Proceedings of the 2025 Winter Simulation Conference
E. Azar, A. Djanatliev, A. Harper, C. Kogler, V. Ramamohan, A. Anagnostou, and S. J. E. Taylor, eds.

SCALING METAL FABRICATION PRODUCTION: A SIMULATION-BASED APPROACH TO FACILTIY DESIGN AND OPTIMIZATION

Adam Sharman[1], Adam Sneath[2], and Chiara Bondi[2]

[1]LMAC Group, Market Harborough, UK
[2]Simio, Sewickley, PA, USA

ABSTRACT

This case study examines how LMAC Group utilized Simio simulation software to support a New Zealand metal fabrication manufacturer in scaling production from 600 to 26,000 units while maintaining onshore manufacturing and reducing unit costs. The simulation model analyzed current production capacity, identified constraints, and evaluated mitigation strategies including shift pattern modifications and automation options. This approach informed capital investment decisions through data-driven insights before physical implementation, resulting in optimized resource allocation, improved machine utilization, and a comprehensive future state factory design.

1 INTRODUCTION

Manufacturing organizations frequently face challenges when scaling production to meet market demand. This case study presents a New Zealand-based metal fabrication company that successfully piloted a proprietary product with 600 units but needed to scale production 45-fold to approximately 26,000 units within the same timeframe. Key business constraints included maintaining onshore manufacturing in New Zealand, reducing per-unit production costs, and accommodating product variations.

The manufacturer partnered with LMAC Group to develop a simulation-based approach using Simio software to address three critical questions: (1) What is the potential production capacity of the current factory configuration? (2) What are the constraints in the current setup and how can they be mitigated? (3) What future state design would optimize production at scale?

2 METHODOLOGY

The simulation approach began with process mapping and data collection. The LMAC team captured machine times, setup times, and process flows before partnering with Simio to build a comprehensive simulation model.

Model Development

The simulation model represented the complete production process including:

- Sheet metal storage and retrieval
- Laser cutting operations that transform larger sheets into multiple smaller components
- Component storage in racks throughout the facility
- Folding and shaping operations
- Assembly processes
- Final product storage

The model incorporated several complex elements:

- Worker behavior modeling with prioritization logic for transport and machine operation tasks
- Storage rack modeling with process logic for interrupting holding and releasing products
- Batching movement simulation based on product characteristics
- Machine processing times and setup requirements
- Worker scheduling and shift patterns

Experimental Design

The team designed experiments to test various scenarios:

- Current state baseline with existing equipment and single-shift operation
- Modified worker allocation strategies to optimize resource utilization
- Alternative shift patterns including dual-shift operations
- Equipment modifications to address identified constraints

Each scenario was evaluated based on throughput, machine utilization, worker utilization, and identification of bottlenecks.

3 RESULTS AND DISCUSSION

The simulation revealed several key insights about the current production system:

Capacity Analysis

The baseline simulation confirmed that the current factory configuration could not achieve the target production volume, validating the need for either significant process optimization or capital investment.

Constraint Identification

The model identified specific constraints in the production process:

- Worker allocation inefficiencies creating bottlenecks
- Storage capacity limitations at key production points
- Machine capacity constraints, particularly at cutting operations

Optimization Opportunities

Scenario testing revealed several optimization opportunities:

- Implementing dual-shift operations significantly increased output without capital investment
- Modified worker allocation improved flow and reduced waiting time
- Adjusted batch sizes optimized worker movement throughout the facility

The simulation provided quantifiable metrics on machine utilization, enabling targeted improvements rather than broad investment assumptions.

4 CONCLUSION AND FUTURE WORK

The simulation-based approach successfully provided data-driven insights to inform strategic scaling decisions. The model demonstrated that while some production increases could be achieved through operational optimization, achieving the full 45-fold increase would require capital investment in new equipment and potentially a redesigned facility layout.

Future work includes developing a detailed 3D model of the proposed future state factory to enable precise ROI calculations and support implementation planning. This approach has broad applicability to manufacturing organizations facing similar scaling challenges while maintaining domestic production.

The partnership between LMAC Group and Simio demonstrates how simulation technology can bridge the gap between current capabilities and future requirements, reducing risk and optimizing investment decisions in manufacturing environments.