Designing A Distribution Centre

Design is one of those activities that everyone gets involved with from time to time, whether its part of the house, garden or a hobby. So why should designing a Distribution Centre be so different or difficult. It's true that the same fundamental principles apply but does the application of these principles or even the application of as set process produce the required results? An example I can use to demonstrate this point is following a cookery recipe. By the application of reasonable skill and diligence and following the instructions of the recipe the (desired) result can be produced. Clearly things can go wrong but if the process is correct the result should be achievable.

Figure 1 - Cooking without a recipe?

Designing a warehouse has more parallels with cooking without a recipe. To produce a good warehouse design a detailed knowledge is necessary of the requirements, the component parts and how they fit together. Whilst the design process is partly scientific with the data collection and analysis there are also those far more subjective issues such as the culture of the business and the ability to cope with complexity.

This is not to say that warehouse design is a black art and can't be defined in a process, far from it and this article addresses this point. There is however a point in all designs where the designer is faced with the blank sheet of paper (or screen) and has to start putting lines on it. For every line drawn more questions are raised:

- Is the area large enough;

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- What about peak periods;
- What about personnel and truck access;
- Is the flow of goods logical.

This is the part of the process that can be most frustrating or most satisfying depending on the amount of preparation work undertaken up to this stage. If every choice of how large to make an area or where to put it in relation to another answers one question but raises several others this is a clear sign that the early and essential design work has not been done.

Having been directly involved in warehouse and logistics design for the last 20 years and having spent a good proportion of these working as a designer or running a design department I've learnt to quickly spot when the design process has been followed and the people who make the best designers. One of the best indications of this is when designers bring their work to you and want you to challenge it. The designer should have the confidence to want to explain and show what a good job they have done but more importantly they should be looking to get a different perspective on the decisions made when creating the design. This not only gets commitment from all stakeholders but also makes the solution more robust to stand the scrutiny of other groups later in the process. There is very rarely a single solution to the design of a Distribution Centre and others will bring different ideas and perspectives to it dependant upon their background and involvement with the project.

To stay with the philosophical theme a little longer, a good designer has to be honest with themselves. You cannot design something well without a clear and detailed understanding of its intended use, the components from which its constructed and how it fits together. Only by developing this clear understanding of these points for each project can a designer openly defend the decisions made in creating the design. When questioned, if designers give defensive answers like: its down to experience; its too complicated or involved to explain or it's a design that's been successful for many other projects; these are clear warning signs that they may not be confident about openly explaining their work.

The Design Team

So far we have talked mostly about the designer. A successful DC design requires a team of the main stakeholders. The business and supply chain objectives, the operations and

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maintenance of the site all need to be included in the process. The designer will include and represent these views in his solution but how these different and not necessarily complimentary objectives have been included, is best reviewed by the stakeholders. It is the designer's role to use and coordinate these essential inputs.

The Design Process

Let's first of all deal with the intended function of the DC. The market, suppliers, products and inventory are usually defined during the design of the supply chain leaving the DC design to cover more practical matters. The starting point can be the customer requirements; what they want, when they want it and how it should be delivered. Satisfying this eventually comes back to the suppliers; what they supply, when they supply it and in what quantities. The function of the DC is to satisfy the customer requirements by holding and processing sufficient quantity of the defined products and stock.

Data Acquisition and Analysis

As many DCs are built to meet future demand criteria such as business growth, company acquisition, product growth etc. need to be defined and modelled. This is often one of the more difficult areas to accurately define and will include information from Sales, Marketing, Strategy and Management. Hard data to support this growth is not often available and needs to be developed by factoring information from current operations. To do this effectively there is a need to understand the source of this data and to interpret it correctly.

As with all data analysis, having the technical ability to acquire, clean and manipulate large amounts of data from different sources is only half the battle. It is as important to define what information is required from the data and how best to develop or extract it.

Operational Models

With the future operations defined it is then a case of translating this into pallets, cases movements and areas. One of the most effective ways of doing this is to create an operational model of the DC. In its simplest form this can be spreadsheet based and can define each operational area by function, size, products, stock and throughput. The key to the effectiveness of these models is to make them interactive, so by changing parameters such as throughputs, tote fills, pallet sizes, days of stock or operating hours, the total DC

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requirements will automatically change. This enables the model to represent many different operating scenarios that could be seen in the future.

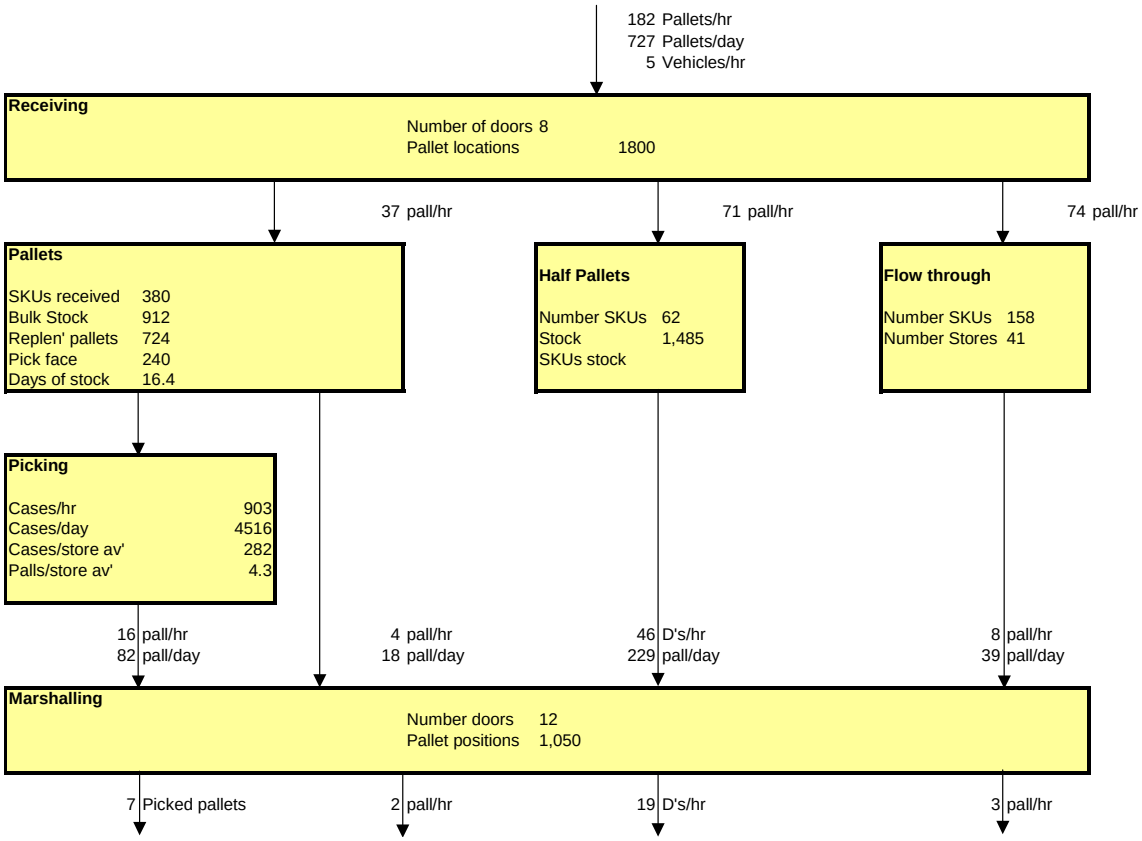

Figure 2 - Example of a simple Operational Model

For more complex functions and data the model can be created in a database to enable more powerful data manipulation tools to be used. This allows more detailed analysis to be undertaken such as the definition of exactly what products will be defined as fast, medium or slow movers and the effects of including or excluding different products or product groups. An example of the output from a database model called "i-flow" is shown in Figure 3. This technique is best used where existing data is used to project growth, flows and stock are required to be defined down to product levels.

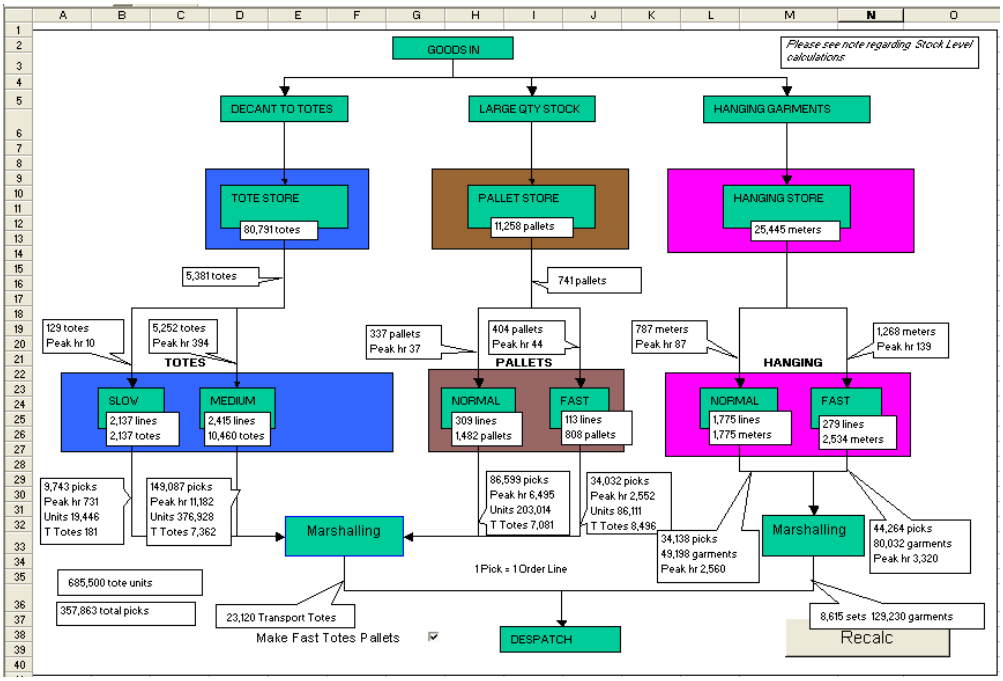

Figure 3 – "i-flow" database model

Concept Design

With the requirements clearly defined and analysed, a number of operating concepts can be investigated. Whilst this is a very creative part of the process the work done to date has often short-listed a number of possible concepts. Customer service levels can demand that each order is order picked and despatched rather than being handled more efficiently as part of a batch of orders; product shelf life may dictate that the item is not held in stock but flowed through the DC; or long lead times for supply from another country may dictate that high levels of stock are required for that product.

Working within these constraints, this is an area where the designer will use his experience to select different operating concepts that are applicable for evaluation. At this stage we often use a combination of the operational models and simple cartoons from our library to describe the concepts to the stakeholder group for evaluation. This way concepts can be easily evaluated and rated on how they meet the project objectives before developing full layouts.

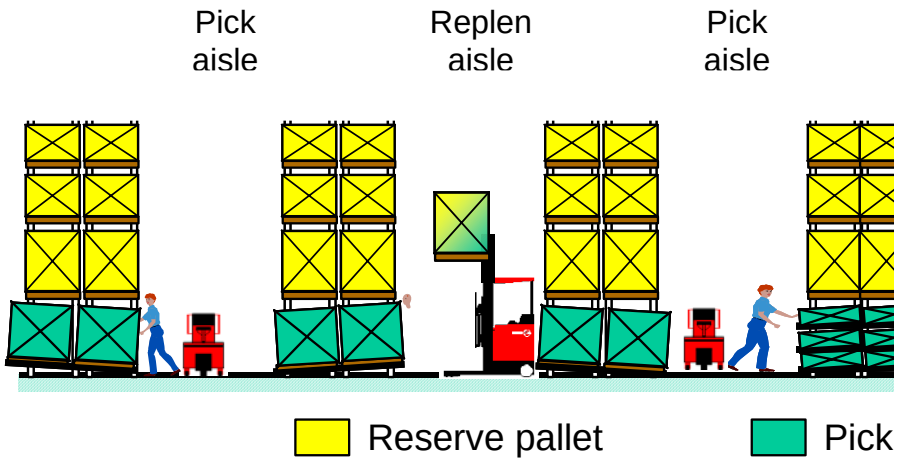

Figure 4 - Examples of cartoons used to describe concepts

Processes and Technologies

The choice of the optimum Processes and Technologies often runs hand in hand with the development of the operating concepts.

There are many options and technologies available from block stacking pallets on the floor to fully automated storage and picking systems. The choice of the most appropriate is largely down to analysis of the throughput, storage, product requirements, budget, costs and savings and the cultural fit of each potential solution. This is an area where the experience of the designer is key in knowing which are likely to be most suitable for this particular circumstance and how to design the system using this equipment.

Depending on the technology, there may be benefits in obtaining information from suppliers during these stages. If solutions and dimensions are dependant on a specific technology or detailed pricing required for a business case suppliers can provide these details.

There may not be a single solution or technology that satisfies the objectives of the project so it is often a requirement to evaluate how each solution meets these and compare this along with capital and operating costs.

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Producing Layouts

We can get to this stage in a project without putting our hypothetical pencil to paper. This comes back to the earlier comments that the design must be built on a detailed understanding of the requirements and building blocks. If I use the analogy of painting an old window frame; if the frame has been rubbed down, filled, treated and the window areas masked; painting the frame is actually quite easy and enjoyable. Likewise if your DC design requires you to jump back to the requirements and analysis stages it can be like painting over the old flaked paint and wiping away the runs. If the preparation isn't done its unlikely to stand the test of time.

Figure 5 - Flaking Paint on old windows

With the processes, technologies and individual areas defined the overall size, shape and physical material flow can be established within a building. It is at this point that we undertake the activity that most understand as the design process – putting the building blocks into the layout then developing the detail. This is undertaken on CAD (Computer Aided Design) systems to give great flexibility to develop different layouts and options quickly and accurately.

Even with the preparation work complete the layout work is still an iterative process. Only with the different elements being laid into their prospective positions to achieve the material flow can you fully evaluate the relationship between them and the effect on other processes. External factors such as building columns and doors; operational factors such as personnel access, safety and truck manoeuvring areas are best detailed from the first layouts.

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This is also time for more input from all the stakeholders on the team to challenge the design to ensure it meets the requirements in the design brief. The designer should be able to provide detailed answers to questions such as:

- How does it meet the volumes in the future?
- What if my customers want smaller orders in the future?
- How do people leave the building in the event of a fire?
- Are there any single points of failure?

Inevitably questions come up that are not in the design brief. Whilst this demonstrates the importance of investing time in the brief, the purpose of the design process is to design and visualise the facility before its built and some requirements only come to light when the layout is reviewed. The time and cost of making changes at this stage are still minimal if compared to making these changes when the system has been built.

From an agreed layout the detail can be added that will allow any selected suppliers to undertake their detailed equipment design.

Three Dimensional (3D) Layouts

Whilst working with two dimensional (2D) layouts is fast and making changes and iterations is more immediate it takes practice to interpret these drawings. There are therefore many benefits in producing three dimensional layouts when the design has been developed.

Designers, engineers and many others involved in the design process will find it perfectly adequate to work from a 2D drawing but a 3D drawing will bring a design to life and provide a far better visualisation of the building and operation. This gives a far better feel for the scale of the equipment, empty spaces in receiving and marshalling and the physical distances that operators will need to walk. Additional time is required for 3D layouts but having already developed the 2D layouts this is not a great deal of extra work.

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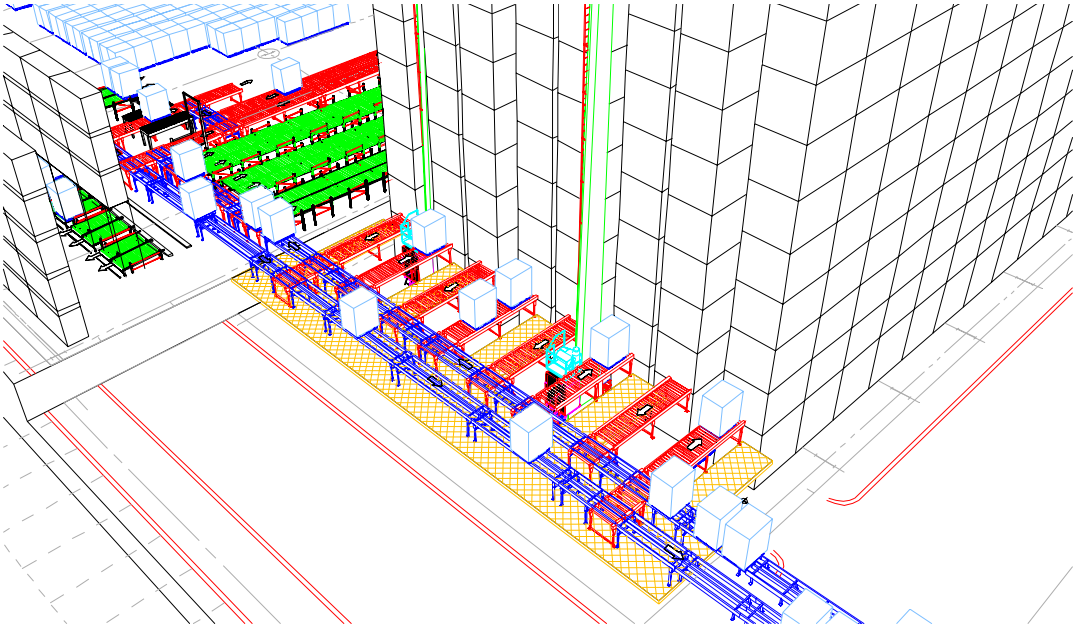

Figure 6 - Example of a 3D Layout

Animation and Simulation

3D layouts bring a better visualisation of the project to technical and non-technical audiences. For presentation purposes these 3D layouts can be both rendered and animated. Rendering is undertaken by defining light sources that will create a shadowing effect on solid objects and animation is to have objects moving within the layout or the viewpoint of the layout continually changed to achieve a walk-through or fly-through effect. Whilst this provides an excellent tool to explain the operation of a DC to the Board, Workforce or Investors it does require additional work to produce and change.

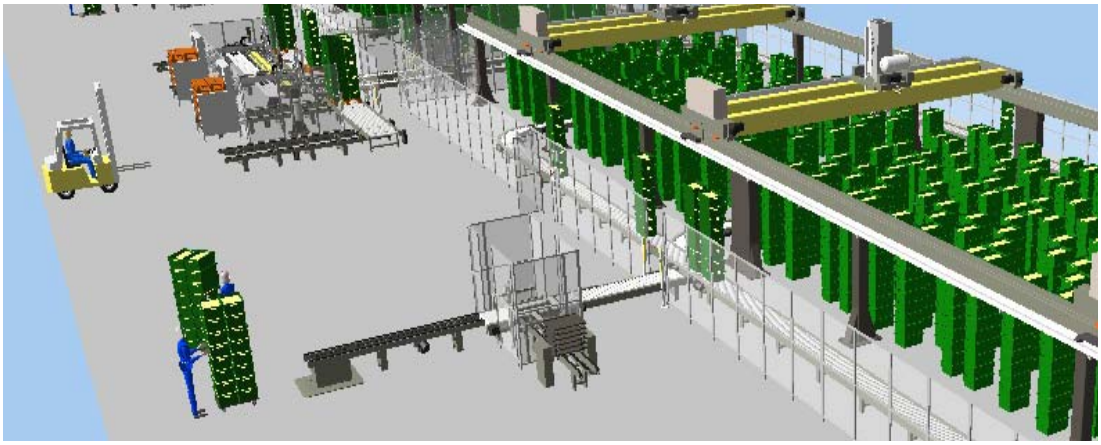

Figure 7 - Example of a rendered layout for animation

An animation does not however work from the full logic of how the system would operate behind the moving images. As the function is to create a visualisation of the operation items moving on a conveyor can for example, be a constant stream or even a random stream. To define the operating logic on how the final system will operate will require a simulation.

The information that is put into a simulation is developed in the early analysis and modelling. The different flows, peaks and bottlenecks should always be defined at the early stages of the project. The role of simulation is therefore a crosscheck or proof that the design work has been undertaken correctly as oppose to being the design tool or process. Simulations become more useful as the complexity of a project increases. Every part of a project should be able to be designed to the brief; where the interrelationships of different elements of the project, complex operating logic and time elapsed play a greater role, this is where a full simulation becomes more important.

An important consideration for simulation is that it will only represent the operation of a DC if the full operating logic and decision making within the DC is modelled. If simplified logic is used and data sets are summarised or reduced, the results will reflect this. How close the final simulation is to the eventual operation of the DC is therefore largely down to how this rationalisation or simplification was undertaken.

Summary

Whilst we have covered many aspects of the design process the following fundamental principles are required to make this successful.

- All stakeholders have to be involved in the design process;
- A clear and detailed brief needs to be developed;
- DC design is a process that starts with a detailed understanding of the requirements, concepts and processes;
- The company culture, operational methods and skill sets available need to be taken into account in the design process;
- The drawings or layouts are developed towards he end of the process when much of the work is complete;

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- Open challenging of the design is essential and should be encouraged. Good designers should not be defensive about their work;

- Tools such as 3D, Animation and Simulation are very useful to achieve specific objectives at the end of the design process but should not be used to replace the design process.

Whilst these points provide valuable guidelines on the design process they cannot be too prescriptive. All DCs are likely to include some form of receiving, storage, picking and despatch but when you consider the complexity of different products, suppliers, customer requirements, operational constraints and company cultures, no two DCs are likely to be the same.

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