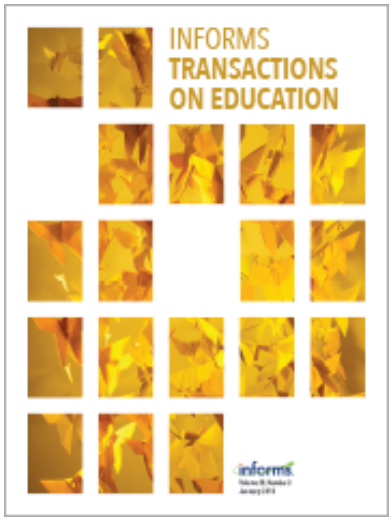

INFORMS Transactions on Education

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

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To cite this article:
John Maleyeff, Canan G. Corlu (2021) Stickley Adhesives. INFORMS Transactions on Education 21(2):101-107.
https://doi.org/10.1287/ited.2019.0231cs

http://pubsonline.informs.org/journal/ited

INFORMS TRANSACTIONS ON EDUCATION
Vol. 21, No. 2, January 2021, pp. 101–107
ISSN 1532-0545 (online)

Case

Stickley Adhesives

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Received: June 17, 2019
Revised: October 25, 2019
Accepted: December 13, 2019
Published Online in Articles in Advance: September 25, 2020

https://doi.org/10.1287/ited.2019.0231cs

Keywords: service operations management • process improvement • lean principles • simulation • capacity

Analysis

Pasquale "Cocoa" Martinez began reviewing his Operations Management course notes in preparation for his first big project at Stickley Adhesives. A recent graduate of Boston University's Metropolitan College, Cocoa had just been hired to be an operations analyst at a Stickley facility in Puerto Rico. Cocoa holds an undergraduate degree in biology and a Master's degree in applied business analytics. This project requires him to analyze capacity requirements for a newly designed service system. Stickley's customers use this service when they are unsure of how to take advantage of Stickley's extensive product line. This *applications service* supplements product sales and is an important component of Stickley's business strategy. In fact, Cocoa's work will be the last in a series of analyses on which a project team of scientists and consultants has been working during the past year. When Cocoa asked why a relatively inexperienced analyst should take on this role, he was told that the project's budget did not include money for a more experienced outside consultant, and in any case, the analysis should not be too difficult.

Company Background

In the early 1910s, Gerald Stickley and his cousin (Dean Happ) began experimenting with making glue for various bonding applications. Gerald, an enthusiastic science student finishing the 11th grade, had just learned that the protein collagen was used to make glue. Living on a farm in Kansas, Gerald's interest was piqued because collagen, contained in connective animal tissues, was abundant on his family's farm. After Dean went off to college, Gerald continued to work on his experiments while assisting with his farming chores. On graduation from high school, he continued to work full time on the farm while taking on an increasing number of responsibilities for both the operation of the farm and the business of farming.

The severe drought of the 1930s and the subsequent economic depression forced Gerald and his family to abandon farming and move to the city of Wichita, Kansas. There, Gerald took a series of low-paying jobs. He supplemented his meager income with sales of glue products. Once the economic situation improved, sales of Stickley Glue increased, and eventually Gerald opened a small factory to make glue products. Over the years, glue production transitioned from the use of animal products to synthetics, and in 1975, the name of the company was changed to Stickley Adhesives. Gerald Stickley died in 1978, and the company was sold to an international corporation, Congisto A/S. Congisto has maintained the brand name Stickley Adhesives because of its excellent reputation for high-quality products that can be used for a multitude of bonding applications.

The Stickley Adhesives division of Congisto A/S employs 6,000 people worldwide. They include about 900 scientists, engineers, and technicians who are devoted to the development of new adhesive products and the support of customers using existing products. Because the majority of Stickley''s customers are not familiar with the science of adhesives, Stickley offers numerous support services. These support services include troubleshooting, equipment rental, and applications consultation, which are considered by Stickley management to be a key source of its competitive advantage and the reason Stickley can charge a premium for its products. Although its headquarters remains in Wichita, Stickley's design, manufacturing,

and support functions are located at various U.S. and international locations. It has customers located in the Americas, Europe, the Middle East, and Asia.

Applications Service Operations

Cocoa's project concerns Stickley's applications service. This service responds to requests from customers who wish to know the best adhesive product to use for a specific application and the recommended application characteristics. These characteristics could include the amount, the recommended cure time, the holding (or clamping) pressure, and other factors that affect the quality of the resulting bond. Examples include bonding requirements for products such as medical (e.g., syringes), personal (e.g., cosmetics), acoustics (e.g., speakers), and automotive (e.g., engine hoses). Often, the materials used or the conditions under which the bond must hold are unusual or extreme. For example, a manufacturer may wish to bond a rubber hose to a specialized metal alloy in an automobile engine with extreme temperature variations, excessive vibrations, and oily or dirty conditions.

The service also includes recommendations regarding the equipment needed to achieve a high-quality result. Both standardized equipment (such as dispensing setups and ultraviolet curing systems) and customized equipment may be needed by customers. Customers who do not own their own equipment may rent or purchase the equipment from Stickley (they usually start by renting the equipment with an option to purchase later). Currently, the applications service is decentralized, with each region performing its own analyses for regional customers. Each region charges customers for the service in different ways, in some cases offering the service free of charge for some or all customers. In every region, the system makes extensive use of scientists, engineers, and technicians to study each application, run experiments, analyze experimental results, and report results to customers.

Recently, Congisto's management became aware of complaints from both customers and Stickley's staff regarding the operation of the applications service. A Lean Six Sigma project found that the number of *reapplications* (i.e., requests concerning applications that had already been evaluated but did not succeed) had increased substantially. The root causes were found to include many inconsistencies in the operation of the applications service across the global landscape. Many of these inconsistencies did not appear to be especially new. However, requests have become more complex, and expectations of Stickley's customers have increased as the service has become more popular. Finally, Stickley's technical staff complained of having multiple job responsibilities with conflicting incentives. As a result, the decision was made to centralize the operation of the applications service.

Part A: Centralization of the Service

The new applications service system will centralize applications services operations while taking advantage of scale economies and low labor costs when sensible. It will use new information technology (IT) systems that will allow for the transmittal of information over great distances. The system design is complete, and the anticipated operational challenges have been addressed. The only remaining questions concern its capacity requirements and the revenue model (whose determination will be made by corporate finance after Cocoa's analysis).

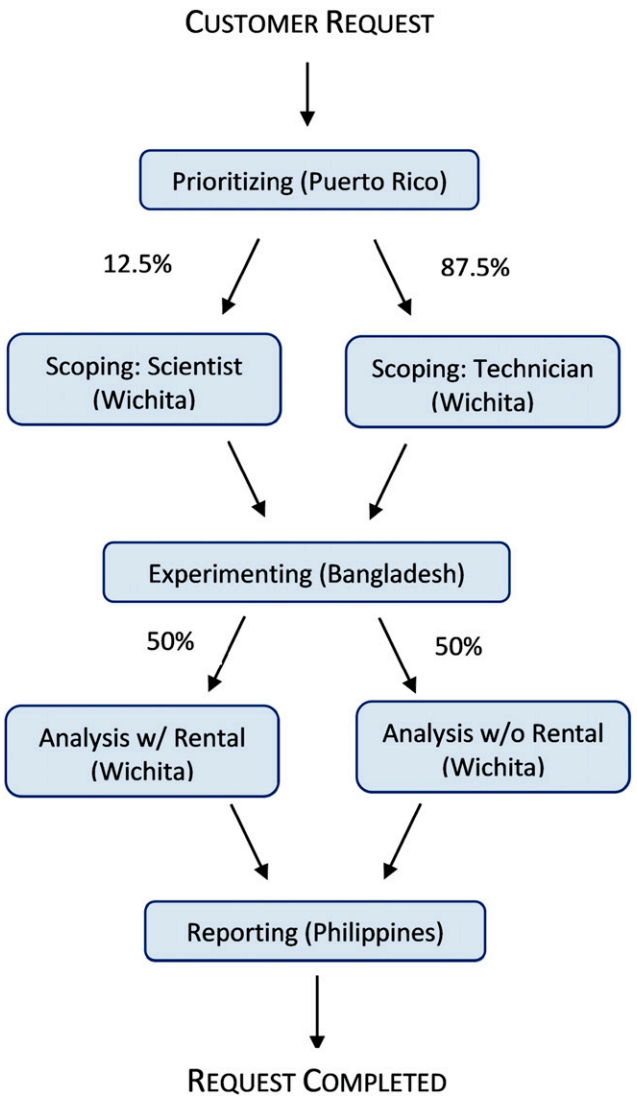
The service will be available 7 days a week; its process flow is shown in Figure 1. It is anticipated that an average of 24 customer requests will be received on a daily basis and that the number of requests per day will vary. Analysis of worldwide demand data indicated that there would be no differences in the average demand across days of the week. Daily demand is expected to vary from 14 to 34 requests, uniformly distributed across this range.

Every customer request will be received on a standard form originating from the company's website. The first process, prioritizing, consists of an expert evaluation. It determines if the request represents a project that should be handled by a scientist or a technician. Prioritizing will take place in Puerto Rico (down the hallway from Cocoa's office). On average, each worker can prioritize an average of 12 requests per day, but the actual number of requests each day varies depending on their complexities.

Once prioritizing is completed, the request is sent to the scoping process. Like all other transitions, the IT system will process transactions at the end of each day. Hence, the output from each process will be ready at the next process on the following day. Based on past scoping requests, about one in eight (12.5%) requests need to be handled by scientists, with the remainder handled by a technician. A scientist can scope an average of three requests per day and a technician can scope an average of seven requests per day. Again, the actual number of requests per day will vary. Scoping will be performed at the U.S. headquarters in Wichita.

After scoping, each request is sent to the experimenting process. This process will be performed by engineers located at a Stickley subsidiary located in Bangladesh (at a facility known to have the best-quality results in the decentralized system). Here, each worker can complete an average of six requests per day. After the experiments are complete, requests are sent for analysis. The analyzing process is performed at the research and development (R&D) facility in Wichita. About half of the requests need equipment rental (which requires design of the equipment system and price determination), and workers

Figure 1. Applications Service System Process Flow



performing these analyses can complete an average of two requests per day. The remaining half do not require equipment rental, and workers performing these analyses can complete an average of six requests per day.

Finally, the last process in the applications service system is reporting. This process will take place at a Stickley subsidiary located in the Philippines. Workers at this facility can complete an average of eight customer requests per day. As with the other processes, the actual number of requests completed will vary by day.

The characteristics of each process including location, average completions per day, and *fully loaded* labor costs per day are shown in Table 1 (fully loaded labor costs include allocations for benefits and other overhead expenses).

Service System Simulation

During earlier phases of the project, a consultant developed a Monte Carlo simulation of the proposed system. Cocoa will make use of this simulation in his analysis. He is informed that the simulation is accurate, and no changes will be necessary to its internal logic. It simulates 30 days of operation based on the structure and parameters described previously. Users must enter the number of workers assigned to each process. Each iteration of the simulation will mimic 30 days of operations. By running the simulation repeatedly, users can observe the variation in throughput (completed requests at the end of 30 days) and other process characteristics.

A video has been prepared by the consultant describing the use of the simulation in detail. Cocoa is advised to watch the video before answering the analysis questions posed to him.

Part A: Case Questions

1. Calculate the number of workers that would be assigned to each process so that the average capacity of each process (requests per day) is equal to the average demand for the applications service (i.e., 24 requests per day). This result will load the service system with a capacity buffer of zero for each process (i.e., 100% planned worker utilization).

2. Using the number of workers calculated in Question 1, run the simulation for forty 30-day periods and summarize these results statistically using two or more numerical summaries and at least one display. Explain the meaning of each numerical summary and display.

3. In one to two paragraphs (about 200 words), summarize your results from Question 2. Include reference to all interesting findings and the displays and other results. Describe each result; do not simply list or refer to the information presented in Question 2 without explanation.

Table 1. Process Characteristics and Locations

Process	Location	Average capacity per worker (customers/day)	Labor cost per worker ($/day)
Prioritizing	Puerto Rico	12	125
Scoping: scientist	Wichita (U.S.)	3	400
Scoping: technician	Wichita (U.S.)	7	250
Experimenting	Bangladesh	6	75
Analyzing without rental	Wichita (U.S.)	6	300
Analyzing with rental	Wichita (U.S.)	2	350
Reporting	Philippines	8	50

4. Analyze the applications service system by running the simulation repeatedly while adjusting the number of workers (i.e., the capacity buffer) to determine how best to allocate workers to each process. Use only whole numbers of servers (1, 2, 3, etc.). Show your key results in tabular form or as a display. Remember that you must run the simulation for multiple iterations to minimize the effect of random variation on your simulated results.

5. Make a final recommendation for the number of workers to assign to each process. Justify your recommendations using one to two paragraphs (about 200 words).

6. List and describe three problems that may occur if the centralized system was implemented. There is no need to solve the problems. Justify your reason for believing that the problem may occur. Use at least one reference citation to support each of your potential problems.

Part B: Service Process Improvement

The implementation of the centralized application service system at Stickley Adhesives is complete. The new globally dispersed system is managed from Stickley's worldwide headquarters in Wichita, Kansas. The system leverages new information technologies that allow for instantaneous communication of customer and service provider information across great distances. Process activities are located where Stickley already has a presence, with workers experienced in various aspects of the applications service. Costs are minimized by locating each service process where the combination of worker skill and labor cost is optimized. Finally, inconsistencies in the fee charged to customers have been removed. Now, customers do not pay a fee for the service unless they would like expedited service. In these cases, a fee is applied based on the nature of the project. The new centralized system is shown in Figure 1, with process locations and current percentage of workflow through the various processes.

The new system was expected to reduce variability that had existed when the service was offered in a decentralized manner. Previously, in the old system, each region (Table 2) had an applications service that independently served its region. The system evolved this way in response to the international expansion of Stickley's business. At the time, management believed that each region had unique features that necessitated their independence. For example, expanding outside of the United States and Canada increased the number of spoken languages, and the prevalence of regulations within the European Union (EU) necessitated separation of EU versus other European counties.

However, there were many inefficiencies associated with six clearly similar service systems, which motivated the need for a more centralized approach. The centralized system enforced a higher level of standardization, which was consistent with Stickley's Lean approach in its manufacturing and service processes.

Table 2. Regions Served by Stickley Adhesives

Region	Main countries
America	United States, Canada
Western Hemisphere	Mexico, Brazil, Argentina, Uruguay
EU Europe	Germany, United Kingdom, France, Italy
Non-EU Europe	Russia, Switzerland, Norway, Turkey
Middle East	Israel, Iran, Kuwait, Egypt
Asia	China, Japan, Korea, Australia

Stickley's management was well aware that the applications service was a key feature of their industry-leading service model. They were confident that centralizing the system would improve their strategic and competitive advantage in the global market.

Implementation

The centralized system was implemented after a one-year trial period, which included training of personnel and IT system development. As expected, the first six months of operation included a lot of *hand holding*, with duplication of effort and significant travel of experienced technicians and scientists to the various locations. Although many Stickley employees were not thrilled with the travel, most understood its necessity. As one technician, Rajiv Patel stated, "It was interesting meeting Stickley technicians around the world and seeing different approaches to doing our type of work. I learned a lot from the experience. And, I was able take my family to Hawaii with my frequent-flier miles!"

Under the new system, a customer request is made based on proposal content guidelines shown in Table 3. It includes information about the requestor, the customer, the application (including materials to be bonded), strength and other quality requirements, application-specific conditions (such as where and how the adhesive would be applied), the operating environment (under which the bond must hold), and any other unusual or important considerations.

After the first six months of operation, the system's performance was monitored more passively using customer and service provider surveys. These open-ended surveys were focused on asking for honest feedback on both the pros and cons of the new system. The service providers were also asked to report any mistakes and other wasteful practices (such as delays, rework, or miscommunications) that they witnessed. Management was clear in its message that personnel were required to report these issues and that they would not be punished for making a mistake. According to management, who following the philosophies of W. Edwards Deming, the system is responsible for almost all of the problems, especially a new system like this one. Therefore, workers would not be blamed when mistakes occurred.

Table 3. Proposal Content

Category	Content
Customer information	Requestor name (and organization), with contact information
	Stickley representative (if any), with contact information
	Proposal submission date
	Project final deadline (last date before project irrelevant)
Problem to be solved	End product description (indicate if new or existing, and include description/photos)
	Current problem description (bonding application), including impact (i.e., cost) of the problem, including scarp costs
	Description of substrates to be bonded, including materials, assembly method, goal cycle time, application environment (e.g., conditions, temperature, humidity, vibration, etc.)
Performance criteria	Quality specifications, including strength, appearance, bond gap, and any other important considerations
	Cost requirements, including direct labor, indirect labor, energy, adhesive, materials, equipment, etc.

Issues and Challenges

After reviewing the surveys and list of mistakes, it was clear that the new system included many *growing pains* and that management underestimated the challenges in operating a global service system that included significant IT development in an extremely diverse setting. Some of the more significant challenges that remain are discussed. They are separated into three categories: proposals, communications, and business-related issues.

Issues with Proposals. Although the content of each proposal is specified, a great deal of variation still exists in the proposals that are submitted to the prioritizing process. An audit indicated that only about 20% of the proposals included all of the information necessary for a thorough analysis. Most proposals lacked one or more types of information. Forty percent lacked detail on the impact of the current problem to the customer. Thirty-five percent of proposals included incorrect information because of the inexperience of the customer making the request. These and other problems necessitated frequent callbacks to the requestor and delayed work progress.

To begin addressing this problem, James Sorenson (global laboratory director) was asked about these problems and was quoted as follows:

> The applications service system is used for three different purposes. First, it is used by our customers and sometimes by a competitor's customer who is having a problem with an existing adhesive. Second, it is used by our customers who are concerned that a modification to an existing product may affect its adhesion. And, third, it is used by an existing or potential customer who has an idea for a new product requiring an adhesive application. Guidelines for each requestor are provided on the applications service web site. The web site includes an online portal where requests are submitted (those entering information can use any format they desire). Staff at the prioritizing process in Puerto Rico use this information to start their work. Today, this activity starts by confirming customer information, verifying accuracy of contact information, logging the details of the request, and determining if the work needs to be done by a scientist or technician. If they have questions or need clarification, they will contact the request directly by e-mail. About 70% are requested by existing customers, and 30% of requests are made by new customers. New customers will often contact a member of the sales team, who will review the request and submit it to the applications service online portal. Many new customers contact the Stickley Worldwide call center (located in Delhi India), who provide the application service web site information to the caller. For existing customer requests, about half concern troubleshooting and about half concern new or modified designs. Requests for modified designs often concern design changes that potentially affect adhesive bonding. Existing customers will often contact a technical service engineer who will review the request and submit it to the applications service on-line portal. Some existing customers submit their request directly to the applications service online portal, while others (who are new to the applications service) may contact the Stickley call center, who provide the application service web site information to the caller.

Other details that may be relevant are also provided. They include issues relating to the following:

Incomplete Information: Many customers and Stickley staff who are inexperienced in the system included irrelevant or incomplete information. One feature of importance is substrates (i.e., the portion of the part that makes contact with the adhesive). For example, they did not indicate the surface roughness or substrate flexibility specifications, both of which are key to successful bonding. Many customers failed to account for all relevant end-product (i.e., the final product that includes the bonded parts) information, such as packaging, warehousing, or other inventory-storage information.

Gaming Requests: Many customers specified deadlines that were much sooner than actually needed. These customers were attempting to save money by not paying for expedited service. Also, members of the sales team often requested work on behalf of potential customers even when it was unlikely that this customer would purchase adhesive products from Stickley. Because the service was free of charge, sales staff felt no need to save the company from incurring unnecessary cost in hope that they would receive a potential sales commission.

Wasted Scientist/Technician Time: The prioritizing process often failed to detect problems with requests. Different prioritizing personal used inconsistent criteria for assigning scientists or technicians. In these cases, the scientist or technician would need to return the request to prioritizing with a note indicated what they thought was wrong. Some scientists and technicians saved time by reaching out to customers or sales force themselves. This was time consuming, and usually the corrections were not logged in the system because the prioritizing process never heard about the change. The lack of documentation had effects when future requests from the customer were made, such as incorrect history of prior project technical details.

Issues with Communications. Many instances have been noted where communications have proven to be the source of problems. A significant number of problems appear to be rooted in language and cultural differences. For example, a customer in China (native language, Mandarin) may be requesting a project that will be prioritized in Puerto Rico (native language, Spanish), scoped in the United States (native language, English), with experiments performed in Bangladesh (native language, Bengali), and a final report written in English in the Philippines (native language, Filipino). The service system itself spans four time zones, with the all-important scoping process located at about a 12-hour time difference from a Chinese customer. Some specific problems related to communications are indicated as follows:

Stickley Call Center: Customers contacting the Stickley call center in India with issues that may require the applications service are not always routed to the applications service. For example, sometimes the call center representative simply tells the caller that they cannot be helped. At other times, callers are instructed to call the application service center, even though there is no way to contact the applications service system by telephone. At other times, customers who need services other than those provided by the applications service are instructed to put a request into the applications service website portal. It has always been clear that retention and training at the call center is critical to productivity and caller satisfaction. Lately, turnover of employees at the call center has been unusually high.

Final Reports: After the experiments are done and the results analyzed, final reports are written in the Philippines and e-mailed to customers. These reports contain very important information regarding how the adhesive is applied and cured. Although customers have always needed to contact report writers with questions, there has been a 60% increase in the rate of these follow-up questions after the centralized system was implemented. This back-end issue is exacerbated in the centralized system because report writers in the Philippines need to get many of the questions answered by contacting the analysis process personnel in Wichita, whose time zone is 14 hours behind them. As stated by Michelle Cranberry, who oversees report writing:

> These problems were anticipated, so the implementation included electronic laboratory notebooks, where the notes written by scientists and technicians were directly imported into final reports. Although this effort helped streamline the process in the Philippines, there appears to be a problem with jargon especially regarding terms and phrases that customers do not understand. In fact, many report writers do not fully understand the content of final reports. For example, U.S. staff may use a local idiom, such as when they stated that a project was 'dead in the water,' meaning it had little hope of succeeding. They also use some American-based expressions. I remember one instance where the scientists listed instructions on clamping a part, indicating that a certain step was not a 'hard and fast rule' meaning that it was not entirely necessary. Because we deal with material hardness and curing time, hard and fast was interpreted as an instruction concerning the materials and clamping time. They also overuse western business slang, such as one project where the report indicated that they needed to 'circle back,' meaning to start again. This was not understood by report writers and customers. Finally, educated scientists tend to use unnecessary complex words that a non-English speaker may be unaware of, such as instructing them to 'grasp the part' instead of a simpler 'hold the part' or 'pick up the part').

Business-Related Issues. Choosing and prioritizing projects based on business needs remains a challenge, even after the centralization of the applications service system. It is difficult to precisely define and quantify business impacts. For example, consider working on a project for a potential new customer that currently buys adhesive from a competitor. In the short term, this project may be unwise, but it could create positive goodwill that will lead to the same customer buying Stickley adhesives in the future. Along with issues related to Stickley's business needs, sometimes projects are chosen that would not benefit the customer. For example, there may be less expensive ways to achieve the same result without using an adhesive product. As designed, the applications service would not identify this potential. Other business-related issues are noted as follows:

Loss of Authority and Control: The technical staff at each regional location feels that they have lost the ability to exercise local discretion and that local market forces and cultural differences are not taken into account. For example, it appears that the newer Asian market is more price sensitive than the more established EU market. Regional general managers agree that they would like more control within the application system's operation. It is also felt that this lack of control has affected their ability to be competitive and address local market conditions.

Limited Career Opportunities: Traditionally, the best jobs at Stickley have been in the R&D division. Chemists and chemical engineers are hired to create new adhesive formulations and increase the application of existing formulations. Those holding Master's degrees are typically assigned to be scientists, whereas those with a Bachelor's degree have positions as a technician. When the applications service was initiated about 15 years ago, it was staffed by many scientists and technicians who were recommended by R&D managers. Managers used this opportunity to replace underperforming employees. Even though the applications service is now an important element of Stickley's business model, its scientists and technicians remain disrespected within Stickley's professional community. Hence, there is limited career advancement for those working in the applications service system.

Technical Joy: Some scientists and technicians do not understand business needs and spend too much time on interesting technical challenges. For example, a technician may attempt to use the latest version of an adhesive when earlier (and less expensive) alternatives were available. Hence, by not appreciating the customer's main concern and Stickley's business, they tend to work on projects in ways that make their professional life enjoyable. Often, *elegant* solutions (those with new adhesives applied using the latest technologies) are given priority over more practical solutions that make more sense to the business.

Plans Going Forward

Solving the problems described previously is a priority for Stickley Adhesives. However, leadership has stated that any solutions offered must conform to the following rules:

1. The centralized system as shown in Figure 1 must remain as-is;
2. The locations for each process within the system must remain as-is;
3. No additional IT or software will be considered; and
4. No modifications to existing IT and software will be considered.

Case Questions for Part B

1. Create a process map for the front of the application service, starting from the customer with a potential issue needing to be resolved and ending with the prioritizing process. Make use of the information provided by James Sorenson and other information included in the case document. Make any assumptions necessary to complete the process map and be sure to include all key activities, routes (flows) through the process, and places where mistakes, delays, and other wasteful activities occur.

   a. List the value-added activities that take place in this portion of the service system.

   b. List six non–value-added (i.e., wasteful) activities that take place in this portion of the service system.

2. Make three recommendations for improvements, using Lean methods to solve issues or challenges discussed in the case study. One recommendation should apply standard work, one recommendation should apply the 5 Ss, and one recommendation should apply poka-yoke. The following parts of the system should be addressed:

   a. One recommendation to solve a front (before prioritizing) issue or challenge: pay close attention to the statement by James Sorenson and other details in the case.

   b. One recommendation to solve a back (reporting) issue of challenge: pay close attention to the statement by Michelle Cranberry and other details in the case.

   c. One recommendation to solve another issue or change of your choice.

Each recommendation should be very specific, including a sketch, step-by-step procedure, revised process map, or other display illustrating the idea. Your detail should be sufficient for Stickley management to make an informed decision whether to accept your recommendation.

Acknowledgments

We thank John Cocco for valuable feedback.