Creating Continuous Flow

An Action Guide for Managers, Engineers and Production Associates

By Mike Rother and Rick Harris
Foreword by Jim Womack, Dan Jones and John Shook

A Lean Toolkit Method and Workbook

THE LEAN ENTERPRISE INSTITUTE
Brookline, Massachusetts, USA
www.lean.org

Version 1.0
June 2001
The Shop Floor is a Reflection of Management

With gratitude to our editors Jim Womack and John Shook, OffPiste Design, our friends at many manufacturing companies, and Dave Logozzo, who coined the apt phrase, “Eyes for Flow, Eyes for Waste”.
We then urged readers to envision a future state for each product family’s value stream in which information flows smoothly back from the customer and the product flows smoothly — indeed continuously — toward the customer. Finally, we suggested an implementation plan for achieving future states quickly.

We have been delighted with the response to *Learning to See*, which has now sold more than 50,000 copies in English and has been translated into Chinese, French, German, Japanese, Portuguese, Spanish, Swedish, and Turkish. However, we have also been struck by the difficulty many readers have had in actually achieving continuous flow within their facilities.

A sight we frequently encounter when touring plants is processing steps relocated from departments (‘process villages’) to product-family cells (as recommended in LTS), but with only intermittent and erratic flow through the cell. Output gyrates from hour to hour and small piles of inventory accumulate between each operation. When we see this pattern, we know immediately that half or more of the benefits of cellularization is being lost. In addition, if the cell is located upstream from the pacemaker process leading directly to the customer, none of the benefit may ever reach the customer due to stagnation and instability in downstream activities.

So how can you create truly continuous flow with the benefits reaching the customer and sustained over time? The methods are not mysterious. Indeed, Toyota and its affiliated companies perfected them years ago. However, we’ve found that to actually apply them most managers, engineers, and production associates need a friendly *sensei* (teacher) to walk them through a step-by-step process that focuses their vision and targets their actions.
To fill this need we decided to publish this sequel volume to Mike Rother and John Shook’s *Learning to See*. In it we move from the plant to the process level as Mike and Rick Harris take your hand and lead the way in introducing and sustaining continuous flow to the maximum extent possible, beginning with the pacemaker process.

You already know Mike from *Learning to See*, but Rick Harris may be a new name. After fifteen years at General Motors, starting on the shop floor in Anderson, Indiana, Rick got his lean education at Toyota where he was a manager in assembly at the Georgetown, Kentucky plant. Rick and Mike now continue their lean learning by working with companies on lean implementation.

Those of you who have already read *Learning to See* and accurately drawn your current and future state maps will find the help you need in the pages ahead to achieve truly continuous flow and its many benefits. Other readers — who are just encountering lean thinking or who are process improvement veterans and think they need only a few tips on improving their existing cells — will benefit from studying the first section of this workbook to correctly identify product families and pacemaker processes. These readers will then discover many shortcuts on the path to truly continuous flow in the remainder of this workbook.

But a word of warning: Drawing maps and envisioning future states is invigorating and fun. After all, anyone can draw an attractive future state on paper. In *Creating Continuous Flow* you will be tackling the real issues of implementation, and success is only possible through intense collaboration between managers, engineers, and production associates. It’s hard work and you will make mistakes. But the benefits are enormous and all the knowledge you will need is summarized here.

Given the nature of your challenge we are particularly anxious to hear about your successes and your difficulties and to connect you with the lean community at [www.lean.org](http://www.lean.org). We also need to hear your suggestions for improving *Creating Continuous Flow* at ccf@lean.org. So please take the time to study this Action Guide carefully, referring back to *Learning to See* as necessary. Then seize the opportunity to implement and sustain continuous flow. And tell us about your experiences so we can share them with the entire lean network.

Jim Womack, Dan Jones, and John Shook
Brookline, MA, USA; Ross-on-Wye, Hereford, UK; Ann Arbor, MI, USA

www.lean.org
CONTENTS

Foreword

Introduction

Part I: Getting Started

Part II: What is the Work?

Part III: Machines, Material and Layout for Flow

Part IV: Distributing the Work

Part V: Connecting to the Customer and Regulating the Flow

Part VI: Implementing, Sustaining & Improving

Conclusion

About the Authors

Appendices
A: A Continuous Flow Refresher
B: The Standardized Work Combination Table
INTRODUCTION

Continuous flow is the ultimate objective of lean production, and creating continuous flow has been the goal of countless kaizen projects. We work at a wide range of manufacturing facilities and see many commendable efforts to create flow. Unfortunately, we see very little of it actually achieved.

For example, it seems that many of us have concentrated on making U-shaped process layouts instead of on the more important part: Creating and maintaining an efficient continuous flow. Almost any grouping of machines that performs processing steps in a sequence is called a ‘cell’, but it is rare to find real continuous flow which is what actually makes a cell a cell.

Ideally, product would flow continuously all the way through your value streams, from raw material to the customer. But that is too much to tackle at first. You need a place to focus. That place is the ‘pacemaker’ process or segment of the value stream, where products take their final form for your external customer. This is usually the most important segment of any value stream, since how the pacemaker operates affects both how well you serve your customer and what demand is like for your upstream processes. A steady production rhythm, level mix, and consistent continuous flow of material at the pacemaker process places regular and consistent demands on your value stream.

Yet a closer look at many pacemaker processes shows erratic and intermittent flow of product, fluctuating inventory accumulations between steps, excessive batching, output varying from hour to hour, and poor use of human effort due to the anchoring of operators to individual machines. Performance has certainly been improved over the old process village layouts, where equipment was grouped by type of machine, but much better performance and much leaner value streams are possible.

The objective of this book is to sharpen your eyesight and equip you with skills to achieve and maintain a truly efficient continuous flow of material. We’ll concentrate on operator-based cells because this type of processing is so widespread and — in a world of geographically scattered customers and short product life cycles — it is often important to be able to design and manage simple, inexpensive, flexible and reliable operator-based processes. We’ll use methods and thinking based on practices pioneered within Toyota and its affiliated companies, which you can utilize nearly anywhere you would like to create a continuous flow.

Tools and techniques can be useful, but the most significant thing you and your team can gain from studying this workbook is a better ability to see and feel flow. As you apply the methods described here you should automatically start to focus less on layout and more on flow. But the most important thing to do is to select one of your pacemaker processes and get started right away — today — because how much we learn depends on our action orientation and persistence in implementation. Don’t wait!

Mike Rother and Rick Harris
Ann Arbor, Michigan and Stamping Ground, Kentucky
June 2001
Continuous Flow
This book focuses on creating continuous flow in pacemaker processes. But the concept of continuous flow goes beyond just pacemaker processes, extending everywhere to any production process. Similarly, the tools described in this book can be used in a variety of applications. This list shows the applicability of this book for various types of processes.

<table>
<thead>
<tr>
<th>Type of Process</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completely manual production</td>
<td>XXX</td>
</tr>
<tr>
<td>Operator driven cells and lines incorporating automated equipment</td>
<td>XXX</td>
</tr>
<tr>
<td>Conveyorized production lines</td>
<td>XX</td>
</tr>
<tr>
<td>Partially automated transfer lines (with operator work stations)</td>
<td>XX</td>
</tr>
<tr>
<td>Fully automated transfer lines (operators as line attendants)</td>
<td></td>
</tr>
<tr>
<td>Highly multifunctional automated machines</td>
<td></td>
</tr>
</tbody>
</table>

Definition of a Cell
A cell is an arrangement of people, machines, materials, and methods with the processing steps placed right next to each other in sequential order, through which parts are processed in a continuous flow (or in some cases in a consistent, small batch size that is maintained through the sequence of processing steps). The most well-known physical cell layout is a “U” shape, but many shapes are possible. Continuous flow processing is also possible in straight production lines. Many companies use the terms “cell” and “line” interchangeably, as we do in this book.
Team Involvement

Please note that you will need a team effort to create continuous flow. Lean systems rely heavily on production associates, especially for daily continuous improvement efforts, but they also depend on the daily involvement of management and engineering to set up systems, show the way, respond to problems, and manage the processes. Your team efforts to develop continuous flow will involve several people in your organization, including:

**Value Stream Manager** (see *Learning to See*): Draws and keeps fine tuning the future state value stream map, which shows the pacemaker process and where continuous flow is possible.

**Area Manager**: Leads the effort to create continuous flow and ensures daily that the flows are maintained and continuously improved.

**Industrial Engineers and Manufacturing Engineers**: Design the initial layouts and staffing levels of continuous flow cells using data they personally collect on the facility floor. They assist closely with implementation and debugging. Engineers also design, specify, and build the small, simple machines that are necessary to support continuous flow.

**Production Team**: The operators, team leader, and supervisor are essential for helping make the flow work, maintaining it, and finding ways to improve it on a regular basis.

**Maintenance**: De-bugs the new cell until it works as intended (with the Industrial and Manufacturing Engineers) and is then on a fast-response call for problems.

**Lean Specialists**: Assist all of these people.