Today’s food and beverage companies often use many different product families or formats, with each product family having a set of specific processes unique to it. SKUs are made up from unique combinations of products (varieties/flavours or qualities), primary packaging formats and secondary packaging formats. In primary packaging, for example, cans and bottles can be different sizes, different shapes and may require widget insertion. Likewise, bottles may require caps or crowns; new glass lines and returnable glass lines frequently merge so common equipment can be shared. Secondary packaging may involve, for example, hi-cones, shrink-wrapping, a wrap-around format, or even more than one of these options. To provide flexibility it is frequently possible to flow products out of several primary packaging modules into several secondary packaging modules.

Even within a packaging module, different products may or may not undergo certain operations. For example, a subset of the SKUs may be shrink-wrapped after being loaded into trays. Moreover, each operation may be performed in a variety of ways e.g. hi-cones may be placed around the top or centre of cans. At each stage in the packaging process, any change in the SKU could instigate a setup on a machine. Optimizing the performance of a packaging facility becomes increasing challenging as combinations increase and the number of SKUs multiply.

Today’s market trends, such as demand for multi-variety packs, further compound the problem and thus many organisations are exploring simulation modelling techniques and simulation software to seek clarity, improve their understanding of complex systems and drive through performance improvements.
**Line Design**

The design of a packaging line usually revolves around the V-curve or V-Profile principal (this is also referred to as the bow-tie by some companies). The concept of the V-curve is to ensure that the bottleneck asset is neither starved of material nor blocked due to any issues upstream and downstream respectively. Therefore it is fed with material at a rate greater than it can cope with; likewise, the downstream process is capable of running at a greater rate hence cans or bottles are pulled away faster than they are processed to prevent blockage. This increase in speed continues both upstream and downstream of the bottleneck asset, which is usually the filler because this is also the most expensive equipment item.

All of the aforementioned concepts relate to good design philosophy. However, there are many unanswered questions. For example, what are the specific speeds that each machine in the line should operate at and how much accumulation should there be between each machine to ensure that minor stoppage profiles do not interfere with the operations upstream and downstream. For example, if the upstream machine stops, then there should be sufficient parts accumulated on the incoming conveyor to continue production until the minor stoppage on the upstream machine is rectified. Similarly, if the machine downstream stops there should be sufficient space on the out-feed conveyor to carry on producing and avoid a blockage. The objectives here being to design the line to maximize the usage of critical equipment and maximize the absorption of minor stops.

**Other Important Factors**

The performance of a packaging facility is also heavily related to the performance of the line preparing the product to undergo packaging. For example, an upstream issue may delay the supply of the materials to be packaged. Likewise, an issue with the packaging lines may cause the upstream production facility to block or even result in waste. This gives rise to the need to validate the design of facilities to ensure that they will perform in accordance with expectations and any unforeseen issues are fully addressed prior to sanctioning capital investment.

**How Simulation Can Help**

The use of simulation modelling is ideally suited to designing new packaging lines and determining the potential for performance improvement in existing facilities. Simulation modelling has been successfully used to validate capital investments (so that performance goals are realised at the minimum cost) and investigate how to sweat existing assets (i.e. make changes to increase efficiency and throughput).

Simulation modelling involves creating a computer model to mimic a real production or logistics process. Simulation’s unique time based approach, in conjunction with the ability to reflect the factors that vary, enable simulation models to accurately mimic the complexities of a real life packaging system. Each breakdown profile, minor stop profile and changeover is accurately reflected using statistical distributions to represent the variations that would naturally occur. Building a simulation of a packaging process provides an invaluable insight into where inefficiencies and the true bottlenecks lie. Simulation quantifies the performance of a packaging process in advance of implementation; ‘what-if’s’ are conducted to evaluate alternative scenarios. This enables proposals to be fine-tuned to exploit opportunities and allows the interested parties to arrive at a consensus reinforced through a proven methodology. The uncertainty and risk associated with major business decisions involving complex processes is mitigated.

Simulation models encompass a dynamic animation reflecting the status of all aspects of the model. For example, cans or bottles can be seen flowing along the conveyors and through the various packaging processes. The animated screen makes use of icons to represent the products and equipment. In the latest simulation software, leading edge graphical technology is used to provide accurate 3d animations which are immediately recognisable as scaled accurate models of the real facilities. This provides a superb communication medium for all members of staff involved in designing and working in the facility.
Benefits Achieved
Example benefits as a result of using simulation on canning and bottling lines are:

- Major Capital Avoidance (i.e. dismissal of business cases that would not have provided the required return on investment)
- Increased Throughput and Efficiency (by understanding where the opportunities for optimizing machine speeds and the use of accumulation exist)
- Better Targeted Continuous Improvement Activities (rather than targeting the machine with the 'worst performance' the bottleneck machine can be targeted; just because a machine is not performing well in isolation, does not mean that is detrimentally impacting the holistic performance of the line)

In many cases such projects help deliver huge savings, improve efficiency and dramatically increase confidence in the outcome of the project. Simulation modelling technology has been adopted both as a continuous improvement tool used by the organisations themselves as well as by the engineering companies who provide specialist design and build services. Companies using simulation software or simulation services include: Guinness, Scottish Courage Brewing, Krones and Pepsi Cola. Typical simulation software used in this sector include Flexsim, Arena, EMPlant, Witness, and Automod.

Expert Advice
This paper was written by Saker Solutions Limited, an independent supplier of simulation services. Using experience gained in over 40 years of working in industry, Saker staff have been involved in applying simulation to a wide range of application areas. Saker has the ability to help clients achieve real business benefits from the use of this exciting technology.

For more information
Visit the simulation centre at www.sakersolutions.com for the latest information on business simulation solutions or call 01527 892296 or email info@sakersolutions.com.

About Saker Solutions
Saker Solutions has been launched to provide a one-stop shop approach to simulation. Linking with some of the worlds leading product developers and utilising experience from across the world Saker Solutions is able to offer its clients the right solution for their needs. Saker Solutions can advise on the right simulation product for the job or provide tailored solutions based around a range of tools always ensuring that their client receives maximum benefit from their investment.