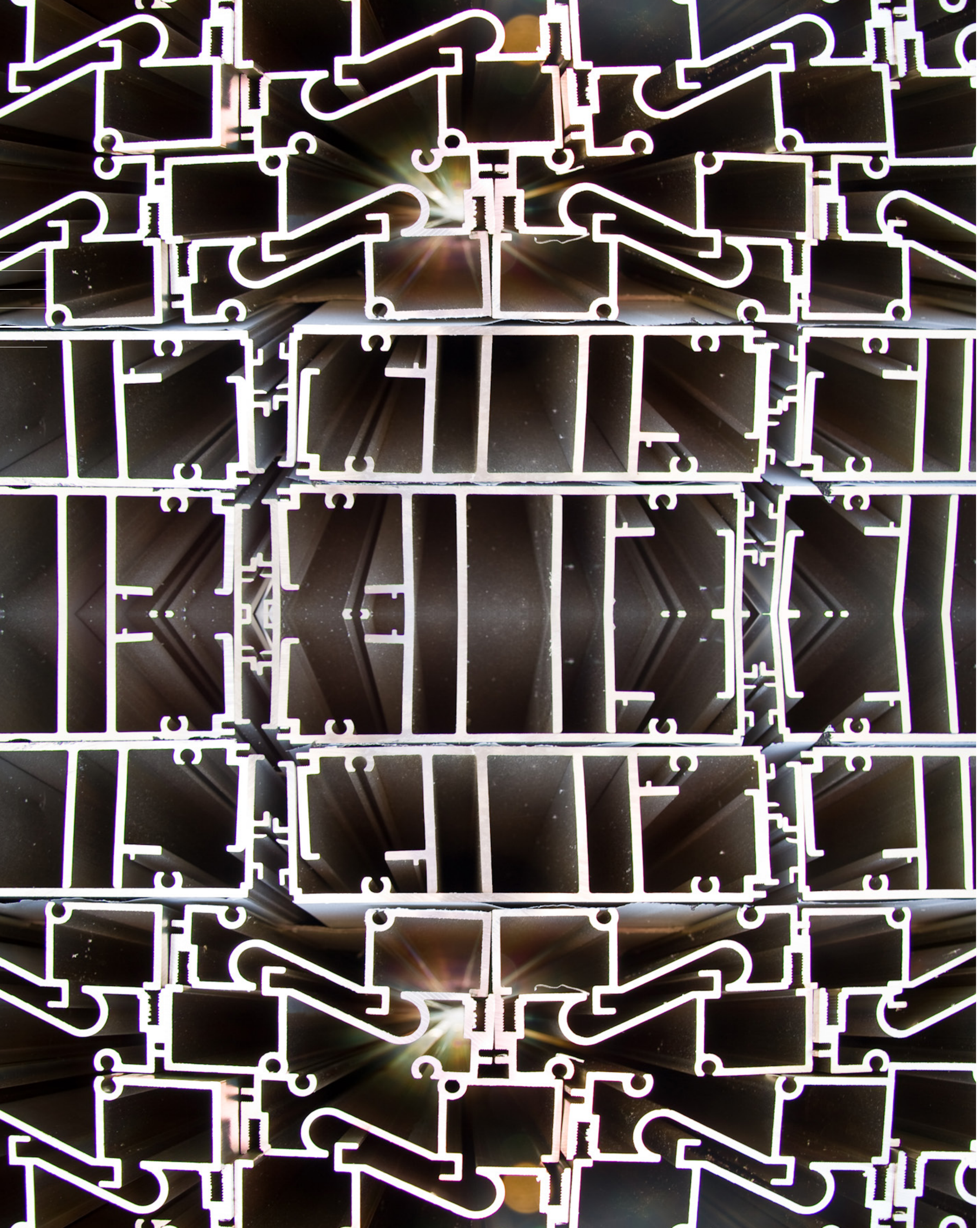

Automatic Parts Generation: Design Automation to Increase Productivity and Profitability

Conventional design is both sequential and iterative. But today's designers are thinking well beyond convention. Fast-track schedules have become the norm. Jobs that used to take years to design and document now take only months, thanks to Computer Aided Design tools and by implementing "Design Automation" we can complete months of custom engineering in just minutes. This paper discusses the current process of drawing generation from engineering point of view, provides a solution to overcome the gap between investment and productivity in generating drawings.

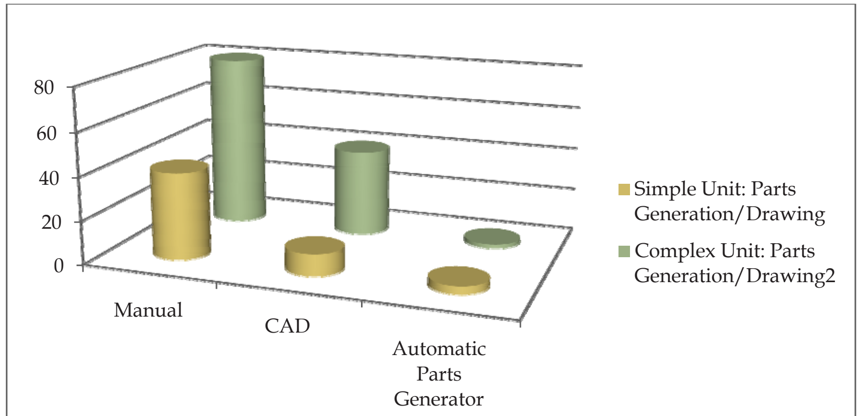

Figure 1. Time to complete a Unit in hours.

1 INTRODUCTION

Productivity increases through the use of computers have been negligible or difficult to achieve in various application domains. The huge investments in the computer revolution, in general, have not paid off in terms of productivity growth [1], a phenomenon that is commonly referred to as the productivity puzzle. CAD productivity in firms using Computer-Aided Drafting (CAD) systems does not differ much from this general picture. Firms that have used their system for one year report productivity increases of only 5% and typically do not report the increase in productivity growth until they have worked with CAD for five years [2]. Historically, the high cost of engineering has contributed so significantly to the attack on profit margins that numerous attempts have been made to cut the process time or the cost of engineering activities. Most of these approaches have been point solutions, which can be highly important in their own right, but are not applicable across the board. Automating design generation, on the other hand, stands out as an effective means of dramatically cutting costs for a well-defined, well-proven range of engineering activities. This is especially so where business needs demand rapid, accurate quoting; consistent engineering; and, most important, minimum time to finished product delivery.

At Enclos in the early 80's, about 40 man hours was expanded to create fabrication drawings for a typical curtainwall unit and about 60-80 hrs for a "special condition" unit, later on the trend changed and until today we use various CAD tools to get the same work done which significantly decreased the amount of resources used to 10 hours for a simple unit and 40 hrs for a complex one; with "Automatic Parts Generation" the same amount of work can be done in a few minutes irrespective of the complexity of the unit.

We attempt to design a system which would not only automate parts generation and drafting process but also significantly improves our productivity.

The goal is to reduce design costs. Traditionally, we have had two options:

1. To design less and standardize the product range, or

2. To design faster.

If we want to limit our customers' choices, the first option is fine. However, the pressure to customize products has risen tremendously over the past few years. Hence to keep customers happy and grow profit margins, the second option is ideal. Along with growth, however, come growing pains, especially if the custom design process is unmanaged.

Here is a typical complaint that we hear from companies that do not automate their design process:

"Because we are always fire-fighting, I often have to use out-of-date drawings just to get the job moving. This can lead to huge mistakes. From receipt of the order, we usually have six weeks to get the job out the door. Unfortunately, we generally don't even get the drawings until after five weeks."

Automatic Parts Generation is the solution to the problem cited above—it provides rapid engineering as well as fast drawing and document production.

In the table below, the key benefits of Automatic Parts Generation are reflected by organizational level.

Table 1

Organizational Level	Benefits
Engineer	✓ Greatly reduces sales support requirements ✓ Dramatically reduces repetitive tasks
Engineering Department	✓ Significantly increases departmental productivity and throughput ✓ Greatly improves consistency, especially with junior engineers
Company	✓ Quickly enables first-to-bid on quotes ✓ Easily helps to ensure accurate bid and product costing for predictable margins ✓ Dramatically shortens time-to-delivery after order is signed ✓ Readily helps develop true teamwork between engineering and sales

2 CRITERIA

2.1 Ease of use

After all, who wants to invest time and money in a system that is so difficult to set up and implement that no one will use it? Engineers need a system that runs on hardware everyone can understand. Automatic Parts Generation captures engineering rules and use current engineering skills, rather than requiring engineers to become programmers, system integrators, or IT specialists.

2.2 Maintainability

The second criterion is maintainability. The introduction of an automation system is generally driven by one or more champions who can see the personal and company benefits of adopting this technology. However, there comes a time in a successful implementation when the system must move beyond the original champions. For this reason, our system can be understood by many and easily maintained by all. No matter what changes take place, we ensure that any project will continue. Additionally, our system enables you to document the details of the rules being used, and also present a clear picture of how they fire, relate, and affect each other.

2.3 Return of Investment

No system developed would be complete without a consideration of return on investment (ROI). CAD system is a major investment. Every minute it is used for design, you increase your investment. The ROI of an automation system depends on a number of factors including some of the criteria discussed above. Clearly, a key consideration is the length of time it takes to begin using Automatic Parts Generation in production. Finally, there is the question of how soon we will begin realizing returns. To a large extent, this depends on how we set your objectives and measure success.

3 METHODOLOGY

As a curtain wall contractor we need to consume design information coming from the architect.

3.1 Revit Process

- Extracts BIM info
- Identifies the Unique Units
- Extracts Unit info and stores in the DB
- Generates Shop Drawings

Revit is the starting point of our new curtain wall design process. The Revit model includes the Building Information Model, basic background geometry, scaled elevations, plans, floor slabs, and sections of the glazed curtain wall work in the context of the overall building. In addition, this process is responsible for storing the unit and BIM info in the database.

3.2 Inventor Process:

- Retrieves Unit info
- Gets the Fabrication Design
- Flex the design based on the data
- Creates new parts
- Saves Part info in the DB and
- Generates Fabrication Drawings

This process is responsible to query the database to retrieve the Unit info, and then uses Inventor to get the appropriate “Fabrication Design” and flex the design to exact dimensions. This includes adding the engineering level of detail such as creating the individual mullions, or to place the gaskets between the mullions and the panels, or to customize the panel surface itself, etcetera. It is also responsible to save the part information in the database and to create all the documentation necessary for manufacturing: assembly views, BOMs, exploded views, detailed part drawings, etcetera.

The manufacturing information can be provided to allow the members to be fabricated by computed numerical controlled (CNC) machines, thus eliminating another interface where error can occur.

3.3 ESP Database:

- Stores all the Unit and Part Info
- Used for Reports

The ESP database is the central database that is accessed by both the Revit and Inventor processes to share information. It plays a vital role in providing integrity of data and it is also used for generating reports.

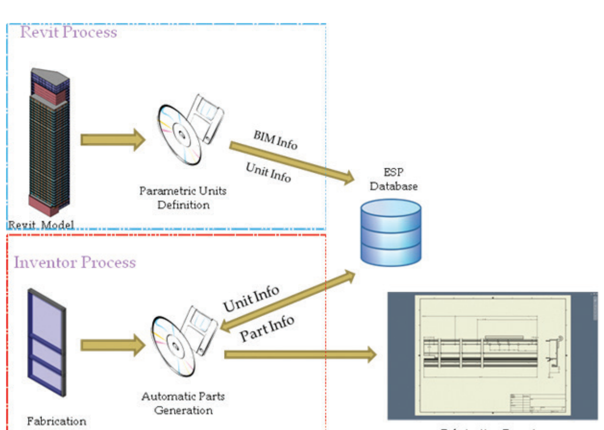

Figure 2. Relationship of different tools in the automatic part generation process.

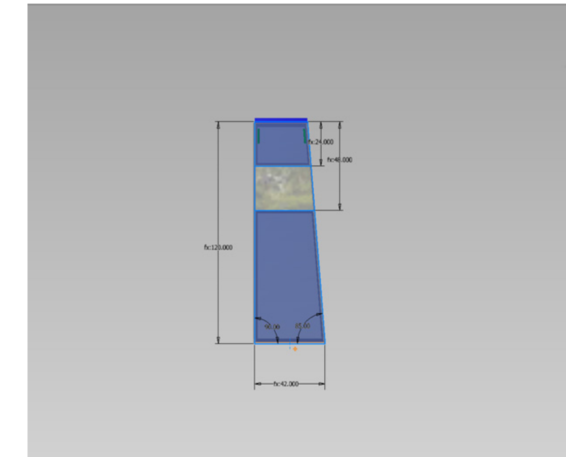

Figure 3

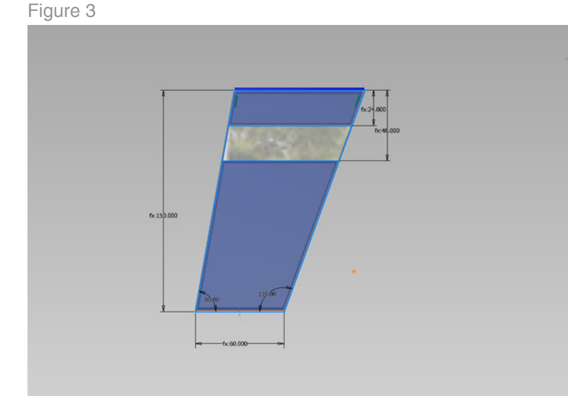

Figure 4

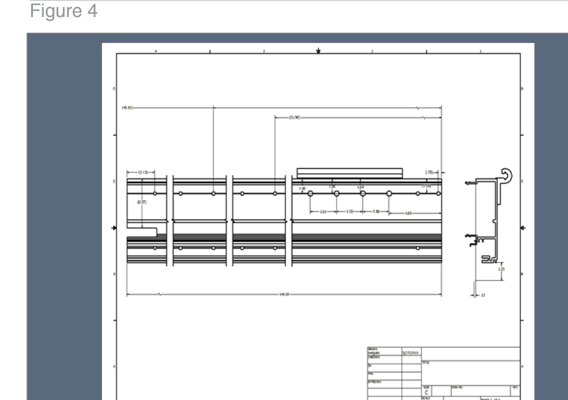

Figure 5

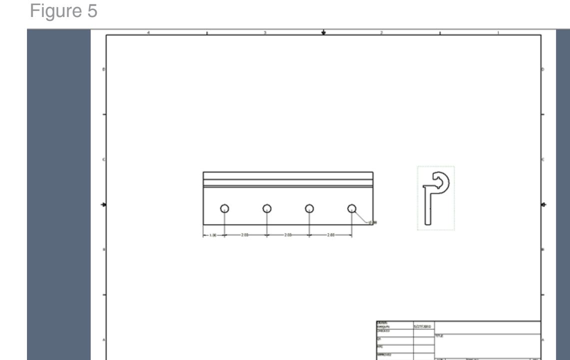

Figure 6

4 CURRENT STATUS

The following are the sample screen shots taken from the project completed so far:

1. Fabrication Design
2. Unit flexed with new Parts
3. Drawing generated for a Mullion and
4. Drawing generated for a fist

Figure 3 is the starting point of the Inventor Process, Based on the BIM Information we select the Inventor design that needs to be flexed/changed.

Figure 4 shows the unit after it has been flexed based on certain parameters retrieved from ESP Database. In this example the length of one side of the unit has been changed from 120 in to 150 in and its respective angle from 90 deg to 80 deg and another side has been flexed from 42 to 60 in and its respective angle from 85 to 110 deg.

Once we have the flexed units and its associated parts created, we generate the drawing for the same.

Figure 5 is the image of the drawing generated of one vertical with breaks at necessary preps along with its dimensions.

Figure 6 is the drawing generated of the fist along with its dimensions.

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