White paper for MHIA:

MAKING A CASE FOR CHOOSING A STANDARD SIZED TOTE FIRST WHEN DESIGNING A SEMI-AUTOMATED OR FULLY AUTOMATED WAREHOUSE SYSTEM.

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Custom box or Custom-Sized box?

One of the most frustrating aspects of being the product designer for a plastics manufacturer is receiving a bid package from a customer for a custom-sized tote. While this sounds counterintuitive, the key word in that statement is “sized.” We welcome the opportunity to design custom, innovative solutions to complex customer problems. However, too often, there is nothing special or unique about the design, features or performance requirements of the tote; its only unique characteristic is its non-standard size.

If the tote’s size is driven by the dimensions of the product that will be transported or stored in the tote, then the unique size is a valid feature that justifies a custom-sized tote. Example: For one of our projects, the height of shampoo bottles fell between two standard tote heights. The bottles were 0.5” taller than one container, but 2.5” shorter than the next size up. The extra 2.5” height was too much to sacrifice in the racking system, so a custom-sized tote was the efficient option.

Unfortunately, the above example is atypical. Usually, it is not the customer’s product that drives the non-standard size, but the requirements of the equipment with which the tote will be interfacing, such as conveyors, shelving and edge-racking storage units.

It’s just an inexpensive plastic box, after all.

The detailed specifications of the infrastructure equipment are usually set, not by the customer, but by a company that it has hired to design and possibly construct its new material handling system. Typically, when most systems are designed, the tote is the last component to be considered. The big money items, the handling, conveying and storage systems, are considered first and by necessity are designed to be compatible with one another. The tote, which is the lynchpin of the system, the container that is storing and transporting the customer’s products, ends up as an afterthought. It’s just an inexpensive plastic box, after all.

While this last statement could be true, the above systems-design approach almost guarantees that it will be false, and that the tote will end up being unnecessarily expensive. This is because the "afterthought tote" is rarely an existing, standard tote size. Instead, it is invariably a custom-sized tote requiring design, its own mold and manufacturing.

Standard totes are those that manufacturers produce and warehouse in high volume. These totes come in all types and sizes. Some are designed for general applications; others are optimized for specific performance requirements. The bottom line is that standard totes are the least expensive boxes that one can buy. For any given automated or semi-automated application, there is usually more than one tote line that will meet the project's *performance* requirements – unfortunately, it is typically the *size* requirement that eliminates them from use.

Since all the decisions made with regard to the automation equipment directly affect the dimensions of the tote, designing the system first without considering the tote usually forces the customer to purchase a custom-sized tote. It is the responsibility of the company which is designing the system to minimize unnecessary expenses for its customer; usually, a custom-sized tote is an unnecessary expense.

Reality of Injection Molding

For those unfamiliar with the plastics industry and its economics, injection molding is the process of choice for high volume runs of dimension critical, multi-featured plastic totes. In general, injection molding consists of molten plastic being injected into a steel or aluminum mold, creating parts in relatively fast cycle times. This process provides the flexibility to create features that would be extremely difficult if not impossible with other molding methods. It also allows for the mass production of seemingly identical parts with minimal post-production operations. These qualities of injection molding result in relatively low-cost piece prices.

The downside of injection molding is the upfront capital expense of the mold. The molds for injection molding are usually much more expensive than those for other processes, typically starting at about 5 times the cost for a given part size. Therefore, injection molding is usually only considered for high volume projects so that the amortization of the mold cost into the piece cost is not exorbitant. "High volume" for a moderate sized tote (12 x 15" footprint) equals a minimum of 30,000 units.

Real World Example = Real Unnecessary Expense

We were invited to bid on a custom-sized tote for an automated warehouse. The customer's bid requirements for the 17,000 totes listed many of the requirements typical of ASRS applications:

Edge-rackable,	4 hot-stamps,	2 ergonomic handles
Conveyable	Molded-in logos	2 Barcode locations

We have multiple lines of standard totes that can address all of these needs, as do many of the other RCPCA member companies. Of our appropriate totes, the largest, most expensive one has an undiscounted list price of $34.79. For the 17,000 quantity, this price drops down into the $20.00+ range (For this example, we will set it at $26.00).

This standard, off-the-shelf tote met all of the bid specifications except for the size requirement – it was 1" too long, 2" too short in height. The tote length restriction was a function of the curve radii already designed into the conveyors. The height dimension had been set by the ASRS rack spacing that was a function of the building height and robot range. Neither of these discrepancies in dimensions was driven by customer requirements – both were forced by the equipment design. In fact, the customer preferred our standard tote's lower height because the shorter height restricted the amount of product that could be loaded into each tote

However, since the system was already designed and the equipment ordered, there was no flexibility to change the system for the plastic tote. In the end, the mold to produce this custom-sized tote cost the customer over $350,000 including associated costs. Since they only required 17,000 totes, the tooling amortization alone contributed $20.60+ to the cost of each tote. Adding the part cost to this mold cost brought the final cost of the tote to around $44.50. The unique size of this tote restricted its use to this specific application (as is the case with most afterthought totes). Since it was not marketable to any other customers, we could not help the customer defray any of the capital expense by running the mold for anyone else. Therefore, the customer had to buy and own the mold, to be run for this one-time project.

The difference in cost to the customer was $315,000, a penalty that was not driven by any of its requirements. This was an unnecessary expense that should not have been incurred.

Relative Cost-vs-Real Cost

One of the aspects that may be contributing to this problem is that compared to the multimillions of dollars spent on the overall automated system, a $315,000 penalty can be perceived as small potatoes by the system designer. As the designer of the system attempts to balance and integrate all the needs of the machinery and computers, a plastic tote can easily be overlooked and, because it is not a complicated piece of equipment, taken for granted. Again, it's just an inexpensive plastic box, after all.

From a customer's perspective, however, $315,000 is still $315,000, regardless of the size of the overall project. And as an unnecessary expense that should have been avoided, it is an amount that will displease every customer, every time.

A Thorn in Timing Charts

Another impact of custom injection molding that is necessary to consider is timing. Not counting product design time, a mold can take anywhere from 18 – 32 weeks to complete, depending on the size of the tote and its design complexity. These numbers are subject to increase because of uncontrollable factors such as tooling steel availability, mold component availability and the mold shop's available time to work on the project. The stated timing range also does not include the time to transport the mold to the manufacturing plant nor the mold shake-out time required before start of production.

After the mold is completed, the totes have to be produced. The required manufacturing time can be substantial as it is directly proportional to the quantity of totes needed. Example: Another one of our custom projects called for 180,000 totes to fill the system. When initially establishing the project's overall timing, the customer had not taken into account that it would take over 5 months to manufacture that quantity of totes. The customer's scheduled equipment changeover and testing phases all had to be delayed because they were set upfront without considering the timing realities of a custom plastic tote.

The common misconception is that the time needed to erect a facility or complete an installation well eclipses the time required to acquire a tote to put in the system. As a result, it is the rare exception that the tote specifications are defined early in the process and typically, by the time the tote bid is awarded, the deadlines are tight if not impossible to meet. A good rule of thumb for a custom tote, design through Start of Production, is 9-12 months.

Another consideration that is commonly overlooked is that the first required use of the production totes is not the filling of the completed system at the end of the timeline. In most cases, there are multiple validation trials occurring throughout the installation that require the use of production totes. These tests are crucial to troubleshooting and fine-tuning the equipment and software.

In the end, proper time allowance for a tote is critical because, as the lynchpin of the system, one can easily have a multimillion dollar plant sitting idle, awaiting a custom-sized tote that was ordered too late. During this wait, it is anything but "an inexpensive plastic box, after all."

Real World Example = Real Pain

A few years ago, one of our salespeople called in from the field with an urgent request for a box. He needed to know if we had a certain style box with very specific dimensions - if so, his potential customer would need a quantity of 30,000 delivered within two months.

He explained that this company was in a major bind – it had a brand new automated warehouse nearing completion and the system designer was having difficulty finding a box to use in it. The project had been active for over 7 months and they had only started looking for a tote one month before completion.

After discussing the requirements and researching the marketplace, I informed him that such a box did not exist anywhere. Because of its strange dimensions, no one manufactured anything close to its specifications. In the end, the company had to rush order paper corrugated boxes to fill the system until a custom-sized box could be made (8 months later). Because the paper corrugated boxes could not stand up to the automated handling, the company's warehouse launch was beset with downtime, lost inventory and a replacement box rotation that caused havoc with their software tracking system.

Thorn Avoidance = Look in the Catalog

The common, frustrating element of all of these scenarios is that the monetary and timing penalties of a custom-sized tote are usually unnecessary and are completely avoidable. Plastic material handling manufacturers (many of the RCPCA members) have thousands of standard boxes readily available with short lead times and very affordable prices as the molds are either already paid for or are amortized over huge volumes.

The first step to specify a standard tote is to research the different box types suitable for an automated or semi-automated system. These usually include:

Stack-only	180° stack-and-nest	Collapsible
Nest-only	Bale stack-and-nest	Nest-with-lids

Determine which style best fits the needs of the application then determine the tote size.

In general, there are two families of tote sizes suitable for automated or semi-automated warehouse use. Both are based on standard pallet sizes. The standard pallet sizes in the U.S. are:

- 48 x 40” (considered the Grocery Manufacturer’s Association (GMA) size)
- 48 x 45” (the Automotive Industry Action Group (AIAG) size).

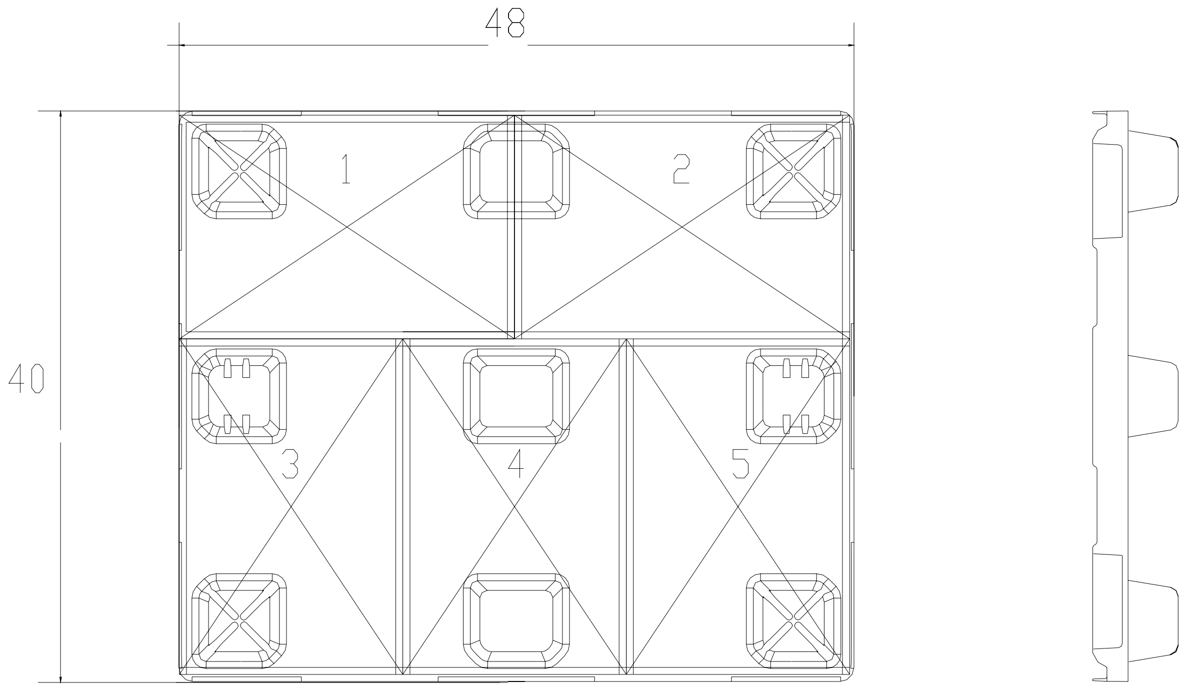
The 48 x 45 is used almost exclusively by automotive companies and their suppliers, so the bulk of the pallets used in the U.S. are GMA 48 x 40.

Since cost during transport is directly dependent on cube utilization, tote sizes are usually whole number fractions of the pallet size. This assures that a palletized load completely fills up the pallet footprint.

For example, the most common size box for the GMA pallet is a 5 mod, or a 24 x 16” box. This size fits 3 x 2 on the pallet, 3 totes side-by-side across the 48” pallet direction, with 2 end-to-end in the 48” direction. The 3 x 2 pattern (shown below on pallet) completely fills the top surface of the GMA pallet, optimizing the footprint. This is the tote footprint of choice for European ASRS systems and, based on the quantity of totes currently in use in the various U.S. drugstore regional distribution warehouses, it is probably the same here in the U.S.

There are multiple standard lines of GMA tote types, all of which include totes with the 24 x 16” footprint. To accommodate differing product needs, these come in varying heights. For greater flexibility, there are also many, many more available footprints.

Example: GMA Pallet

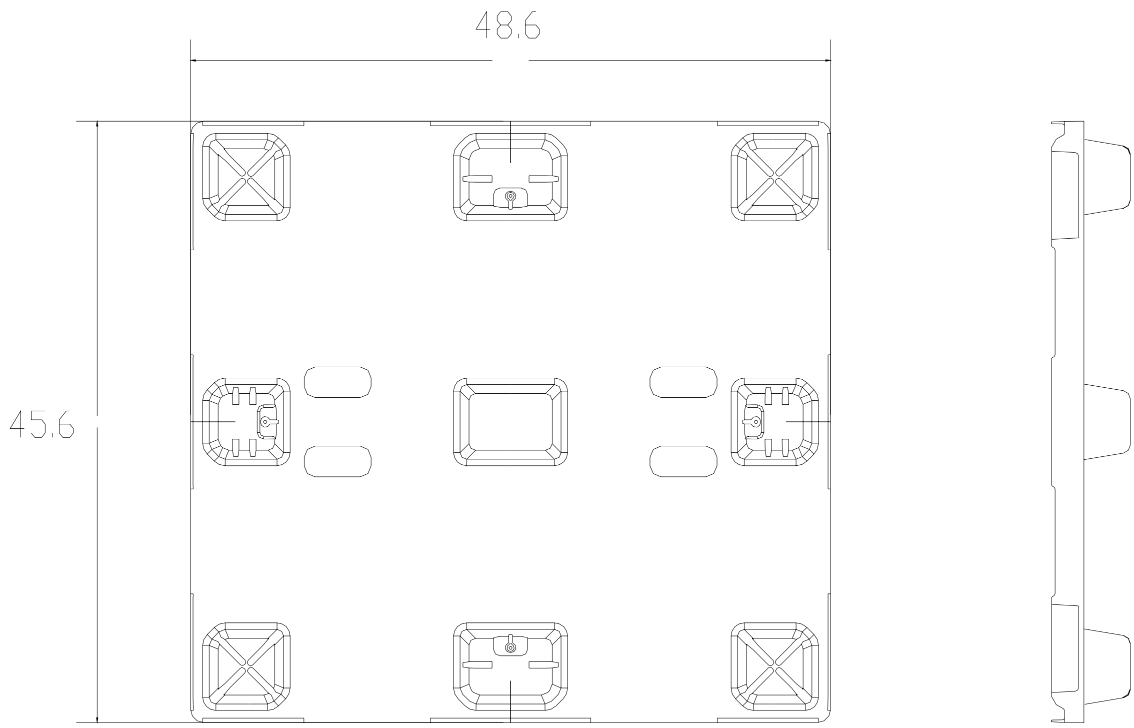


Note the outside dimensions: For GMA pallets, the outer perimeter dimensions are 48 x 40" or slightly smaller. The usable deck size varies depending on the process used to make the pallets and the thickness of the vertical lips around the edge.

The AIAG box lines, designed for the 48 x 45 pallet footprint, are extensive. They start with 2 mod boxes at 48 x 22.5" (also known as "half mods") and shrink down to 24 mods at 12 x 7.5", with a full range of sizes in between. For example, our company's AIAG lines include the AF line (19 box sizes), the CF line (7 box sizes) and the NF line (5 box sizes). These lines are designed to completely cube out the 48 x 45" pallet whether one uses a single box size or a combination of box sizes.

You will note in the layout below that the outside dimensions are larger than 48 x 45". Unlike the GMA pallets, AIAG pallets have a usable deck size that matches its identifying dimensions of 48 x 45". It is the outer perimeter dimensions that vary, depending on the process used to make the pallets and the thickness of the vertical lips around the edge.

Example: AIAG Pallet



<u>Bottom Line</u>

Regardless of the tote type required by the application, a standard size can usually be found for any application.

1) If a tote is to be used in a warehouse system and transported off-site in trucks, a system designer should:
    - take into consideration which pallet is going to be used (probably GMA),
    - limit the tote search to those designed for that pallet size,
    - determine which standard tote size (footprint and height) best suits the customer's product and logistical needs, and then
    - design the building's system around that size.
2) If a tote is to be used solely within the warehouse system, the number of available standard totes skyrockets as both GMA and AIAG sizes can be considered. One has only to:
    - determine which standard tote size (footprint and height) best suits the customer's product and logistical needs, and then
    - design the building's system around that size.

The benefits of determining the tote size at the beginning of a project cannot be over emphasized. Choosing a standard tote at the beginning and designing the equipment around that tote will:

- Save the customer unnecessary expense by eliminating mold and custom tote costs
- Eliminate wasted time and man-hours in extra logistical planning
- Reduce the project engineers' stress by eliminating what could become a very laborious and demanding task
- Avoid one more task that can be affected by Murphy's Law
- Guarantee that totes are readily available for system tests at any point in the installation
- Eliminate the possibility of delaying the system implementation

Order of Operation

In order to develop the system requirements of a new project for a customer, take into account all the SKUs and how they will be handled, moved and stored. The very next step in the project checklist should be determining and selecting the plastic tote in which all of the product will be transported and stored.

The tote will be handled in all phases of the system by almost every piece of equipment. To design a conveyance, sorting and storing system without determining the tote is backwards, inefficient and will end up costing the customer unnecessary time and expense. It *can* be just an inexpensive plastic box, after all, but *only* if you plan for it.