

# It's About Time

The Competitive Advantage of  
Quick Response Manufacturing

RAJAN SURI



CRC Press

Taylor & Francis Group

Boca Raton London New York

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CRC Press is an imprint of the  
Taylor & Francis Group, an **informa** business

A PRODUCTIVITY PRESS BOOK



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# Appendix E

## *Implementing POLCA: The Material Control System for Low-Volume and Custom Products*

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I introduced you to POLCA (Paired-cell Overlapping Loops of Cards with Authorization) in Chapter 4, where I also listed the benefits of using this system to support your QRM strategy. I also explained why a “pull” system (using Kanban cards) would be wasteful if used for low-volume products, and wouldn’t work at all for custom-engineered products. I will not repeat those discussions here. In this Appendix, I help you get started with designing a POLCA system for your company.

Before you proceed with implementing POLCA, you need to put in place two key elements of QRM strategy:

- You must start by creating QRM Cells. Identifying the FTMSs and creating the cellular structure first is important; you don’t want to try to use POLCA to fix a poor organizational structure. It is not necessary to convert the whole organization into cells before implementing POLCA. You can put a few cells in place and start the POLCA system working in a limited area of your organization, and then grow the cellular structure and expand POLCA over time. Many companies have implemented POLCA in this incremental fashion with success.
- You also need to modify your MRP system to work at a higher level so that it performs as a High Level Materials Requirements Planning (HL/MRP) system explained in Chapter 4. Also, this HL/MRP system should be able to produce dispatch lists for each cell sequenced according to release authorization times for jobs at that cell, and indicating the next cell for each job, as also illustrated in Chapter

4. Usually both of these requirements are easily accomplished with only minor software programming in any modern MRP or ERP system and so they do not pose any obstacles.

There is one other important point I'd like to state before you go down the path of putting in a POLCA system. Remember that POLCA is a control system, not a planning system. The function of a control system is to help execute a plan. However, if you begin with a poor plan, then even the best control system can do little to make it succeed. Keeping this in mind, it is important that you have reasonable rough-cut capacity planning performed regularly, which ensures that you maintain sufficient spare capacity within all the cells as explained in Chapter 3. Otherwise the POLCA system will not work properly and your employees might even blame the newly implemented POLCA system for the failure to achieve your schedules and targets.

With these prerequisites and observations in place, you can now begin designing your POLCA system using the tips that I give you in the rest of this Appendix.

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## **BEGIN BY DETERMINING ALL THE POLCA LOOPS**

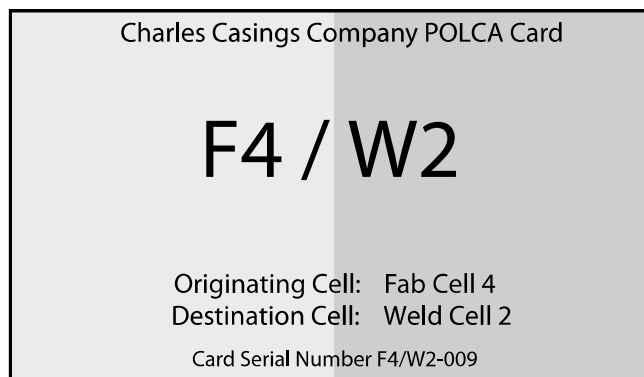
The first step in designing your POLCA system is to decide on the set of POLCA loops. This is easily done. Decide which cells to include in your initial implementation. Then take each cell in turn and for that cell ask your planners: When jobs are completed by this cell, what other cells might those jobs go to next? For example, if jobs from Cell A can potentially go to Cells D, G, and K, then you need to plan for three POLCA loops: A/D, A/G, and A/K. You perform the same analysis for each cell and thus generate the complete set of POLCA loops. If you are in doubt whether jobs flow between certain cells, analyze some historical data. Also, don't worry about getting it perfect because it is easy to add POLCA loops later. In fact, as job characteristics change or new products are added, you will need to modify your POLCA loops from time to time anyway. So take a first stab at the set of POLCA loops and get started.

It isn't necessary that the POLCA loops go only between cells. You can also include a few stand-alone resources. For example if you have a shared oven, or a specialized machine, and jobs need to go from the cells to that

resource and back, you can include that resource in the POLCA loops as well, just as you would a cell. However, do look through Appendix C (on the enclosed CD) for ideas about modifying situations with stand-alone resources before you include them in the POLCA loops.

As part of deciding on the set of POLCA loops, you should also assign a color to each cell or stand-alone resource and design the corresponding POLCA card for each loop. Figure E.1 shows an example of a POLCA card. The card should be large enough to be visible from a distance, and the most important information is the names of the two cells in the loop such as the “F4/W2” label on the example card, which should also be in a large font. Along with the label, the card background has two colors corresponding to the two cells. The left half of the card has the color of the first cell in the loop (the “Originating Cell”) and the right half has the color of the second cell (the “Destination Cell”). The colors help with visual management such as allowing planners or material handlers to identify a card from a distance. If you run out of colors, you can use black or colored cross-hatching on the card or any other innovative patterns to denote a particular cell. Get your cell teams to help brainstorm these ideas so that they “own” the color or pattern allotted to their cell.

The card also contains detailed explanations of the abbreviations for the cells in case an employee is not familiar with a particular abbreviation. As shown in the example, I also recommend that you put a unique serial number on each card, which helps planners keep track of the POLCA cards and—through occasional audits—to determine if a card has been misplaced or lost. Finally, you should note that the card does not have any part numbers, which a Kanban card always has—this is one of the



**FIGURE E.1**  
**Example of a POLCA card.**

advantages of POLCA over Kanban for low-volume or custom products as explained in Chapter 4.

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## **DECIDE ON THE QUANTUM—THE AMOUNT OF WORK TO BE DONE PER POLCA CARD**

The next step in your design is to determine how much work a POLCA card represents; in a POLCA system this quantity of work is called the quantum, and the motivation for it is as follows. A POLCA card returning to an upstream cell signals available capacity at the downstream cell. The question then is, how much work should the upstream cell send to the next cell along with this POLCA card? The trade-off involved is that on the one hand, if the quantum is too large, it will result in infrequent and “lumpy” flow—no work will be sent for a while and then a large amount of work will be sent to the next cell. As you saw in Chapter 3, variability in arrivals and large batches both make Flow Time worse, so this is not desirable. On the other hand, if the quantum is too small, many tiny jobs will flow between the cells and this will require a lot of material handling as well as a large number of POLCA cards in the loop, making it time consuming to manage and keep track of them. In setting the quantum, also take into account the ideal batch sizes you would like to run in the cells. Finally, you should consider how material is moved between the cells. For example, if housings are typically moved on a pallet that has room for four housings, then a quantum of four housings would work well with the material-handling process as each pallet could carry a POLCA card attached to it while it is being moved.

The quantum should be specified in any easy-to-use unit. The simplest quantum is a job (or work order). If jobs usually don't get too big in terms of their workload, then assigning a POLCA card to each job is the ideal situation and easy to implement. You can also specify a quantum in pieces, such as the preceding example of four housings. A third option is work content, such as 20 hours of machining.

When the quantum is the same as a job or work order, then POLCA works as described in Chapter 4. However, if the quantum is pieces or hours, here's how the quantum rule is used by the cell team. When a job is authorized and a POLCA card is available, if the workload in the job is less than or equal to the quantum, then the job is launched into the cell. If the

workload exceeds the quantum, then one of two methods can be used: If the job can be split, then the amount allowed by the quantum is launched into the cell. For example, if there are seven housings in the job and the quantum is four, then four housings are started in the cell. The remaining three housings will need to wait for the next POLCA card of the same type to arrive. If the job cannot be split, then the team must wait for another POLCA card of the same type to arrive before the job can be launched at all. Suppose this is Cell A, the housings are going on to Cell D next, and the planners don't want jobs to be split. Then the Cell A team needs to have two A/D POLCA cards before it can start work on the housings. Until the two cards are available, the team will need to skip this job just like it did when it was waiting for the one card to show up, and it can work on a job destined for a different cell (any cell other than D) if that job is authorized and has a POLCA card. As part of designing the POLCA system for your operation, you need to decide which of the two methods will be used so that the rules are clear for the cell teams.

The quantum doesn't need to be the same for all POLCA loops. Based on the characteristics of each of the flows, you could have different quantum rules for different parts of your shop floor, as long as this doesn't cause confusion or too much job splitting.

After you have decided on the POLCA loops, the quantum (or quanta if there are several different ones), and the rules for starting jobs, you should document all these in a flowchart. In addition to being a handy reference for cell teams, this flowchart serves as a valuable tool in the initial training of the cell teams, planners, schedulers, and material handlers as well as any new employees in the future.

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## **KNOW HOW TO CALCULATE THE NUMBER OF POLCA CARDS**

Now that you have the POLCA loops and the quanta decided, there is a simple formula to help you calculate the number of POLCA cards you should have in each loop. I'll use an example to show you the formula and how to use it. Suppose there is a POLCA loop between Cell A and Cell B, in other words an A/B POLCA loop. Let's say the lead time (in days) used in the HL/MRP system is  $L_A$  for Cell A and  $L_B$  for Cell B. Typically you calculate your POLCA cards for a planning period such as a month or a

quarter. Suppose the number of workdays in your planning period is  $D$ . You need to estimate the number of POLCA cards that will flow from A to B during this planning period. Note that this number depends on your choice of quantum: if a particular work order requires two POLCA cards, then you need to count this as two cards flowing. In Table E.1, I show you how to do this calculation easily using a situation where the quantum is five housings. This calculation requires that you have rough estimates for the number and types of jobs you can expect during the planning period. You need these types of estimates for your rough-cut capacity planning anyway, which is a prerequisite for POLCA as I explained at the beginning of this Appendix, so you should be able to get the rough numbers required for this table.

Using the approach in Table E.1, let's say you estimate that the total number of cards that will flow from A to B is  $F_{AB}$ . You now have all the data you need to calculate the number of A/B POLCA cards—let's call this number  $N_{AB}$ . The formula for this is simply

$$N_{AB} = (L_A + L_B) \times (F_{AB} \div D)$$

If you are interested in how this formula is derived, the explanation is also simple: The formula is just the first version of Little's Law, which I explained in Appendix A (on the enclosed CD). You can see this by noting that here  $(L_A + L_B)$  is the Flow Time for the card to get through both cells and  $(F_{AB} \div D)$  is the Flow Rate of these types of cards.

**TABLE E.1**

**Calculation of Number of Cards for A/B POLCA Loop**

<b>Order Size</b>	<b>Estimated No. of Orders</b>	<b>No. of POLCA Cards Needed per Order</b>	<b>No. of POLCA Cards Flowing Between the Cells</b>
1–5 Housings	70	1	70
6–10 Housings	20	2	40
11–15 Housings	6	3	18
<b>Total No. of Cards Flowing from A to B</b>			<b>128</b>

*Additional data:*

*HL/MRP Lead Time for Cell A = 3 days*

*HL/MRP Lead Time for Cell B = 2 days*

*Planning Period of One Quarter = 63 working days*

*POLCA card calculation using formula in text:*

*No. of A/B POLCA Cards =  $(3 + 2) \times (128 \div 63) = 10.2$*

*Rounding up to the next integer = 11 A/B POLCA Cards*



Then you always round up  $N_{AB}$  to the next whole number. Since the numbers used in the formula are averages and you can expect some demand and lead time fluctuations, some companies feel more secure if they add around a 10% safety margin to the number of cards when they first start their POLCA system (if you are familiar with Kanban card calculations, you will know that a similar safety margin is used there too). Note that as you get your system operating, you can fine-tune the number of cards based on the actual experiences of the cells. If a cell team complains that it is always waiting for a particular type of card, and there is no obvious problem in the downstream cell, you can consider adding a card to that loop. Conversely, if you frequently see several cards of a given type posted on a cell team's bulletin board, you can consider taking a card out of that loop.

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## **DESIGNATE A POLCA CHAMPION AND PROVIDE TRAINING AND OTHER ORGANIZATIONAL SUPPORT**

The POLCA implementation should be carried out by a cross-functional team comprised of manufacturing managers, planners, schedulers, selected operators from the cells involved, material handlers, and other shop floor personnel who would be influenced by the implementation. At the outset, management should designate one of the POLCA implementation team members as the POLCA Champion. This person needs to learn about POLCA and attend training sessions in order to serve as the in-house expert on the system. Thus, the POLCA Champion can be the central point of contact to whom questions regarding the design or operation of the POLCA system can be directed. The POLCA Champion also serves as the liaison between the implementation team and upper management.

Following the design of the system and prior to its launch, it is critical that all the operators from the cells involved in the implementation, as well as the corresponding material planners, schedulers, material handlers, and any supervisors or managers responsible for these cells, be trained on the POLCA process. The training should involve both the general concept of POLCA and why it is needed for the company's manufacturing environment, as well as detailed training on the specific implementation procedures to be used at the company. Management and the POLCA implementation team should also agree on overall metrics and goals for the POLCA system. Baseline values of these metrics should be established

prior to the POLCA implementation, and after the launch these metrics should be tracked regularly. To support this, the POLCA Champion should conduct periodic audits of the system and fine tune the system as needed in order to ensure that the envisioned goals are being achieved.

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## FOR FURTHER READING

A detailed explanation of how POLCA works along with a step-by-step walk-through of the rules for a company with 10 QRM Cells can be found in Chapter 9 of *Quick Response Manufacturing: A Companywide Approach to Reducing Lead Times*, by R. Suri (Productivity Press, 1998).

For a step-wise procedure for implementing POLCA, along with additional practical details such as the use of safety cards to address part shortages or other real-world problems, see *How to Plan and Implement POLCA—A Material Control System for High-Variety or Custom-Engineered Products*, by R. Suri and A. Krishnamurthy (Technical Report, Center for Quick Response Manufacturing, University of Wisconsin–Madison, Wisconsin, May 2003).

An industrial case study of POLCA in use at Alexandria Extrusion Company, Alexandria, Minnesota, is described in detail along with photographs in *Principles and Tools for Supply Chain Management*, by Scott Webster (New York: McGraw-Hill/Irwin, 2008).

Several organizations conduct regular workshops that train people on the concepts of POLCA. As part of these workshops, attendees participate in a hands-on simulation and experience the POLCA system in use in the simulated factory. The workshops also provided a detailed guide on how to implement POLCA and cover many of the practical and real-world issues that companies must deal with to get a successful implementation. Two such organizations are:

- POLCA workshops in the United States are offered by the Center for Quick Response Manufacturing. Visit [www.qrmcenter.org](http://www.qrmcenter.org) for more information.
- POLCA workshops in Europe are offered by the LeanTeam. Visit [www.leanteam.nl](http://www.leanteam.nl) for more information.