Summary

Mammoet is a global company specialized in integrated heavy lifting and transportation projects. Mammoet has designed, engineered and built a new crane called the PTC140DS/PTC200DS three times. The PTC140DS/PTC200DS has been designed to be shipped in containers to save up to 70% on transportation costs compared to bulk shipment. The number of items that need to be shipped was estimated at 1400 during the design phase. The number of needed containers was estimated at 200-260. It will be operated by Mammoet Global Cranes, a sub company of Mammoet.

The crane is designed to be flexible. It can be set up in different configurations. Some of these configurations require extensions with extra items. These extensions can be used with each of the three cranes. This flexibility requires the logistics to be up to date. The current logistics are expected not to be able to support it. This research focuses on this subject and answers the research question:

What parts of the logistics at Mammoet Global Cranes need to be addressed in order to raise the logistics to an acceptable level and how can the most urgent parts be addressed?

All elements of the logistics of Mammoet Global Cranes are investigated using information gathered from interviews with employees and internal documents. Each element of the logistics of Mammoet Global Cranes is evaluated and challenges are exposed. The value of their impact when solved and effort to solve these challenges is determined based on the interviews. The challenges are plotted in an Impact-Effort graph to determine which challenges will be addressed in this research. Three challenges are addressed first. These challenges have a high impact when solved and require low effort to solve. The challenges are (with impact and effort scaled 0-100):

1. Various subsets of items due to various configurations (impact 100; effort 50);
2. ERP structure usability too low (impact 80; effort 30);
3. Manual containerization (impact 70; effort 50).

Subsets

The PTC140DS/PTC200DS is designed to be large, fast and flexible. The size of the crane makes it large; the type of the crane makes it fast. To be flexible as well, the crane can be setup in several configurations. Each configuration demands a different subset of items out of the total set of items that are needed to build the crane. To make sure all the needed items are available when a configuration is built two basic solutions can be used. The lower bound solution is to ship only the needed item each time. The lower bound solution is not ideal because then containers need to be rearranged each time a different configuration is shipping. This requires relocating welded frames. The upper bound solution is to ship all the items all the time. The upper bound solution is expensive because unnecessary shipping costs will occur.

The optimal solution is achieved by first stripping down the configurations to its smallest configuration. The subset of items that is needed in this configuration is appointed as the base configuration. Items that are needed to construct other configurations are grouped into extension kits. Some kits will only be shipped when needed; others will always be shipped because they are expected to be needed 80% of the time. The expectation of 80% is based on projects from the past as well as predictions about future projects.

All configurations can still be used with the optimal solution. The solution is expressed in table S.1 that shows which kits are needed for which configuration. This reduces the risk for error. The solution can be implemented in the current system. The implementation of the solution leads to an average saving of 7.1 containers per shipment. The implementation of the optimal solution will also save costs.

ERP Structure

Mammoet uses an ERP system called SAP. It is used to share information across the world. It is also used to extract statistics for intelligence on the organization and operation of Mammoet. Logistics are supported by SAP as well.

The current structure of equipment and items is mostly a two-layer structure. The top layer exists of equipment and stand-alone items. Items that belong to equipment are attached to the equipment and make up the second layer. Sometimes a layer is added in between to group items based on the function of these items when they are in use.

Mammoet designed the PTC140DS/PTC200DS to be a base crane with extensions. The main boom, the jib, the base and the masthead can all be extended. Unfortunately the configuration that is set as the base configuration is not the smallest configuration possible. Also some of the items can be used on all cranes, while other items are crane specific. Mammoet has more pieces of equipment that have 'variable' items. The current SAP structure cannot cope with the logistics of these two types of items:

- Interchangeable/non-interchangeable items;
- Always needed/not always needed items.

The solution presented in this research splits items with opposing characteristics of these two types. Interchangeable items are grouped together and are not attached to the equipment. These are grouped as a kit. Non-interchangeable items are attached to the crane. Items that are not always needed are grouped together and are not mixed with items that are always needed. These groups are attached to the equipment as well, but as a group they can be treated separately from the rest of the equipment. This is useful when the group with not always needed items is left behind because it is not needed.

Other parts of the SAP system can be improved as well. Recommendations are given.

Containerization

Containerization is the process of packing (general cargo) into huge, standardized containers for more efficient shipment, as in transferring from one mode of transportation to another. Mammoet goes through this process manually. Items that are needed in the same phase of the setup of the crane are put together in containers. All items need to be packed.

The Mammoet Packing Problem (MPP) is based on the Bin Packing Problem (BPP) which packs all items into bins, can handle multi-constraints, but only uses one type of bin. Characteristics from other packing problems are integrated into the MPP to ensure the model resembles reality.

A computer model is written to run the algorithm to solve the MPP. The model respects the dimension of the containers. The maximum weight is not exceeded. The model uses a simple version

of a 3D placement model to make sure all items will indeed fit in the containers. The model can use a Fitting Algorithm (FA) and a Genetic Algorithm (GA). The FA is carried out by the First Fit, Best Fit and Worst Fit methods. All three FA's can use the input weight sorted, random sorted or unsorted. The solutions are valued on the total costs of buying and shipping of the used containers during the lifetime of the crane. The GA uses the input of two (top 10) previous solutions to calculate one new input. This new input is used with the three FA's to calculate new solutions.

Although the model can be applied to any container packing problem, this research focuses on finding solutions to the MPP. The input for the experiments with the model is based on the actual shipping of one PTC140DS/PTC200DS to Brazil in November 2011. The experiments with the model are compared to the manual calculation that Mammoet performed. The solutions generated by the model have lower lifetime costs than the manual calculation. The experiments with the FA's show that the weight-sorted input outperforms the other FA's. The GA outperforms the weight sorted FA's, but not by much. The results are show in table S.1.

Table S.1: Summary of the results

Algorithm Type	40" container	20" container	40" and 20"	TEU	Lifetime Costs	% of minimum
(-)	(-)	(-)	(-)	(-)	(1000€)	(%)
Manual Calculation	133	13	146	279	5951	100%
Fitting Algorithms	108	34	142	250	4539	76%
Genetic Algorithm	105	34	139	244	4404	74%

The most important conclusion is that the lifetime costs of the model are 74% of the lifetime costs of the manual calculation. The main reason for that is that the computer uses more 20' containers than the manual calculation.

Conclusions

The research question of this research is successfully answered. The analysis of the logistics of Mammoet Global Cranes is completed. The parts that are the most urgent to addressed are successfully addressed.

The most urgent parts are the grouping of items into useful subsets, the ERP structure and the containerization. The items are grouped into subsets based on the requirements of use on site as well as transportation requirements. The ERP structure is redefined based on the subsets of items, the interchangeability between equipment and whether or not they are always needed. The containerization is addressed using computer-modeled algorithms.