Addenda

We made the following changes to the RFP, as listed in order of appearance.

1. Photos were added throughout the RFP to aid understanding of the problem, and therefore the same photos which were in Appendix C before were removed to avoid redundancy. Instead, CAD drawings of the whole system were added to the Appendices.
2. Some terminology relating to "Reliability", and Appendix A, was eliminated, as "Reliability" was eliminated due to lack of adequate measures and criteria.
3. In section 3.1, The dictionary definition of community was replaced with a group definition. This change was made as per lecture regarding the uselessness of dictionary definitions.
4. Section 3.2, engagement with the community. This section was reworded to make it appear as more of a summary instead of a narrative. The reason for this change is comments made on the RFP that suggested the narrative structure of the section did not work in the RFP.
5. Sections 5.1/5.3were merged into a single section, so as to explicitly link the problems faced and their consequences. 5.2 was eliminated in order to connect 5.1 and 5.3. 5.2 was also redundant.
6. Problem 4 was split into two problems, as they were referring to distinct enough issues to warrant division.
7. Formerly 5.3, Scoping the Problem section, was augmented to better match our constraints. This made it more explicit what we wanted the responding team to focus on. Specifically restricted scopings involving the laneway, as our constraint restricts changes to existing infrastructure.
8. Section 6.2, Administrative staff, we expanded the needs of the staff to include legal codes requiring them to provide a safe work environment for employees.
9. Section 6.4, Delivery Truck Driver, The needs of the delivery truck driver were expanded to incorporate why the stakeholder matters, and what matters to the stakeholder. We believed the basic description we gave was not thorough enough.
10. 7.1, High Level Objectives, The framing and objectives section was removed because it seems redundant.
11. 7.4, Criteria and Metrics, Table of criteria and metrics was added to summarize and collect the subparts of 7.4.
12. 7.4, Criteria and Metrics, DFX for reliability was removed due to a lack of credible metrics to back up our claim.

Request for Proposal

Improving The Scott Mission's Donations Processing Framework

March, 02, 2014

Abstract

The Scott Mission is a homeless shelter and soup kitchen that is unable to safely and efficiently process donations that it receives on a weekly basis. Due to limitations in the existing infrastructure for the handling of donations, the system requires excessive manual materials handling (MMH), namely the lifting and pushing of donations. As a result safety concerns have been raised for the staff. Additionally, space limitations in the current infrastructure inhibit bulk donations from being transported from the delivery trucks into the storage area located in the basement of the building as quickly as desired.

According to the Canadian Center for Occupational Health and Safety, MMH is the most common cause of occupational fatigue, as well as contributing to a third of all lost work and compensation costs in Canada [1]. As a result, Mr. Lynwood Strickland, the Head of Distribution and Food Services at the Scott Mission, has directed our team's attention to this issue. Furthermore, our team observed that it takes 5-6 employees approximately half an hour to unload one truck during an average donation processing session. Mr. Strickland has also expressed his interest in making this process more efficient from a logistical standpoint.

This RFP requests an improvement to the intake system, mainly by reducing the amount of MMH necessary to process donations and increase the overall efficiency of the system.

[1] Canadian Centre for Occupational Health and Safety, "Health Hazards : OSH Answers," 7 October 2013. [Online]. Available: http://www.ccohs.ca/oshanswers/ergonomics/mmh/hlth_haz.html.

Improving The Scott Mission's Donations Processing Framework

Table of Contents

1. Introduction

The purpose of this Request for Proposal (RFP) is to frame a challenge that The Scott Mission faces in such a way that it can be interpreted and solved as an engineering design problem. Our team has identified that the staff at The Scott Mission are unable to safely and efficiently transport donations from the inside of the delivery truck into the storage area located in the basement of The Scott Mission. The present method allows for an average truck to be unloaded in 30 minutes and requires excessive lifting and pushing of heavy boxes weighing up to 45 kg (Appendix C). (To gain a better understanding of how the system functions please see the CAD drawings in Appendix F). These recurring motions can cause repetitive strain injuries, which can lead to nerve and muscle damage [2]. Moreover, certain inefficiencies in the system cause the processing area where donations are unloaded, sorted, and stored to become crowded very quickly. This RFP will first describe the community, give a detailed account of the particular challenges that the community faces, define the stakeholders with a direct interest in finding a solution to this problem, frame the requirements for the requested solution and finally provide reference designs that we believe will exemplify the requirements in use.

Fig 1. In basement, space is tight as pallets are filled with boxes.

2. Key Terminology

Rollers: of the unpowered type, picture in Fig 1.
MMH: manual materials handling
Unloading phase: the series of events pertaining to the movement of donations from the inside of the truck to the conveyor belt.
Conveyor belt: refers to the conveyor belt that is connected to the rollers in and is clearly visible in Fig 3.
Docking station: the area at the rear of the building where donations are dropped off (see Fig 2 far right).

3. The Scott Mission, a Christian Ministry

To better understand the challenges faced in processing donations, our team must first describe the community of The Scott Mission and how this particular challenge negatively affects the quality of life of the community as a whole. This information was obtained by touring the facilities and meeting with staff members.

3.1. The Scott Mission as a Community

The Scott Mission is a Christian Ministry founded in 1941 whose goal is to give food, shelter and opportunities to those in need. They provide meals to hundreds of people every day and provide shelter for 50 men in their “Men’s Ministry.”

Our team has defined a community as comprising a group of people who have come together as a result of sharing similar interests. As a community, The Scott Mission shares the same interests in their Christian faith and desire to help those in need. This community that The Scott Mission has formed is part of the larger society of homeless shelters and food distribution services across Toronto. This community is consists of over 100 staff and thousands of volunteers who work together to provide food, clothing, daycare and hygienic facilities to those in need [3].

3.2 Engagement with the Community

Our team determined a list of challenges that The Scott Mission faces on a regular basis by talking with three members of the community. Our team held successful discussions with Ron Gardener, Trevor Smith, Manager of Volunteers, and Lynwood Strickland, Director of Distribution and Food Services. During our discussions with Mr. Strickland, he outlined numerous challenges his colleagues face and we held follow-up meetings to clarify many of the finer details in this particular set of problems. Through these discussions, our team identified the method by which donations are brought from the delivery truck into the storage facilities inside the building do not suit the needs of the community. In order to gain a better understanding of this problem, our team observed the delivery of donations on Feb. 6, which allowed us to gain a firsthand impression of the challenge that this community faces.

4. Overview of the Current System

Fig 2. From left to right; The Scott Mission's own medium-sized truck, the ramp connecting the inside of the truck into the building, and the ramp as seen from inside the building. (original photos)

Fig 3. Above left; opening into conveyor belt. Above right; conveyor belt as seen from the basement downstairs. (original photos)

The Scott Mission receives a truckload of donations at least once a week. Our team has summarized how the donations are processed as follows:

1) The donations truck drives to the loading bay behind the building (Fig 4, next page).
2) The truck backs into a chute, and a makeshift ramp is positioned between the chute and the truck to establish a means of transferring the goods from the inside of the truck to the chute (Fig 2).
   a) Boxes of food are picked up manually and slid down the ramp into an opening which is connected to a conveyor belt that leads into the basement. Some goods may be selected by the chef for use, in which case it is loaded on a handcart.
   b) The handcart is pulled into a walk-in freezer on the same floor.
3) In the basement a team of 3 staff members take boxes off of the conveyor belt and onto sorted pallets (Fig 4 right). They must wear safety belts and steel-toed boots.
4) The pallets are lifted manually and brought into storage.

Fig 4. Employees await boxes to stack onto pallets (original photo)

5) This process is repeated until all of the goods have been transported from the inside of the truck to the storage facilities in the basement. This process can also be reversed if goods need to be relocated from the inside of the basement to the upper level (the conveyor belt is put in reverse and this moves the goods up the belt).

Due to limitations in the existing infrastructure, the current method for receiving donations is insufficient to manage the large influxes of goods which are delivered in medium-sized commercial vehicles [4]. This method also requires numerous staff members to repeatedly lift and transport boxes which can cause back problems. This safety concern has been brought forward by Mr. Strickland specifically, who has expressed his desire to improve how goods are transported from the inside of the donation truck to the storage facilities in the basement. He has also stated, as a secondary concern, that he would appreciate if the system was made more efficient.

5. Problem of Donation Intake

The opportunity presented is to improve the donation intake process at The Scott Mission. This section will first focus on noted problems, discuss the consequences, and then frame and suggest different scopes of the problems and their effect on the end product.

5.1. Challenges and Consequences

A myriad of problems in the intake process contribute to safety issues and inefficiencies. The problems observed by the team are listed below in order of occurrence:

Fig 5. Scott Mission building, blue represents route of truck, yellow, alternate path for large boxes or trucks. [15] (Google Earth)

1) Semi-large trucks that are 2.6 meters in width [4] pass through the laneway adjacent to the building. This laneway is only 4 meters in width leaving very little space for manoeuvring (Appendix B – 4th meeting). Trucks that are too large to drive into the loading/unloading area must have their donations manually transported through the front door and down the elevator into the basement (Fig 5), which greatly increases the time needed for goods to be processed, and the amount of MMH.

2) Trucks that are small enough to manoeuvre through the laneway must back into the docking station so that the donations can be processed. The boxes, which are already stacked on pallets, have to be manually lifted and slid through a chute because the pallets are too large to pass through this opening. The system cannot accommodate donations larger than a maximum of 28 inches (0.7m), with at least one side less than 18 inches (0.46m) (Appendix C, Measurements), so if a truck arrives with boxes that exceed these dimensions, these must also be manually transported through the alternate route using the elevator (Fig 4), adding to processing time and MMH.

3) Boxes often collect at the boundary between the rollers and the conveyor. As a result, some boxes may fall off the conveyor if there is a sufficiently large accumulation of boxes, which exposes the staff to the safety hazard of boxes being dropped on their feet. However, this hazard is partially

mitigated through the use of steel-toe boots, so this is only a secondary safety concern. The main safety issue described in the following problem 4) should be addressed first.

4) Boxes that are carried on the conveyor belt reach a path of rollers in the basement, where 3 people must simultaneously sort and stack the boxes back onto the pallets (Fig 4). Here, we observed a bottleneck as sometimes the conveyor is stopped for the rollers to be cleared of the boxes. Conversely, there are lulls in the process where no boxes are coming down the chute and the employees are left waiting.

   The need for unwanted MMH and the compromised efficiency of the process are consequences of Problem 4. This is due to the large volume of boxes being processed (approximately 100 per donation multiplied by 4-5 truck visits per week) (Appendix C) and the large average weight of the boxes (20 kg) (Appendix C). This is an area of great concern for the staff as MMH can cause both short and long term health effects ranging from bruises, lacerations, to musculoskeletal injury, especially spinal and back pain [2]. Additionally, legal requirements and the organization's values demand a safe working environment [5].

5) Normally, to transport items from the basement into the kitchen and clothing pick-up rooms, the conveyor belt system is used in reverse. However, if donations are being delivered during "peak times" when the kitchen is at its busiest (usually at lunch or dinner), the staff is unable to utilize the conveyor belt system and must manually transport goods upstairs via the elevator or stairs. This results in unnecessary MMH. Instead of the donations simply being transported down the chute, they must instead be lifted from the basement to the elevator and then transported from the elevator on the second floor to the kitchen (all done manually). In ideal circumstances, the goods would be lifted from their pallets onto the conveyor, and then from the conveyor to the kitchen (a shorter distance requiring less carrying).

5.2. Framing the Problem as an Engineering Design Challenge

This RFP centers on discussing potential engineering solutions to the health, safety, and efficiency concerns that surround the excessive material handling required to move donations from the inside of the truck to the storage location in The Scott Mission building. In order to better the living conditions of this community, the present system of receiving donations needs to be reformulated to accommodate the volume of goods being delivered, and the needs of the staff members who are involved in unpacking and storing donated goods.

5.3. Scoping the Problem

This section addresses two possible scales of scoping of the problem.

1. The problem can be broken down into smaller problems and specific parts of the overall scheme can be focused on. This may result in the proposed solution only improving a particular facet of the overall mechanism. For example, a solution that can reduce the time required for unloading falls into this scoping category. However, certain aspects of the problem are infeasible scopes, such as changing the width of the laneway, as it violates the constraint of interfering with the existing infrastructure.
2. The scope can include the entire process of donation intake. As such, solutions that have to do with system optimization, or wholly new systems solutions fall into this category.

The choice is left to the team receiving this RFP as long as the requirements (Section 7) are met. Depending on the scoping chosen, solutions may range from improvements in the method by which goods are processed to developing a physical product.

6. Stakeholders

This section will list the stakeholders of the opportunity discussed earlier and look into how they are affected by the situation at hand. The stakeholders identified are:

1. The employees of The Scott Mission
2. The administrative staff of The Scott Mission
3. The customers using The Scott Mission's services
4. The delivery truck driver

6.1. Employees

The employees at the Scott Mission are stakeholders that directly interact with the current delivery and unloading system. They comprise the full-time staff, part-time staff, and volunteers. In this section, 'employees' will refer to any person who performs manual labour tasks and chores in the Scott Mission, in contrast to Section 5.2 where only administrative employees are discussed.

The employees are required to perform many manual labour tasks. Boxes that are accidentally dropped or mishandled by the employees may tumble down the stairs or down the conveyor belt, leading to additional labor being required from the employees, who will have to collect and reorganise the contents of the boxes.

According to our observations and our stakeholder interactions, there are times when unsorted boxes accumulate in the basement. This accumulation of boxes is a result of a disjointed transition between the donation intake system and the system in place for organizing donations. The employees who deal with the donation intake system are also responsible for sorting the donations. If the workload related to the main problem identified in this RFP can be reduced, this could also indirectly decrease the build-up of donations that are unsorted.

Any improvement to the system should primarily cater to the employees' and volunteers' needs, as they have the most direct connection to the problem. Solutions to this RFP that fulfill their needs for reduced effort while performing tasks, reduced MMH, and therefore reduced exposure to safety hazards would greatly improve their quality of life.

6.2. Administrative Staff

The administrative staff would also benefit from a solution to this problem despite not being as directly impacted by this problem as their employees. While there are some staff members who act as both administrative members and employees (as defined in 6.1), this section will only describe the interests of the administration.

The administrative staff are wary of the efficiency of the current unloading system, as they have elucidated in our meetings with them (Section 2.2). They find that the current donation processing mechanism restricts the Scott Mission from operating at their desired level of effectiveness and this problem is a burden on their delivery organization process. In addition, as directors and managers, the administrative staff are legally responsible for providing a safe work environment for their employees as stated in the Ontario Occupational Health and Safety Act [6]. Mr. Strickland too has voiced concerns about the safety and well-being of the employees he manages or oversees, supporting the primary need of the employees.

6.3. Customers

The customers who use and benefit from the Scott Mission's services are secondary stakeholders whose lived experiences are affected by the capabilities of The Scott Mission to provide goods. If an improved donation intake system is developed, The Scott Mission will be able to receive and process donations faster, resulting in more efficient delivery of their goods, and services that make use of these goods, to their customers.

6.4. Delivery Truck Driver

The truck driver does not interact with the system directly, but he/she is also a stakeholder in this problem. An improvement that decreases the time required to unload goods from the donations truck saves time for the driver as they will not have to spend as much time parked at The Scott Mission. This will provide the driver with more time to deliver goods to those in need or driving elsewhere. However, a solution that makes it more difficult for the driver to pull into the laneway or park near the docking station is not preferred, as this will potentially result in the driver needing an extended period of time to park (increasing the duration of the entire donations process) and require that the goods be transported a further distance from the truck to the unloading dock, which is undesirable.

7. Requirements for a New System

7.1. Objectives

The objectives are itemized in order of importance with the primary area of concern listed first and secondary issues listed in following. Any improvements to the system would be considered successes, however addressing concerns that are higher on the list of objectives are preferred.

7.2. High-Level Objectives

1) Should decrease the risk of injury for the staff at the Scott Mission during the transportation of donations from inside of the delivery truck into the storage facilities in the basement.
2) Should improve the efficiency of the material handling process by decreasing the amount of time required to process goods.
3) Must develop an inexpensive solution that can be integrated into the currently existing infrastructure that is already in place for materials handling.

7.3. Detailed Objectives

The following detailed objectives are summarized in order of greatest importance as described by Mr. Strickland.

1) Should decrease the amount of material handling by the volunteers and staff during the unloading phase.
2) Should decrease the amount of material handling once the donations have been received at the end of the conveyor.
3) Should limit staff from “adopting awkward and uncomfortable postures” while operating the conveyor belt as this is a common “conveyor workstation MSD risk” [7].
4) Should optimize the conditions under which manual materials handling tasks are performed during the unloading phase and at the end of the conveyor.
5) Should improve the process pertaining to the categorization, organization, and storage of materials.
6) Should develop a solution that does not make the delivery truck driver’s job more difficult than it is currently.

7.4 Criteria and Metrics:

7.4.1 Safety:

1) Decrease the number and/or duration of lifting tasks required to move the donations from the inside of the truck to the collection area in the basement of the building (Metric: number of lifts, duration of lift for extended lifting episodes). (If the number of lifting tasks cannot be decreased, optimize the lifting conditions (Metric: the lifting conditions must be within the acceptable range as specified in Appendix A)
2) Any pushing tasks should comply with the Snook ideal for maximum weight/duration of said task [7] (Appendix E).

7.4.2 Facility Utilization:

Minimize the amount of space needed in the existing infrastructure to facilitate the movement of donations to their destination (metric: percent utilization in terms of space occupancy relative to the original system in m^2 and m^3).

7.4.3 Maintainability:

Limit the number of steps required to replace or repair parts of the system and should increase the number of standardized parts used (Metric: number of steps and number of standardized parts).

7.4.4 Truck Utilization:

Limit the amount of time that the donations truck must remain parked at the unloading dock as donations are being processed (metric: time).

7.4.5 Material Functionality:

Chemical Properties: The materials used in the solution should not oxidize or corrode to the point where the material strength of the material is compromised (metric: oxidative, corrosive properties of the substance). (This design criterion was adapted from Farag's "Functional Requirements of Engineering Materials." [8])

7.5 Constraints:

1) The system must not be completely redesigned or overhauled.
2) The proposed solution must not cost more than $50,000.00 [Appendix B].
3) If the proposed solution is at all exposed to the elements, its material strength (i.e. weight supported) must not be compromised as a result of corrosion, oxidation etc.
4) Any alterations or changes to the existing conveyor belt system infrastructure must be compliant with the IRRST's (Institut de Recherche Robert-Sauvé en santé et en securité du travail) documentation on conveyor belt safety) [9].
5) The proposed solution must not decrease the width of the laneway (metric: distance in metres relative to current width of 3.94 m) (Appendix C).
6) The proposed solution must not be larger than 0.71 m in height (Appendix F) and 0.46 m in width (Appendix C) if it is attached to the conveyor. (See Appendix F for a visual representation of the space).

7) Load-Carrying Capacity: The proposed solution must not buckle under loads weighing 200 lbs [Appendix D].

Summary of Objectives and Requirements

Objectives	Overview	Criteria	Metrics	Constraints
Safety	Decreasing the amount of MMH required as requested by the stakeholders, and optimizing the MMH conditions	Number of lifting tasks; fewer is better	Count	None
		Duration of lifting tasks; less is better	Minutes	None
		Conditions under lifting/pushing is performed as per the Snook Ideal; closer to within optimal ranges is better	Proximity to optimal range (see Appendix D)	None
Facility Utilization	Minimizing the amount of space used to allow for more space to be devoted to storage	Area and volume occupied by the solution; less is better	Square metres, cubic metres (m^2 and m^3)	Must not exceed the dimensions of the existing facilities specified in Appendices C and F
Maintain-ability	Improving maintainability by making repairs easier and promoting the use of standard parts	Steps required to perform repairs; fewer is better	Number of steps	None
		Standardized parts used; more is better	Count	None
Truck Utilization	Minimize the amount of time the donation truck is parked during the unloading phase	Time required; less is better	Minutes	Must be less than 30 minutes on average, which is the time required with the current system
Chemical Properties	Oxidative and corrosive properties of the materials used	Oxidation and reduction of the material; lower is better	Reactivity	If the materials are subject to oxidation/ corrosion this must not impact material strength in temperatures between -39.4˚C and 37.2 ˚C (Toronto weather temperature range) [citation]
Load-Carrying Capacity	Choosing the strength of materials	Buckling load; higher is better	kg	The proposed solution should not buckle under loads less than 91 kg (the maximum load The Scott Mission receives, then a factor of safety of 2)
Cost	Minimize the cost of the proposed solution (in	Money spent by stakeholders on the solution; less is better	$ CAD	Must not exceed $50,000.00 CAD, as

	prototyping, implementation, final product, etc.)			specified by our The Scott Mission

8. Reference Designs

8.1 Current System

As summarized in sections 4 and 5, the current system suffers from many drawbacks. However, for all its faults, it is low in cost and appropriately uses the manual power available. By using detachable ramps made of sections of rollers and empty crates, The Scott Mission does not need to invest in new equipment or systems. For safety reasons, only employees of The Scott Mission wearing safety belts and steel toe boots can complete this task, so volunteers are excluded. Yet during two of our visits, our team observed that employees may be called to help with the donation intake. For these reasons, the current systems has been in use for around 20 years.

8.2 The MOVECO "Automatic conveyor belt system"

The MOVECO Automatic conveyor belt system is a mechanized system that is designed to be outfitted to a semi-trailer to improve the unloading of goods. This system utilizes a floor-sized conveyor belt to transport goods from the inside of the semi-trailer onto an attached loading dock. This design, if it were implemented, would prevent the need for manual materials handling as it enables goods to be seamlessly transported from the inside of the truck onto the conveyor belt. However, this design does face two major drawbacks that bar it from being a viable solution. Firstly, this solution does not solve the issue related to the maximum dimensions of donations that can be transferred into the building as the donations must still pass through the chute onto the existing conveyor. This would still mean that larger donations would have to be manually carried out of the truck before the rest of the donations were processed. Secondly, this solution exceeds the dimension of the current chute. (The MOVECO design is 2.5 m in width as opposed to the available 1.0 m) [10]. As such the conveyor belt is too wide to be integrated into the existing infrastructure.

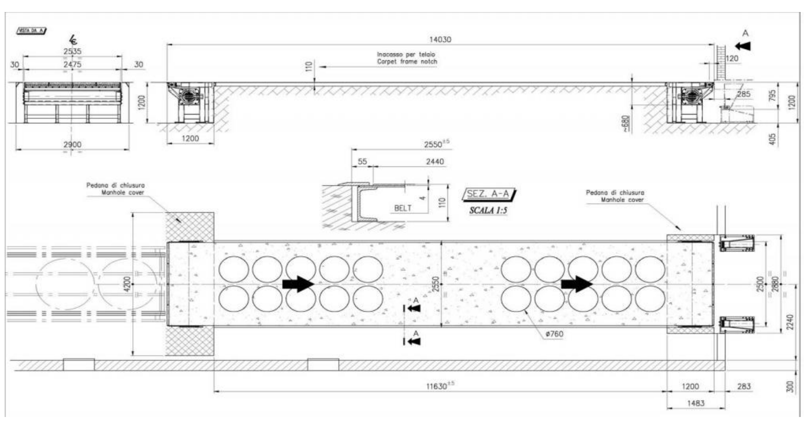


Fig 6. Diagram of the MOVECO "Automatic conveyor belt system" [11]

8.3 The Model ProSort 221/231 High Speed Shoe Sorter Sortation Conveyor System

The Model ProSort 221/231 High Speed Shoe Sorter Sortation Conveyor System allows for incoming goods to be sorted into multiple evenly distributed piles. By sorting the contents, this conveyor would help remove bottlenecks in the current conveyor belt used by The Scott Mission. Thereby allowing for multiple employees to work at different parts along the conveyor, while receiving the same amount of goods. This would improve the efficiency of the employees as they would have more space to work with when working on the conveyor. While this conveyor belt does address some of the needs of The Scott Mission, it fails to meet some requirements. This new conveyor belt would require the old one be completely replaced and would also require some restructuring of the basement. The cost of implementing such a system would be over budget, and, for smaller loads of donations, the sorting would be unnecessary and may even hinder efficiency.

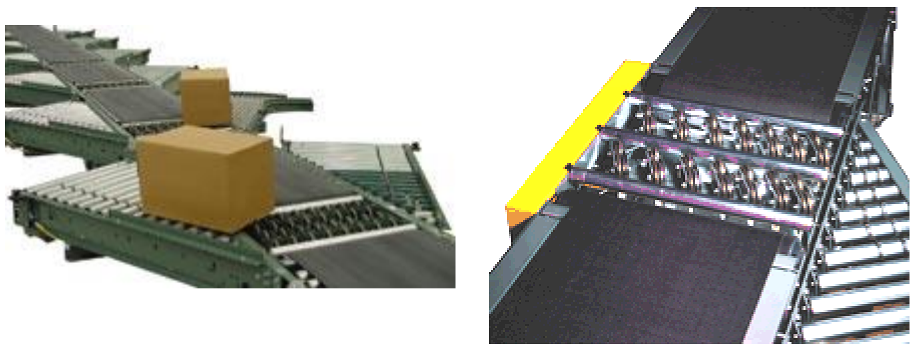


Fig 7. ProSort 221/231 High Speed Shoe Sorter Sortation Conveyor System [12]

9. Summary

The Scott Mission is a shelter faced with the challenge of being unable to safely and efficiently process donations through their current system for donation intake. This challenge is partly due to the infrastructure in place. The current system requires excessive manual material handling, namely lifting and pushing of donations, and as a result safety concerns arise for the staff. Additionally, space limitations in the current infrastructure inhibit bulk donations from being transported from the delivery trucks into the storage area as quickly as desired.

Lynwood Strickland, the Director of Operations, has stated that he finds the current donation intake system flawed, and both he and Ron Gardener, another member of The Scott Mission community, have expressed interest in dealing with the problems.

We are requesting a solution to the problems elaborated in this RFP. The solution must be designed with the main objectives of safety and efficiency in mind, in line with the interests of the stakeholders at The Scott Mission. The solution can be in the form of a new system implemented, or an improvement to one area of focus, provided that the constraints regarding cost and excessive infrastructure interference are met.

Appendices

Appendix A

The following diagrams is taken from the Snook standard that summarizes optimal lifting conditions as a function of the horizontal location of the load.

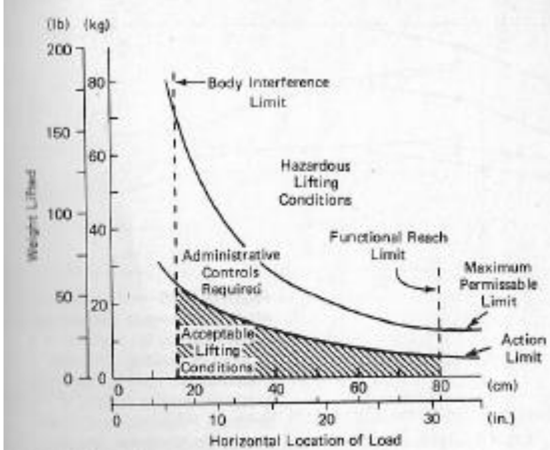


FIGURE 8-24
Levels of risk for lifting tasks as related to horizontal location of load and weight lifted for infrequent lifts from floor to knuckle height. *(This figure is derived from a guideline formula developed by NIOSH, 1981.)*

[7]

Appendix B

Summary of meetings and correspondence with stakeholders

First meeting (Plenary Tour January 29th 2014):

We were given a basic rundown of the operations of The Scott Mission including from food preparation to donation intake by Trevor Smith. He introduced us to Lynwood Strickland, the operations manager, and Ron Gardener who is responsible for storage. Without any particular problems in mind, we asked these Mr. Smith, Mr. Gardener, and Mr. Strickland what they consider to be challenges and difficulties that the Scott Mission faces. The issue of processing donations was immediately mentioned by Strickland. Following this, Trevor gave us a tour of the bedding facilities, and the now empty daycare center (which has moved to their new location)

Second Meeting (February 4th 2014):

Two members of the group followed the first meeting by interviewing Strickland. Investigating further into the direction we had chosen (which is donation intake). Mr. Strickland clarified the problem of donation intake by first emphasizing the safety of the employees, specifically concerning material handling. Then, he discussed interest in implementing a systems solution to improve the whole process. Being an industrial engineer himself, Mr. Strickland expressed that such a scoping (improving the system itself) would indeed be a viable solution.

Third Meeting (February 6th 2014):

One member of the group visited The Scott Mission during an unloading operation. He took pictures and videos of the process and noted the safety measures in place for donations processing, i.e. the need for steel toe boots and safety belts. In short conversations with the employees doing the MMH, they expressed interest in improving the current method/system. When asked about safety, they pointed to their safety belts, gloves, and work shoes. Though half-jokingly, they asked for a robot to do their work. This means there is a desire to improve the current system. At the basement, he saw a team of three men unloading boxes from conveyor onto pallets for storage.

Fourth Meeting (February 13th 2014)

Three members of our team met with Mr. Strickland to learn more about a past proposed solution to the problem - which involved a moving a whole truck using a hoist - and why it was rejected. In addition, we discussed with Mr. Strickland the maximum price that the Scott Mission would be willing to pay for a solution to their problem. (This figure was subsequently used as a constraint for the maximum price that an engineering team can spend in developing their solution). Then we were directed to Ron Gardener, the de facto lead in storing donations coming down the conveyor. Mr. Gardener has worked for more than 20 years at the mission, as such he showed some tricks he learned handling boxes. However, when asked about any short-cuts pertaining to the donation intake process using the conveyor, he replied that he hadn't given it much thought and added that he would indeed like "progress" in terms of the system. Finally, our team took some measurements of the docking station, the chute, conveyor belt and various height and width measurements at key locations where donations are processed. These values were then used to develop the criteria, metrics and constraints and are summarized below.

Email from Mr. Strickland (February 27 2014)

Upon the completion of the RFP, it was sent to Mr. Strickland for review. He made some comments on certain formalities in the document and stated that our “evaluation [of the problem at hand] is correct and with data presented and the conclusion [we came to], that with the restraints we have…, we continue as is.” Therefore, our team believes that the request for proposal is consistent with the desires of the community.

Appendix C

<u>Summary of Important Measurements and other Important Figures:</u>

Conveyor platform width	30 in/0.76m
Conveyor belt width	18 in/0.46m
Roller platform width	23 in/0.58m
Roller width	20 ¾ in/0.53m
Total length of conveyor (horizontal to surface)	27 ft 5 in/2.18m
Available height above the conveyor belt (clearance)	28 in/0.71m
Angle of inclination of the conveyor	approximately 28.5 degrees
Chute dimensions (width x height)	28 ¾ x 38 ½ in (0.73m x 0.98m)

Width of donation truck (as measured on site)	101 ½ in/2.57m
Width of laneway adjacent to the building	155 in /3.94m
Average donation weight (approximate)	40 lbs/18kg
Maximum donation weight (approximate)	100 lbs/45.5kg

Appendix D

The following equation describes how to develop a value for the buckling load of a member when subjected to loading where *L* is the load, and *I* is the moment *E* is the elastic modulus [13].

$$P_{crit} = \frac{\pi^2 EI}{L^2}$$

Appendix E

Height	Percent	2.1 m push One push every							7.6 m push One push every							15.2 m push One push every							30.5 m push One push every					45.7 m push One push every					61.0 m push One push every			
		6	12	1	2	5	30	8	15	22	1	2	5	30	8	25	35	1	2	5	30	8	1	2	5	30	8	1	2	5	30	8	2	5	30	8
		s		min				hr	s		min				hr	s		min				hr	min				hr	min				hr	min			hr
Initial forces																																				
144	90	20	22	25	25	26	26	31	14	16	21	21	22	22	26	16	18	19	19	20	21	25	15	16	19	19	24	13	14	16	16	20	12	14	14	18
	75	26	29	32	32	34	34	41	18	20	27	27	28	28	34	21	23	25	25	26	27	32	19	21	25	25	31	16	18	21	21	26	16	18	18	23
	50	32	36	40	40	42	42	51	23	25	33	33	35	35	42	26	29	31	31	33	33	40	24	27	31	31	38	20	23	26	26	33	20	22	22	28
	25	38	43	47	47	50	51	61	27	31	40	40	42	42	51	31	35	37	37	40	40	48	28	32	37	37	46	24	27	32	32	39	23	27	27	34
	10	44	49	55	55	58	58	70	31	35	46	46	48	49	58	36	40	43	43	45	46	55	32	37	42	42	53	28	31	36	36	48	27	31	31	39
95	90	21	24	26	26	28	28	34	16	18	23	23	25	25	30	18	21	22	22	23	24	28	17	19	22	22	27	14	16	19	19	23	14	16	16	20
	75	28	31	34	34	36	36	44	21	23	20	20	32	32	39	24	27	28	28	30	30	36	21	24	28	28	35	18	21	24	24	30	18	21	20	26
	50	34	38	43	43	45	45	54	26	29	38	38	40	40	48	29	33	35	35	37	38	45	27	30	35	35	44	23	26	30	30	37	22	26	26	32
	25	41	46	51	51	54	55	65	31	35	45	45	48	48	58	35	40	42	42	45	45	54	32	36	42	42	52	27	31	36	36	45	27	31	31	38
	10	47	53	59	59	62	63	75	35	40	52	52	55	56	66	40	46	49	49	52	52	62	37	41	48	48	60	32	36	41	41	52	31	35	35	44
64	90	19	22	24	24	25	26	31	13	14	20	20	21	21	26	15	17	19	19	20	20	24	14	16	19	19	23	12	14	16	16	20	12	14	14	17
	75	25	28	31	31	33	33	40	16	19	26	26	27	28	33	19	21	24	24	26	26	31	18	21	24	24	30	16	18	21	21	26	15	18	18	22
	50	31	35	39	39	41	41	50	20	23	32	32	34	35	41	23	27	30	30	32	33	39	23	26	30	30	37	20	22	26	26	32	19	22	22	28
	25	38	42	46	46	49	50	59	25	28	39	39	41	41	50	28	32	36	36	39	39	47	28	31	36	36	45	24	27	31	31	39	23	26	26	33
	10	43	48	53	53	57	57	68	28	32	45	45	47	48	57	32	37	42	42	44	45	54	32	36	41	41	52	27	31	36	36	44	26	30	30	38
Sustained forces																																				
144	90	10	13	15	16	18	18	22	***8***	9	13	13	15	16	18	***8***	9	11	12	13	14	16	***8***	10	12	13	16	***7***	8	10	11	13	7	8	9	11
	75	***13***	17	21	22	24	25	30	***10***	***13***	17	18	20	21	25	***11***	***13***	15	16	18	18	22	***11***	13	16	18	21	***10***	***11***	13	15	18	***9***	11	13	15
	50	***17***	22	27	28	31	32	38	***13***	***16***	22	23	26	27	32	***14***	***17***	***20***	20	23	24	28	***15***	***17***	20	23	28	***12***	***14***	17	19	23	***12***	14	16	19
	25	***21***	***27***	33	34	38	40	47	***16***	***20***	28	29	32	33	39	***17***	***20***	***24***	25	28	29	34	***18***	***21***	25	29	34	***15***	***18***	21	24	28	***15***	17	20	24
	10	***25***	***31***	38	40	45	46	54	***19***	***23***	***32***	33	38	39	46	***20***	***24***	***28***	29	33	34	40	***21***	***25***	29	33	39	***18***	***21***	24	28	33	***17***	***20***	23	28
95	90	10	13	16	17	19	19	23	***8***	10	13	13	15	15	18	***8***	***10***	11	12	13	13	16	***8***	10	12	13	16	***7***	8	9	11	13	7	8	9	11
	75	***14***	18	22	22	25	26	31	***11***	***13***	17	18	20	21	25	***11***	***13***	15	16	18	18	21	***11***	13	16	18	21	***9***	***11***	13	15	18	***9***	11	12	15
	50	***18***	***23***	28	29	33	34	40	***14***	***17***	22	23	26	27	32	***14***	***17***	***19***	20	23	23	28	***15***	***17***	20	23	27	***12***	***14***	17	19	23	***12***	14	16	19
	25	***22***	***28***	34	35	40	41	49	***17***	***21***	27	29	32	33	39	***18***	***21***	***24***	25	28	29	34	***18***	***21***	25	28	33	***15***	***18***	21	24	28	***15***	17	20	23
	10	***26***	***33***	40	41	46	48	57	***20***	***24***	***32***	33	37	38	45	***20***	***25***	***28***	29	32	33	40	***21***	***25***	29	33	39	***17***	***20***	24	27	32	***17***	***20***	23	27
64	90	10	13	16	16	18	19	23	***8***	10	12	13	14	15	18	***8***	***10***	11	11	12	13	15	***8***	9	11	13	15	***7***	8	9	11	13	7	8	9	10
	75	***14***	18	21	22	25	26	31	***11***	***13***	17	17	19	20	24	***11***	***13***	14	15	17	17	21	***11***	13	15	17	20	***9***	***11***	12	14	17	***9***	10	12	14
	50	***18***	***23***	28	29	32	33	39	***14***	***17***	21	22	25	26	31	***14***	***17***	***19***	19	22	22	27	***14***	***16***	19	22	26	***12***	***14***	16	18	22	***12***	14	15	18
	25	***22***	***28***	34	35	39	41	48	***17***	***21***	26	27	31	32	37	***18***	***21***	***23***	24	27	28	33	***17***	***20***	24	27	32	***14***	***17***	20	23	27	***14***	17	19	22
	10	***26***	***32***	39	41	46	48	56	***20***	***25***	***30***	32	36	37	44	***21***	***25***	***27***	28	31	32	38	***20***	***24***	28	32	37	***17***	***20***	23	26	31	***16***	19	22	26

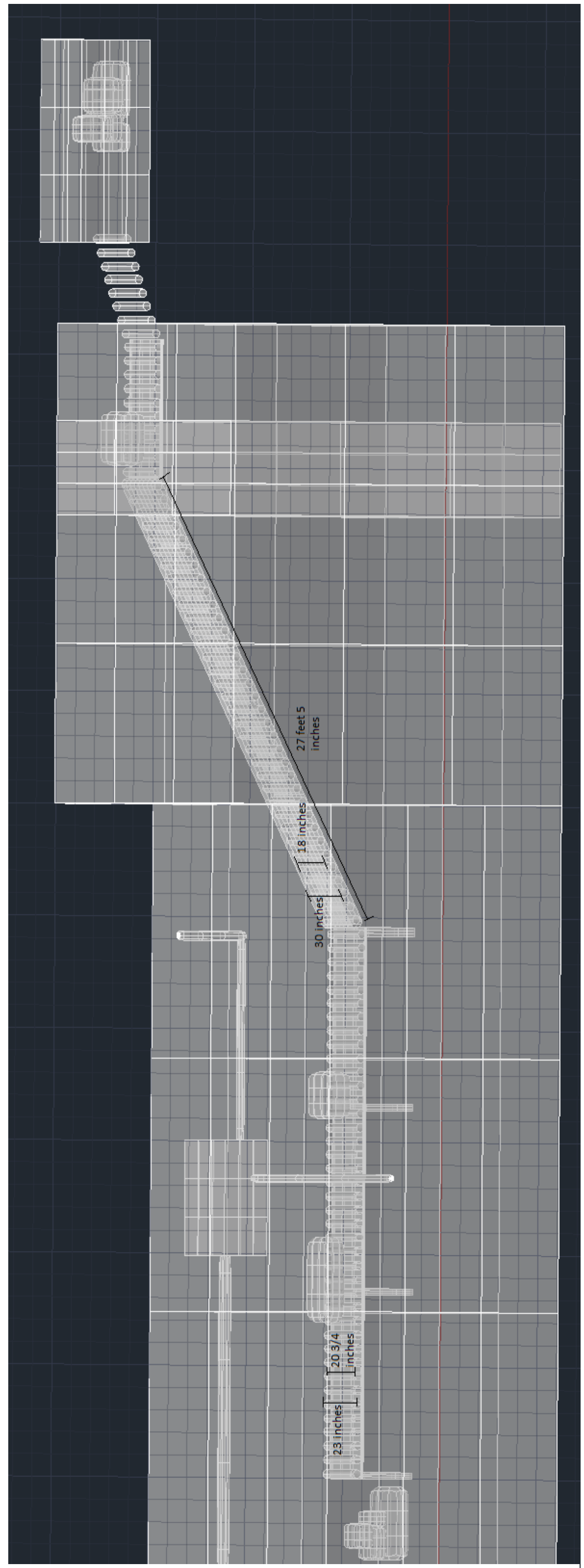
Maximum Acceptable Forces of Push for Males (kg) [14]

Height	Percent	2.1 m pull One pull every							7.6 m pull One pull every							15.2 m pull One pull every							30.5 m pull One pull every					45.7 m pull One pull every					61.0 m pull One pull every			
		6	12	1	2	5	30	8	15	22	1	2	5	30	8	25	35	1	2	5	30	8	1	2	5	30	8	1	2	5	30	8	2	5	30	8
		s		min				hr	s		min				hr	s		min				hr	min				hr	min				hr	min			hr
Initial forces																																				
144	90	13	16	17	18	20	21	22	13	14	16	16	18	19	20	10	12	13	14	15	16	17	12	13	14	15	17	12	13	14	15	17	12	13	14	15
	75	16	19	20	21	24	25	26	16	17	19	19	21	22	24	12	14	16	16	18	19	20	14	16	17	18	20	14	16	17	18	20	14	15	16	18
	50	19	22	24	25	28	29	31	19	20	22	23	25	26	28	14	16	19	19	21	22	24	17	18	20	21	24	17	18	20	21	24	16	18	19	21
	25	21	25	28	29	32	33	35	21	26	25	26	29	30	32	16	19	21	22	25	26	27	19	21	23	24	27	19	21	23	24	27	19	20	22	25
	10	24	28	31	32	36	37	39	24	26	28	29	32	34	36	18	21	24	25	27	29	30	22	24	25	27	31	22	24	25	27	31	21	23	24	27
95	90	14	16	18	19	21	22	23	14	15	16	17	19	20	21	10	12	14	14	16	17	18	13	14	15	16	18	13	14	15	16	18	12	13	14	16
	75	16	19	21	22	25	26	27	17	18	19	20	22	23	25	12	15	17	17	19	20	21	15	16	18	19	21	15	16	18	19	21	15	16	17	19
	50	19	23	25	26	29	30	32	19	21	23	24	26	27	29	14	17	19	20	22	23	25	18	19	21	22	25	18	19	21	22	25	17	18	20	22
	25	22	26	29	30	33	35	37	22	24	26	27	30	31	33	16	20	22	23	26	27	28	20	22	24	25	29	20	22	24	25	29	20	21	23	26
	10	25	29	32	33	37	39	41	25	27	29	30	33	35	37	18	22	25	26	29	30	32	23	25	26	28	32	23	25	26	28	32	22	24	25	29
64	90	15	17	19	20	22	23	24	15	16	17	18	20	21	22	11	13	15	15	17	18	19	13	14	15	17	19	13	14	15	17	19	13	14	15	17
	75	17	20	22	23	26	27	28	17	19	20	21	23	24	26	13	15	17	18	20	21	22	16	17	18	20	22	16	17	18	20	22	15	16	18	20
	50	20	24	26	27	30	32	33	20	22	24	25	28	29	30	15	18	20	21	23	24	26	18	20	22	23	26	18	20	22	23	26	18	19	21	23
	25	23	27	30	31	35	36	38	23	25	27	29	32	33	35	17	21	23	24	27	28	30	21	23	25	27	30	21	23	25	27	30	21	22	24	27
	10	26	31	34	35	39	40	43	29	28	31	32	35	37	39	19	23	26	27	30	31	33	24	26	28	30	34	24	26	28	30	34	23	25	27	30
Sustained forces																																				
144	90	***6***	***9***	10	10	11	12	15	***7***	***8***	9	9	10	11	13	***6***	***7***	***7***	8	8	9	11	***6***	***7***	7	8	10	***6***	***6***	7	7	9	***5***	5	5	7
	75	***8***	***12***	13	14	15	16	20	***9***	***11***	12	12	13	14	18	***7***	***9***	***10***	10	11	12	15	***8***	***9***	10	10	14	***8***	***9***	9	9	12	***7***	7	7	10
	50	***10***	***16***	17	18	19	21	25	***12***	***13***	***15***	16	17	18	22	***9***	***11***	***13***	***13***	14	15	19	***11***	***12***	12	13	17	***10***	***11***	***11***	12	16	***8***	***9***	9	12
	25	***13***	***19***	21	21	23	25	31	***14***	***16***	***18***	19	21	22	27	***11***	***14***	***15***	***16***	17	19	23	***13***	***15***	***15***	16	21	***12***	***12***	***14***	14	19	***10***	***11***	11	15
	10	***15***	***22***	24	25	27	29	36	***16***	***19***	***21***	22	24	26	32	***13***	***16***	***18***	***18***	20	22	27	***15***	***17***	***17***	18	25	***14***	***15***	***16***	17	23	***12***	***12***	13	17
95	90	***6***	***9***	10	10	11	12	14	***7***	***8***	9	9	10	10	13	***5***	***6***	***7***	7	8	9	11	***6***	***7***	7	7	10	***5***	***6***	6	7	9	***5***	5	5	7
	75	***8***	***12***	13	13	15	16	19	***9***	***10***	11	12	13	14	17	***7***	***8***	***10***	10	11	12	14	***8***	***9***	9	10	13	***7***	***8***	9	9	12	***6***	7	7	9
	50	***10***	***15***	16	17	19	20	25	***11***	***13***	***15***	15	16	18	22	***9***	***11***	***12***	***13***	14	15	18	***10***	***12***	12	13	17	***9***	***11***	***11***	12	15	***8***	***8***	9	12
	25	***12***	***18***	20	21	23	24	30	***14***	***16***	***18***	18	20	22	27	***11***	***13***	***15***	***15***	17	18	22	***12***	***14***	***15***	15	21	***11***	***13***	***13***	14	19	***10***	***10***	11	15
	10	***14***	***21***	23	24	26	28	35	***16***	***18***	***21***	21	23	25	31	***13***	***15***	***17***	***18***	20	21	26	***15***	***16***	***17***	18	24	***13***	***15***	***16***	16	22	***12***	***12***	13	17
64	90	***5***	8	9	9	10	11	13	***6***	***7***	8	8	9	10	12	***5***	***6***	***7***	7	7	8	10	***6***	***6***	6	7	9	***5***	***6***	6	6	8	***4***	5	5	6
	75	***7***	***11***	12	12	13	14	18	***8***	***9***	11	11	12	13	16	***7***	***8***	***9***	9	10	11	13	***7***	***8***	9	9	12	***7***	***8***	8	8	11	***6***	6	6	9
	50	***9***	***14***	15	16	17	18	23	***10***	***12***	13	14	15	16	20	***8***	***10***	***11***	***12***	13	14	17	***9***	***11***	11	12	16	***9***	***10***	***10***	11	14	***8***	***8***	8	11
	25	***11***	***17***	18	19	21	22	27	***13***	***15***	***16***	17	19	20	24	***10***	12	***14***	***14***	16	17	21	***11***	***13***	13	14	19	***11***	***12***	***12***	13	17	***9***	***10***	10	13
	10	***13***	***20***	21	22	24	26	32	***15***	***17***	***19***	20	22	23	28	***12***	14	16	***16***	18	19	24	***13***	***15***	***16***	16	22	***12***	***14***	***14***	15	20	***11***	***11***	12	16

Maximum Acceptable Forces of Pull for Females (kg) [14]

Appendix F

2D Rendering: Overview of the entire system from the unloading dock to the storage facilities in the basement.



3D Rendering: Overview of system.

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