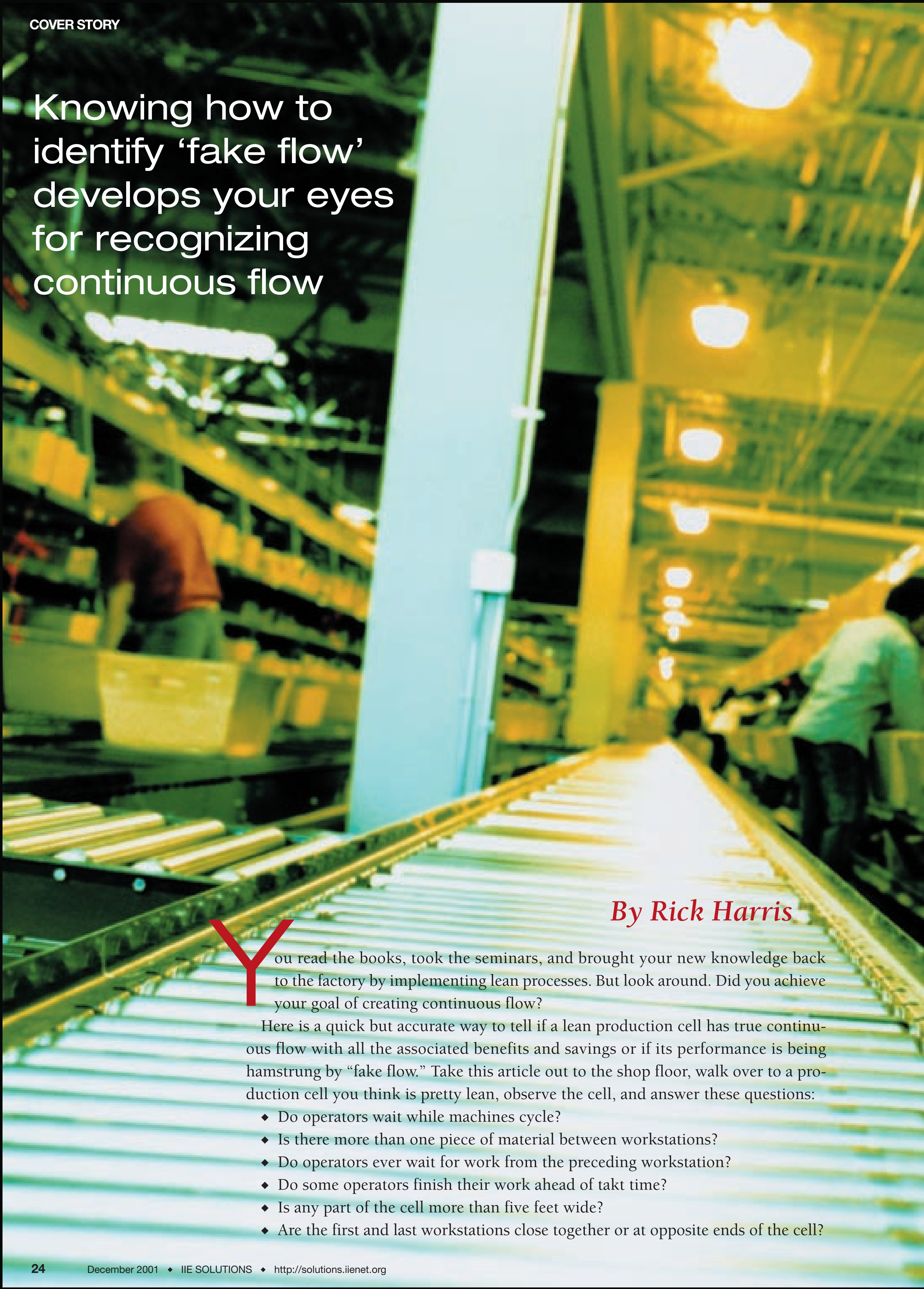


# Knowing how to identify ‘fake flow’ develops your eyes for recognizing continuous flow

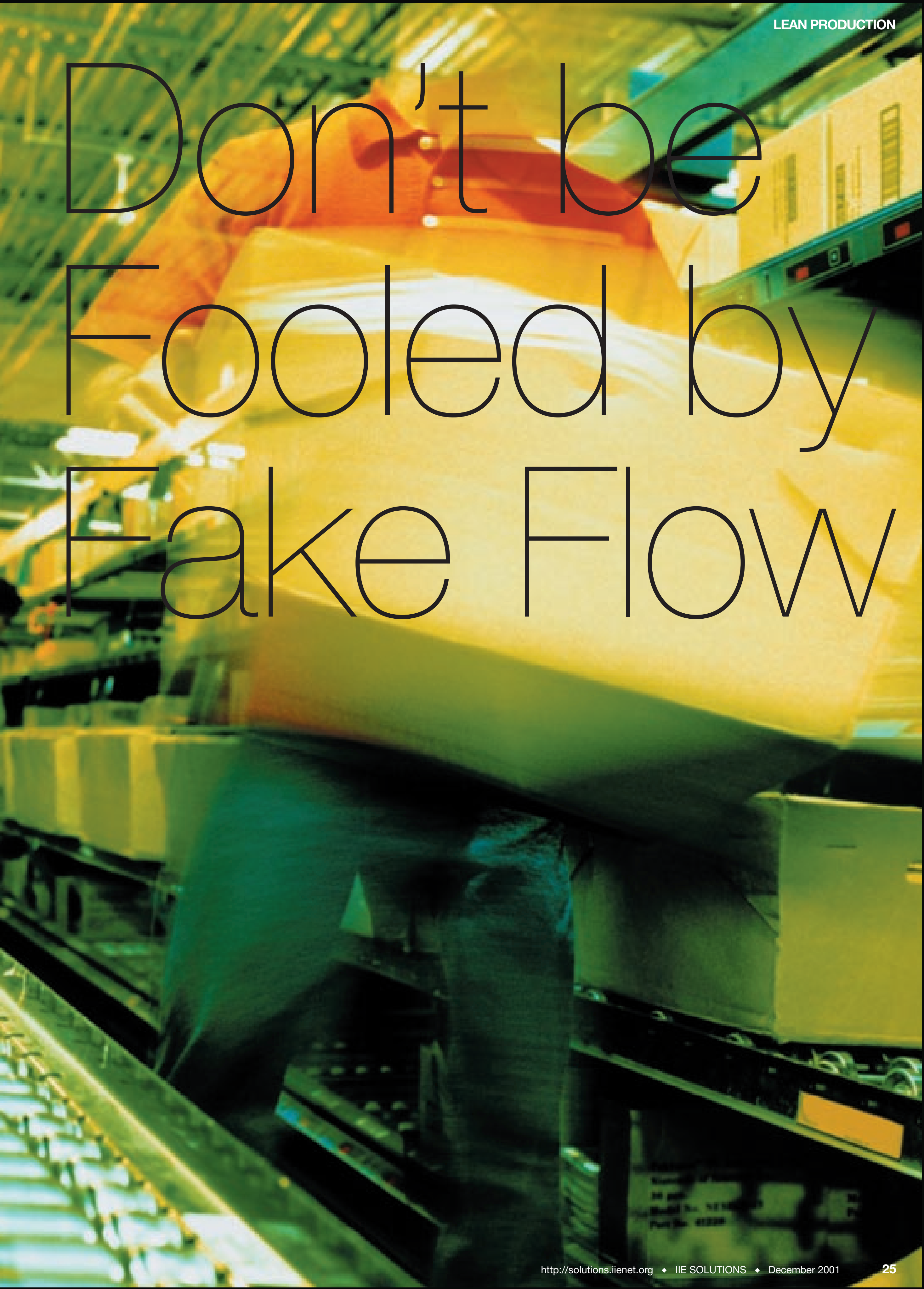
### By Rick Harris

You read the books, took the seminars, and brought your new knowledge back to the factory by implementing lean processes. But look around. Did you achieve your goal of creating continuous flow?

Here is a quick but accurate way to tell if a lean production cell has true continuous flow with all the associated benefits and savings or if its performance is being hamstrung by “fake flow.” Take this article out to the shop floor, walk over to a production cell you think is pretty lean, observe the cell, and answer these questions:

- Do operators wait while machines cycle?
- Is there more than one piece of material between workstations?
- Do operators ever wait for work from the preceding workstation?
- Do some operators finish their work ahead of takt time?
- Is any part of the cell more than five feet wide?
- Are the first and last workstations close together or at opposite ends of the cell?

# Don’t be Fooled by Fake Flow



- Does the output of the cell vary from hour to hour or shift to shift?
- Is there an operator at each workstation?

If you answered yes to any of these questions, you're missing out on the biggest benefits of cellular production because you don't really have a lean cell. A lean production cell has continuous flow. This cell has fake flow, and it means you're leaving a lot of money on the table in unrealized benefits. This is especially true if the cell you're standing at is the pacemaker cell for the value stream. The pacemaker is generally the cell furthest downstream and closest to the customer, such as a final assembly cell, and is controlled by takt time, which is the rate of demand. Continuous flow is critical at the pacemaker cell because of the cell's close connection to customer demand.

The pacemaker also controls demand for processes upstream. So how you operate this segment of your value stream sets the pace for satisfying the customer and operating upstream processes smoothly. If you don't have continuous flow at the pacemaker cell, you're using extra people, equipment, and material upstream to meet demand.

But don't feel too bad. You have a lot of company. During plant visits, I'm often escorted over to "the lean cell." When I get there, I often have to tell them that what they have isn't a cell at all, it's a module. They've moved islands of batch production closer together, but it isn't a cell because there is no continuous flow.

Rearranging equipment into a U-shape does not make a cell. Continuous or single-piece flow is what makes a cell. Goods are processed and moved immediately to the next step in a cell. Continuous flow pays off in a pallet-load of benefits, including very short lead times, rapid identification of problems, quick communication between steps, increased productivity, higher output, and conservation of resources.

There is another reason not to feel too bad: Fake flow is an improvement over traditional batch-and-queue production, which groups machines by type. Even though it falls far short of the ideal, a fake flow cell generally improves such key measures as lead time, productivity, and the amount of space used by 50 percent. These are good results. So most managers and engineers stop there without realizing they have captured only half the gains possible, as illustrated in Figure 1.

If you're willing to keep going, to break through fake flow to continuous flow, your results will go from good to excellent. It's a step that relies on the skills and active participation of industrial engineers. First, let's understand the symptoms of fake flow and their underlying wastes uncovered by the questions above.

**Targets for Apex's fuel line cell**

| | Original State | Current State | Target |
|---|---|---|---|
| Continuous flow | No | No | Yes |
| Production per shift (actual/target) | ? / 690 | unstable ≈622 / 690 | 690 / 690 |
| Space (sq. feet) | 1130 | 580 | 252 |
| Assembly lead time (WIP x Takt) | 11 days | 37 min | 200 sec |
| Number of operators | 6 | 4 | 2 |
| Productivity (pieces/ associate/hr) | 13.5 | 20 | 40 |
| Functions effectively as pacemaker | No | No | Yes |

**Figure 1. This chart shows the improvement that is possible by implementing true continuous flow. In the sample company called Apex, the current state results were achieved with a fake flow cell. It's an improvement over the original state but falls short of the target, which is attainable with continuous flow.** Source: *Creating Continuous Flow*, The Lean Enterprise Institute, 2001

### *Do operators wait while machines cycle?*

Waiting for a machine to cycle is a non-value-adding activity, in other words, waste. You will have to find a way to convert the waiting time into value-adding time by giving operators work while the machine works. Whenever you see people waiting on a machine, view it as free time you can go get.

### *Is there more than one piece of material between stations?*

Excess inventory between workstations means operator workloads are not balanced. Adding inventory between steps is an inefficient way to balance stations because it decouples them from one another. When the buffer in between stations gets too full, the supplying operation usually stops to let the subsequent operation catch up. If one station makes a defective part, it isn't caught immediately because it goes into the inventory stacked between stations.

### *Do operators ever wait for work from the preceding workstation? Do some operators finish their work ahead of takt time?*

These conditions lead to overproduction, the worst of all wastes because it covers up a host of problems that should be surfaced and solved. For instance, suppose you need a part every 30 seconds, but the operator is making one every 15 seconds and stacking the extras between stations. That creates excess inventory, which can be damaged, lost, or conceal a quality problem. This also creates a problem for production control because it must purchase more material than is required

**Takt time:** The available production time divided by the rate of customer demand. Takt time sets the pace of production to match the rate of demand and is the heartbeat of any lean system.

**Value stream:** All the actions, including value-added and non-value-added, currently needed to bring a product through the two main flows essential to every product — the production flow from raw material to the customer and the design flow from concept to launch.

**Work element:** The smallest increment of work that can be moved to another operator. Breaking work into its elements helps you identify and eliminate waste that is hidden within the operator's cycle.

**Cycle time:** The time needed to complete one cycle of an operation. If cycle time for every operation in a complete process can be reduced to equal takt time, products can be made in continuous flow.

**Pacemaker process:** Generally, the process furthest downstream and closest to the customer, such as a final assembly cell. The pacemaker is controlled by the outside customer's orders.

**Overproduction:** The most significant form of waste because it hides other waste, such as defects. Overproduction means producing more, sooner, or faster than the next process requires.

**Continuous flow:** The most efficient way of turning materials into products. Continuous flow, in its ideal state, means items are processed and moved directly from one processing step to the next.

and deliver it in a non-cyclical manner. For example, let's say the material handler is on a 20-minute route. During every 20-minute cycle, she removes finished goods from the cell and replaces the raw materials the cell has used. If the cell is supposed to produce 50 widgets every 20 minutes to satisfy demand, she will withdraw 50 widgets and drop off enough raw materials to make 50 more. If the cell is producing 80, 90, or 100 widgets every 20 minutes, she must bring more material more often. The variation wrecks the nice smooth cycle of producing just what customers want.

### *Is any part of the cell more than five feet wide? Are the first and last workstations close together or at opposite ends of the cell?*

Answering yes to these questions means operators will do too much walking, which is a waste. Also, the first and last processes in a cell are typically the more inefficient. At these processes, operators typically are taking raw material out of a container or putting finished parts into one. These are naturally less efficient than moving work from machine to machine.

### *Does the output of the cell vary from hour to hour or shift to shift?*

This is slam-dunk evidence that the cell's performance can be greatly improved by continuous flow. Let's examine how to do it. I'm assuming you have calculated takt time and created a current and future state map for the value stream afflicted by the fake flow cell.

### *Is there an operator at each workstation?*

One operator per station means they can't flow — move from one value-adding step to the next.

Based on the cells I've seen in plants — whether automotive, aerospace, high-tech, or any other industry — most people make two key mistakes in the first few steps of the cell design process, which leads to fake flow and the above symptoms. First, when establishing the cell, they don't identify the work elements correctly. This is crucial raw data for designing continuous flow. Get the work elements wrong, and continuous flow is doomed.

Second, people often fail to distribute the work elements correctly among operators. People tend to assign an operator to each machine. As we'll see, this just locks in waste and guarantees the mediocre results of fake flow.

### Work elements

A work element is the smallest increment of work that can be moved to an operator. For example, "Pick up the part" is not a work element because it can't be transferred easily to another operator. It's very difficult to give the work of picking up a part to any operator other than the person who is loading the part into the machine. A complete work element would be "Pick up and drill the part."

Keeping in mind what a work element is, you can re-kaizen the fake flow cell to create continuous flow. But don't just show up at the cell with stopwatch in hand. Give the cell team leader or supervisor a heads-up about what you will do. This is simple shop-floor courtesy, and it assures that you won't interrupt operators in a way that affects safety or output.

You'll need a pencil and a sheet of paper. Don't take a stopwatch yet. You have to identify the work elements correctly before timing them. At the cell, introduce yourself to the operators and explain what you will do before taking any notes. Make it clear that you are not critiquing people, gauging performance, or trying to see how fast or slow people work. Explain that you are there to identify the exact work elements in an effort to eliminate the waste. To do that, you must study the work elements or steps needed to make the part, and then you will time the steps.

Not only does talking to people before you begin taking notes show respect, it also relaxes people so they don't try to work faster than normal because they are being watched. And don't worry if people don't like the idea of being observed. It's OK. The important thing is that they understand you are there to study the work, not them.

Make several observations of the work process, noting important points along with the work elements. Let's say there is a work element "Get part and place in fixture." You should make a note if the operator has to turn the part 10 degrees to make it fit properly. Hand write the list of work elements and any rewrites. It keeps you focused on understanding the actual work process in front of you. Observing and listing the work elements in a cell can easily take half a day. It's slow and labor-intensive, but there's no way around it.

Rewrite the list of elements until you are satisfied you have them all and understand the process. Show it to the operators and ask what you missed. Then write the list again.

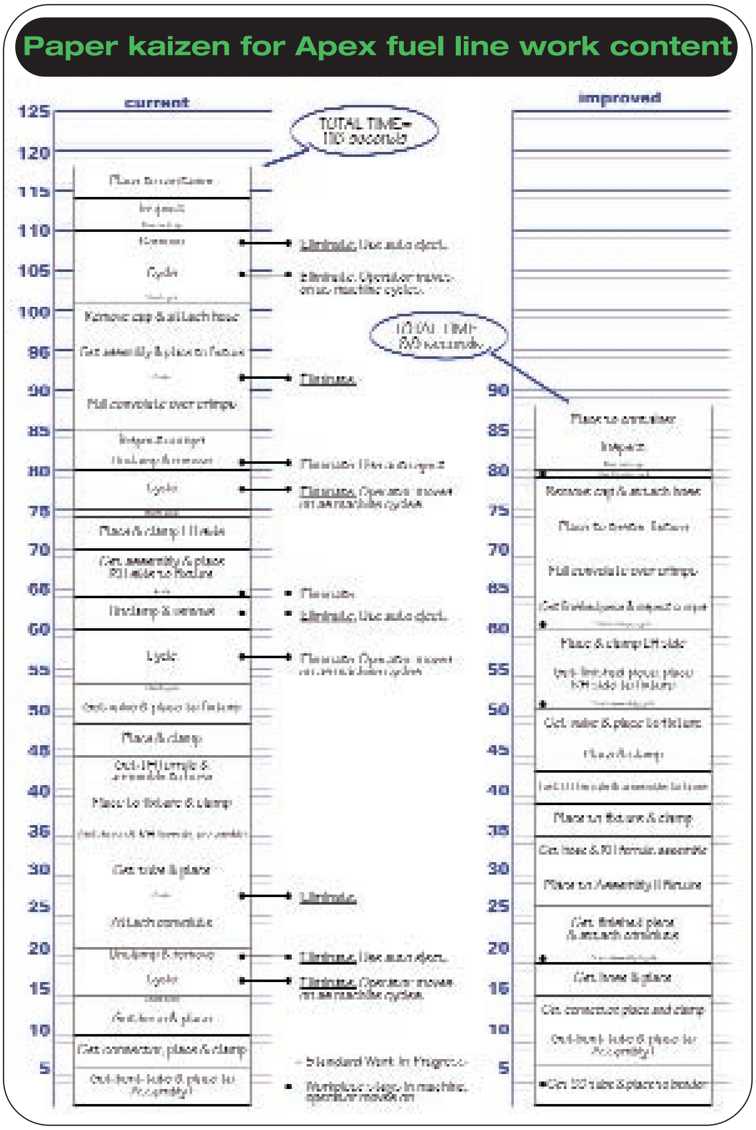


Figure 2. A stack chart on the left shows the total work elements for Apex's fuel line cell. The stack chart on the right shows the improvement in total time after paper kaizen has eliminated some obvious wastes before the new cell is put in place. The height of each work element corresponds to the number of seconds it takes. Source: *Creating Continuous Flow*, The Lean Enterprise Institute, 2001

## Paper kaizen

As you rewrite the list, you will naturally start to see more waste, such as operators waiting while machines cycle or walking to get parts. Remember that value-adding actions, such as drilling, welding, and painting, transform the product into something the customer wants. Waste or non-value-adding elements add costs but do nothing to transform the part. Don't include them on your final list of work elements. Eliminate them right there on paper. This is called "paper kaizen." Here are some tips for doing it:

- Ignore walking as a work element. Walking will be minimized in your continuous flow cell, so ignore it here.
- Don't include out-of-cycle work as a work element. Leaving the workstation to get parts or moving a container of finished parts are examples of out-of-cycle work. These jobs might be necessary, but they should be done by team leaders or material handlers or converted to in-cycle work that doesn't interrupt the workflow.
- Incidental work such as clamping and unclamping a part is waste but is necessary to make the product. Minimize the time for these elements.
- Waiting for a machine to cycle is not a work element. Waiting is waste. Operators should load a machine, start it, and move on to the next workstation while the machine does its work.
- If you think the automatic ejection of parts could be reasonably installed on a machine, don't list the manual removal of parts as a work element. Stopping to remove a part so the next one can be loaded is waste. When an operator returns to a machine on his or her cycle through the cell, the fixture should be empty, waiting for the next part to be loaded.

Using the list of work elements, time each work element for several cycles. Don't use data from files or time-and-motion tables. You have to observe actual operations. This takes time, just like the previous step, but your patience will result in accurate data that's absolutely critical to creating continuous flow.

Make sure you time work elements, not whole processes. This is a common mistake, too. For example, the operator starts a process and stops 30 seconds later, so the timekeeper writes down 30 seconds. But the 30 seconds included 10 seconds while the operator waited for the machine to cycle. That's 10 seconds of waiting waste that should not be included in the time.

Sometimes it's hard to see when an operator stops one element and begins the next one or sometimes you can't reset the stopwatch in time for the start of the next element. You just have to wait for the next cycle to re-time these elements.

Time each element eight to 10 times, then take the lowest repeatable time for each element. It's more indicative of what is realistically possible than the average time. As you time operators, record the machine cycle times in a separate box on your form. A work element list arranged as a stack chart (Figure 2) shows the list of work elements for a sample company.

## Resisting temptation

We're at the point in the cell design process where we calculate the number of operators and plan the cell's continuous flow. It's here where a second key mistake is typically made.

Divide the total work content (the sum of the time of the work elements) by the takt time. The answer is the number of operators needed for the cell. This is often a mixed number such as 2.2 operators. Obviously, you can't have a fraction of an operator in a cell. What do you do?

Most organizations make the mistake of using three operators and dividing the work evenly among them, especially if there originally were three workstations and three operators in the cell. The result is that all three will work at a pace well below takt time. This means each is underutilized; each will have plenty of time to wait before the next process needs another part. If the operators don't wait, they will overproduce. Either way, the result is fake flow with all its waste and higher costs built right into the new cell's design

The way to avoid this fake flow pitfall is to assign each operator work elements equal to 95 percent of takt time. Then follow the guidelines below for handling the fractional part of an operator that is left over:

◆ If the remainder is less than 0.3, don't add another operator. Remove more waste and incidental work to eliminate the 0.3.

◆ If the remainder is 0.3 to 0.5, hold off adding another operator until you've been able to evaluate the cell's operation for two weeks. During this time, kaizen the cell in an effort to eliminate the fractional amount of work.

◆ If the remainder is more than 0.5, add the extra operator but keep reducing waste and incidental work to eventually eliminate the need for that operator in the cell.

At 95 percent of takt time, operators will be busy but will have some time to spare when they need it. For example, they will need extra time if a part doesn't fit perfectly, if they drop a part, or when it's time to pull a kanban card from a new box of material and position the empty box for pick up. If you give them more than 95 percent, they'll be too busy and will ultimately fall behind.

Create a model on a sheet of graph paper of continuous flow for the cell. With each line equal to one second, draw a red horizontal line at the level for takt time. Draw boxes for each work element with the box height proportional to the time needed for each element. (You also can use sticky notes or flexible magnetic tape cut to the proportional length to represent work elements.) Many of you probably have done this exercise before. The key is to make the stack of work elements for each operator equal 95 percent of takt time.

If an operator's work extends over the takt time line you must try to find and remove more waste from the job or else move work elements to another operator. An alternative to adding another person to the cell is to work daily overtime until you can kaizen out the waste. If a bar is well under the takt time line, the operator needs additional work. Otherwise, he or she will have time to run batches ahead of the next operator, and you may use too many operators.

The resulting chart is called an operator balance chart. Only after you have created this plan for the cell's continuous flow should you consider its materials management and whether machines are capable of making takt time.

In the above example calling for 2.2 operators, the right thing to do is assign two operators to the cell by finding a way to identify and eliminate waste or incidental work. Running with two operators will be tough at first. You might only reach 65 percent of target output. Resist the temptation to add the third operator. This is a moment of truth — not just for the cell, but for the whole lean effort. Taking the easy way out here sends the message that good enough is, well, good enough.

A team willing to intensely kaizen a cell to reach the target number of operators based on the above guidelines will usually hit 80 percent of the required output within a week and 90 percent within two weeks. In the meantime, run the cell with two operators at the end of the shift or on weekends to make the necessary output while you continue to kaizen the cell. Getting from 90 to 100 percent is the hardest part, requiring engineers, managers, and operators to work hard together to develop eyes for continuous flow so they spot the pitfalls leading to fake flow. The reward is a cell that will run at low cost with true continuous flow and a new standard of excellence and commitment for the entire organization. ◆

## For further reading

Rother, Mike and Rick Harris, *Creating Continuous Flow: An Action Guide for Managers, Engineers & Production Associates*, The Lean Enterprise Institute, 2001.

Rother, Mike, and John Shook, *Learning to See: Value Stream Mapping to Add Value and Eliminate Muda*, The Lean Enterprise Institute, 1998.

**Rick Harris** is co-author with Mike Rother of *Creating Continuous Flow: An Action Guide for Managers, Engineers & Production Associates*. He received his lean education with Toyota at the Tsutsumi Assembly Plant in Toyota City, Japan, and at Toyota Motor Manufacturing Kentucky where he was a manager in final vehicle assembly. His previous experience includes 15 years with General Motors. Harris is president of Harris Lean Systems Inc., Stamping Ground, Ky.