. Approximately how much time did you spend preparing your analysis for the case (in hours)?
7. What was the most interesting aspect of the case to you?
8. Please provide any additional comments on the Atlas Scrapyard Case that you think could help me to improve the assignment for future students.

Appendix B. Case report rubric

Category	Low range	Mid-range	High range
Executive Summary that provides a clear recommendation for the company on whether to sell or process further the mixed non-ferrous material.	Provides unclear recommendations on the decision, and / or lacks a summary of the analysis that supports the recommendation.	Provides a clear recommendation with a weak preview of substantiating analysis.	Presents an appropriate and clear recommendation with a preview of the analysis supporting the recommendation.
An overview of the steel and mixed metal reclamation business at Atlas that discuss the company's products, customers, and operations, to help the management team better understand Atlas' current position in the industry.	Provides a shallow overview of the industry and company.	Provides some overview of the industry and company.	Presents a clear overview of the industry and Atlas' business by describing the industry and the company. Clearly demonstrates a strong grasp of the industry.
A discussion of the most important internal and external opportunities and risks that will contribute to the company's success, to help the management team better understand Atlas' options.	Identifies one to three opportunities and risks.	Identifies two to three opportunities and risks. Does not provide substantial analysis on the implications of these risks and opportunities for the company.	Identifies three to five opportunities and risks that affect the company's decision making. The analysis clearly identifies how these risks and opportunities affect the company.
A discussion of your recommendation to the management team on the sell-or-process-further decision. That is, let the management team know why Atlas should seek new customers for the mixed non-ferrous material, or process the mixed non-ferrous material inhouse using skilled labor or automation.	Provides a recommendation that is inconsistent with the quantitative and qualitative analysis.	Provides an appropriate recommendation, with some support from the quantitative and qualitative analysis.	Synthesizes the analysis to provide an appropriate recommendation that is supported with the quantitative and qualitative analysis. Clearly identifies why the recommendation is appropriate and identifies any caveats to the recommendation.
A discussion of the company's current cost allocation system and a recommendation to either maintain the current allocation system, or to update the cost allocation system to allocate costs to steel and mixed metals based on relative fair value.	Provides an unsupported opinion on the cost allocation system the company should use.	Provides an opinion on the cost allocation system with some explanation of the strengths and drawbacks of the cost allocation systems.	Provides an appropriate opinion on the cost allocation system that is supported with examples of why the proposed system is beneficial for managerial decision making (e.g. by contrasting the data provided by the proposed cost allocation systems). The analysis also clearly discusses the strengths and drawbacks of the proposed cost allocation system.

Appendix B (*continued*)

Category	Low range	Mid-range	High range
Writing style, organization, tables.	The paper is difficult to read. It lacks headings, appropriate grammar and flow.	The paper is easy to read. It contains clear headings and generally uses accurate grammar.	The paper is very easy to read. It is written in one voice, contains clear headings, and uses accurate grammar. All technical data is presented clearly in tables that are appropriately labeled and referenced.

Appendix C. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jaccedu.2020.100660.

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