

# **Flexible Mandrel and Well System for Folding Corrugated Fibreboard Trays**

by

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## **Abstract**

This research was a collaborative project funded by Visy Research and Development Pty. Ltd. and undertaken between Visy Packaging Systems Division (PSD) and the Industrial Research Institute Swinburne (IRIS). The project commenced in July 2000 and was completed in July 2002.

The primary objective of the project involved an investigation of how to increase the flexibility of corrugated fibreboard (CFB) tray forming equipment by developing a flexible (size changing) mandrel and well system which folds the trays from a flat blank. This type of equipment is produced by Visy PSD and installed at customer sites. This objective was achieved, and a working, innovative prototype was developed and manually tested. This paper provides a background introduction to the corrugated fibreboard folding machine history with particular regard to flexible mandrels. The industrial implications of the research and development program are overviewed and an introduction to the CFB tray folding process is provided. The size change requirements are defined and the design and development process used in guiding the research and development program is outlined. The prototype was designed, built and subjected to manual testing and was adopted by Visy PSD and was being incorporated into a complete machine for customer production use.

## **1. Introduction**

Paperboard folding machines which used the mandrel/plunger through well/die system have been in operation since the late 19<sup>th</sup> Century. They had developed in various forms since this time and were still being developed in the 21<sup>st</sup> Century. Most of the designs were for fixed size tray folding and to fold another size tray using the same machine required additional tooling and tooling changeover and resetting of the machine. This tooling changeover and machine resetting could take 45 minutes or more, which required downtime for the machine and skilled labour to perform the task. For these reasons several flexible (size changing) mandrel and well systems had been developed, the earliest recorded design found was in 1893 in the USA (Patent No. US497949). From 1893 to the time this research program was conducted, another 16 designs, were found, for flexible mandrels which had been patented.

The objective of this research program was to develop an innovative (i.e., incorporating new methods) size changing mandrel and well system that could adjust to size change requirements for folding trays as an integral part of the machine and not require additional tooling, excessive downtime or skilled labour to perform a size change.

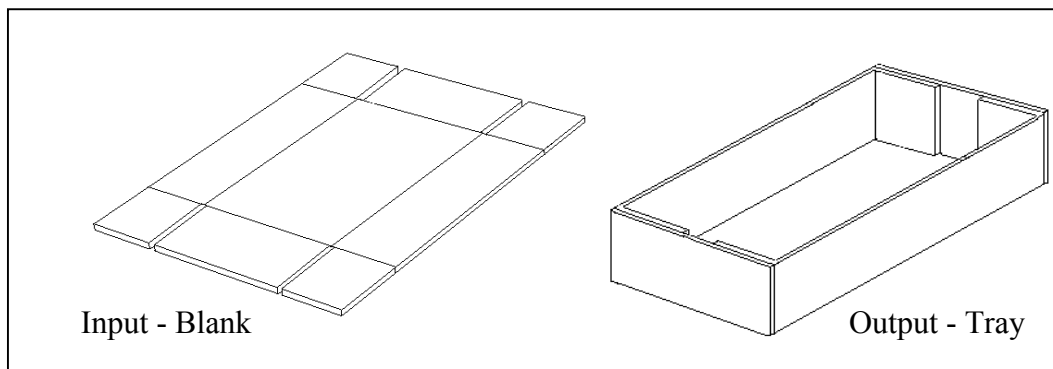
The risk level associated with this project was low to medium and there was a good probability of realising an operational prototype, which was evaluated and which may later be enhanced and commercialised by the collaborating partner company.

## 2. Industrial Implications

This system could provide a competitive advantage for packaging machine manufacturers. At the time of this research program machines with a fully flexible mandrel size change ability, within a specified size range, were not available on the market. To develop a system that is technically simple and cheap to produce will enable customers to have greater operational flexibility and efficiency in folding CFB trays. Current customers include meat abattoirs, fruit growers and vegetable growers. A market survey to identify other potential users could be conducted.

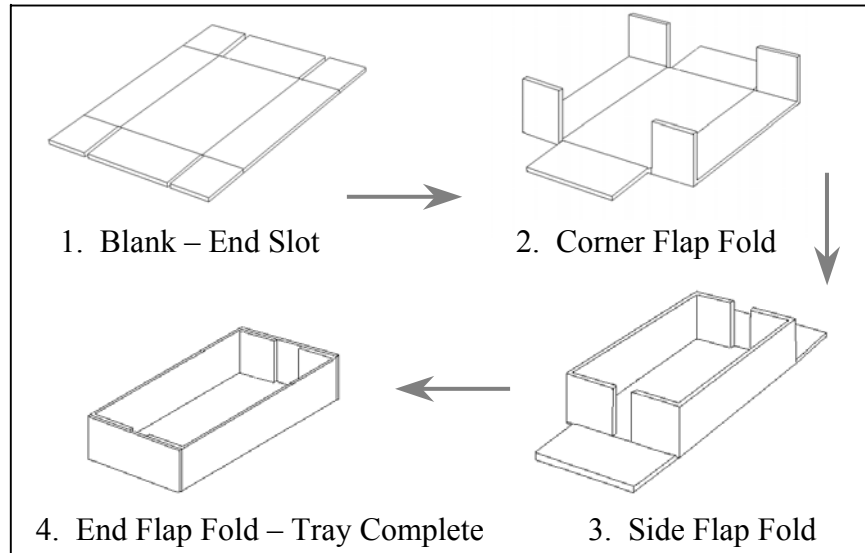
## 3. Tray Folding Process

The input to a tray folding machine was a corrugated fibreboard blank and the output was a glued and folded tray. Figure 3.1 shows a CFB blank and folded tray.



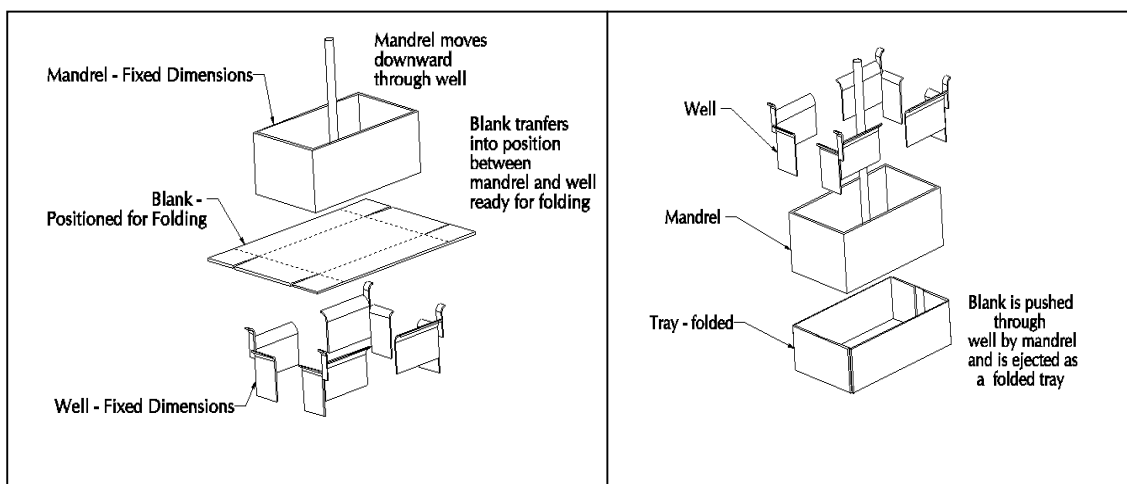
**Figure 3.1 - Corrugated Fibre Board Die Cut Flat Blank and Folded Tray**

The folding sequence for an end slot tray is shown in Figure 3.2. The flat blank was fed in and the corner flaps folded, then the side flaps folded and finally the glued end flap was folded to produce the finished tray.



**Figure 3.2 - Folding Sequence for End Slot Tray**

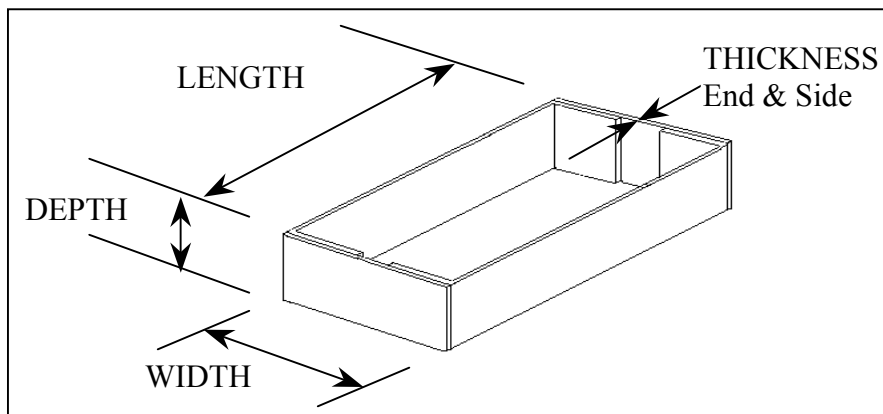
Figure 3.3 shows the mandrel through well principle for folding the blank into a tray. The blank was positioned between the mandrel and well and the mandrel moves downward and pushes the blank through the well. The blank corner, side and end flaps contact the well fold guides and fold the tray flaps in the sequence as shown in Figure 3.2.



**Figure 3.3 - Mandrel through Well Folding Principle**

#### 4. Size Change for Tray Folding

On a tray, the dimensions which could be varied were the length, width, depth and thickness (side and end), as shown in Figure 4.1. The length multiplied by the depth (i.e., the bottom area of the tray) was commonly referred to as the footprint. Three main characteristics can vary for the trays. These are the tray type, board flute type and tray dimensions. For this program the tray type selected was an end slot and flute types were A, B, C and E (these are different thicknesses). The mandrel and well system needed to adjust to fold trays with variations in all five dimensions.



*Figure 4.1 - End Slot Tray with Dimensions (variable) Shown*

#### 5. Prototype Design and Development Process

The main objective of the research program was to develop a working innovative prototype flexible (size changing) mandrel and well system for folding corrugated fiberboard trays. The outcome was of a practical engineering nature and therefore an engineering research, design and development method was deemed appropriate. Figure 5.1 shows the design and development process adapted for the research and development program.

The process started with a design brief outlining the general requirements of the research and development program. To define the requirements more specifically and technically a product design specification was developed. To assist with the planning and methodology of the program a resource assessment was performed. The literature review provided a insight into the history and current state of the industry manufacturing tray folding machines. To obtain technical information that was used in the design and build process a fixed size tray folding machine performance was benchmarked. Analysis of the size changing requirements was also performed.

From the previous stage, conceptual potential solutions were generated, evaluated and a suitable concept selected. The concept selected progressed to the detail design stage and was finally built and manually tested, for fold and size change performance.

The detail design, build and test section was divided into the two stages of preliminary and final. A preliminary detail design, build and test stage was performed, to test the primary function of folding performance, and in the final stage the size change mechanism was included.

## **6. Prototype Developed**

The prototype was designed, built and subject to manual testing. This marked the end of the research and development program. The prototype was adopted by Visy PSD and was being incorporated into a complete machine for customer production use.

## **7. Conclusions**

A prototype flexible size changing mandrel and well system was developed. The design was innovative in operation and cost effective to build and sell. The process shown in Figure 5.1 was effective and efficient in guiding the design and development process.

The prototype needed some minor design modifications before being fitting to a purpose built machine and tested under full machine production conditions before being sold to a customer requiring a range of tray sizes.

## **8. Acknowledgments**

The assistance, advice and guidance provided by the following people was greatly appreciated in helping this project to progress more effectively and efficiently.

Ed Kosior - program progress

Ian McBride - prototype design and build

Brian Dempster - prototype component manufacture

Colin Mierisch - prototype component manufacture.

## **9. References**

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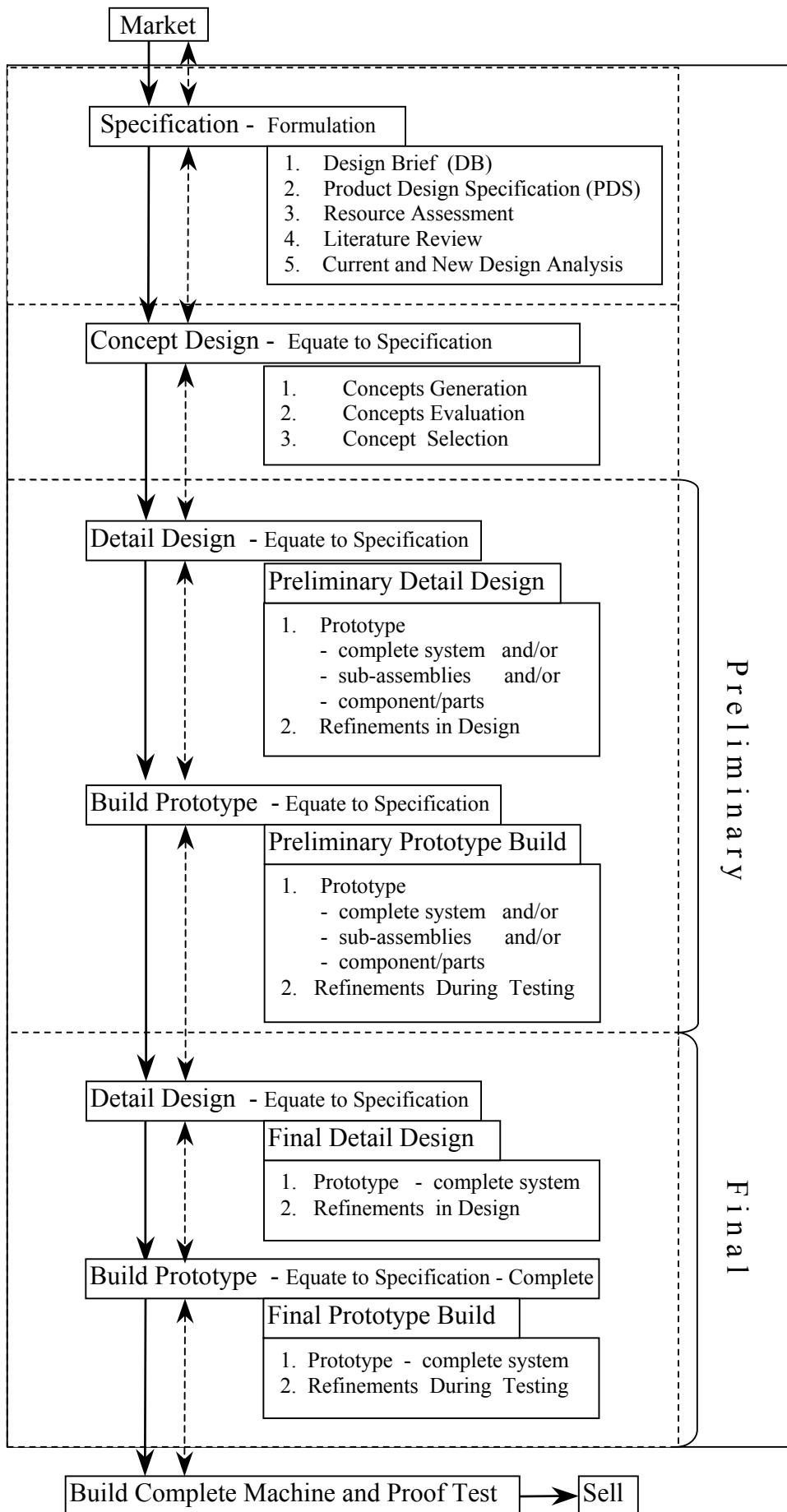


Figure 5.1 - Engineering Design Process Applied