

A MANUFACTURING INSIGHTS VIDEOTAPE

THEORY OF CONSTRAINTS:

MEETING CUSTOMER DEMAND WITH SYNCHRONIZED PRODUCTION

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MUSIC UP AND UNDER

NARRATION (VO):

Manufacturing insights...

Manufacturing Engineering magazine's video series for process improvement.

NARRATION (VO):

This program examines the practice of the theory of constraints, or TOC, and shows how manufacturing companies are meeting customer demand with synchronized production.

NARRATION (VO):

First, Doctor David Bergland, a consultant for TOC Solutions and a professor at Iowa state university, EXPLAINS the five focusing steps of the theory of constraints and some of the common problems encountered during the first stages of implementation...

NARRATION (VO):

Then we'll see toc being applied at..... Brenco, where the theory of constraints has been practiced in production scheduling for more than 6 years, Synchronizing production in order to supply millions of roller bearings to the global railroad industry. and at...

NARRATION (VO):

... Dixie iron works, an oil field repair shop that uses the THEORY of constraints to remain highly responsive to customer demand without carrying the high inventory levels TRADITIONALLY found in their industry. and at...

NARRATION (VO):

... the Monroe table company, a supplier of tables and platforms to the hospitality and trade show markets. Here, the theory of constraints was recently implemented in a manufacturing environment that had not seen significant change in more than 40 years.

NARRATION (VO):

In the final portion of the program, we will explore what other changes are anticipated as each company gains more insight into the theory of constraint's ability to improve their business performance.

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NARRATION (VO) :

For most manufacturing companies, meeting the iso 9000 quality standard has been one of the most important steps ever taken to improve their manufacturing operation. but in most cases, business owners and stock holders are not satisfied merely by knowing that a company makes products with consistent quality.

NARRATION (VO) :

business leaders know that the most important measure of any manufacturing company is continued profitability.

NARRATION (VO) :

and in most manufacturing operations it is hard to have every single employee understand the company's financial performance, or have the ability to improve it.

NARRATION (VO) :

to help everyone to understand profitability, Eli Goldratt wrote a novel about a manufacturing operation that needed major improvements to avoid being shut down. this book written in 1984, "the goal", sold millions of copies and popularized the theory of constraints. the novel was a simple way to introduce the theory of constraints to employees at all levels. but what is meant by a constraint?

NARRATION (VO) :

to find out, we asked Dr. david Bergland, a certified tea oh sea trainer, to define what a constraint is.

David Bergland (ON-CAM) :

The basic assumption of theory of constraints is that every organization exists to accomplish a goal, and typically the goal is to make more money now and in the future. At any point in time, there is something that is limiting your ability to achieve more of your goal, and that something is what we call a constraint. To manage a company well, to achieve its goal well, we have to manage its constraint.

NARRATION (VO) :

one key factor EMPHASIZED by the theory of constraints is how difficult it is to measure the impact that various divisions of a company have on its PROFITABILITY. To help companies break out of the standard cost ACCOUNTING methods, the theory of constraints measures financial performance using the throughput accounting concept.

David Bergland (ON-CAM) :

As you get the theory of constraints going, it seems like everything starts just working better. People are working together, they're focused on what's important, and working on that goal. *So throughput, which is defined as sales minus raw materials in the case of the factory, or totally variable costs in general,

basically increases—we can put more out.

NARRATION (VO) :

most people know which operation is the constraint or bottleneck in their operation.

David Bergland (ON-CAM) :

In a manufacturing company, often there is a particular workstation, a particular machine, or a particular process that can only process so many things per hour. Typically that piece of equipment would be something that would be relatively expensive and that you would not like to go and buy a number of these just to have them sitting there. **Cut out** . If we go into the company to find that limiting factor, often we'll find it's the place that has the work in process inventory piled up in front of it, it's the place that the supervisor always goes to look for things that are late or not on time, it's the place that people recognize intuitively as limiting the operation of the company.

NARRATION (VO) :

after you have found your constraint, what can you do to manage it better?

David Bergland (ON-CAM) :

If this constraint that is limiting your ability to achieve your goal is something physical, then we have what's called a five-step process, a process for ongoing improvement. The first step is to identify the constraint; the second step is to exploit it; the third step is basically to subordinate everything else in the organization to the constraint; the fourth one is to finally elevate the constraint if nothing else gives you what you need; and the fifth one is to go back and do it over again, part of the process of ongoing improvement.

NARRATION (VO) :

in some companies, the CONSTRAINT is not physical. sometimes a constraint may be a policy such as the traditional effort to achieve full equipment UTILIZATION or the past institution of standard lot size REQUIREMENTS.

David Bergland (ON-CAM) :

Often the thing that is limiting your company is actually its own policies and procedures that are put in place, or things as they used to be, and those policies can in fact be the constraint of the business, limiting its ability to achieve its goal.

NARRATION (VO) :

at the heart of the theory of constraints is a concept for production scheduling called drum-buffer-rope. Depending on the size of your BUSINESS, Drum-buffer-rope can be used with or without the aid of a computer.

NARRATION (VO) :

to help visualize Drum-Buffer-Rope, we'll use this sample process flow diagram. once you know where your constraint is, you have found the "drum" that beats out the pace for your operation. the rest of your processes operate to the beat of the constraint.

the constraint is always protected by an up-stream "buffer" so it never runs out of work. the next step is to tie "ropes" from the constraint to points that control the release of raw materials into the factory. By theory, the non-constraint operations should have extra or "protective" capacity that will allow them to surge to fill the buffer you manage in front of your constraint.

all downstream operations are performed as soon as they arrive at each workstation to keep the output of the constraint from being delayed. theoretically, the flow of constraint parts should never stop until they reach the customer.

NARRATION (VO) :

many BENEFITS come from the subordination step. subordination limits the flow of MATERIALS into the system to the rate that they can be processed by the constraint.

David Bergland (ON-CAM) :

Because we're limiting the flow of materials into the process, and doing this so-called subordination step, is that the work in process inventory is dramatically lower. So the money and capital tied up in that work in process inventory is lower. Just the clutter and crowding in the system is lower. Finally, operating expenses tend to be lower as well, because some of the processes, some of the policies and procedures we put into place, basically make better utilization of the people that you have.

NARRATION (VO) :

ADDITIONAL BENEFITS of constraint management come in the form of cash freed up for capital improvements, a more ORGANIZED workplace, the ability to meet promised delivery dates, and the ABILITY to respond faster to special customer requests.
(PAUSE)

NARRATION (VO) :

since companies USUALLY have A manufacturing Strategy already in place, how does the theory of constraints fit with an existing program like TQM?

David Bergland (ON-CAM) :

The theory of constraints actually fits very well with TQM in that TOC helps us to focus quality improvement efforts on the constraint where it will do the best for the company. So it actually fits very well with TQM. Theory of constraints is about focus and follow-through TQM is about techniques for improving. So if we focus the improvement efforts in the right place, it can benefit the company dramatically.

NARRATION (VO) :

now let's see HOW three manufacturing companies have put the theory into practice.

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NARRATION (VO) :

Brenco, located in Petersburg, Virginia is a GLOBAL SUPPLIER of tapered roller bearings for the railroad industry. in 1992 they began production SCHEDULING using a computer application based on the theory of CONSTRAINTS. before then, experienced planners scheduled production by following sales forecasts developed from customer data and market trends.

NARRATION (VO) :

over the last few years Brenco has added many new products, and producing these MULTIPLE product lines has complicated the production scheduling task. as a result, Brenco suffered from high inventories and had built up over a million dollars in back orders.

Rick Louthan (ON-CAM) :

What was happening is things weren't synchronized. Everybody would run what they were supposed to run, but depending on when in the month they ran it, or when it came to them, you'd have assembly not having product that they needed when they needed it. So I think the basic thing was trying to synchronize the factory * to make sure that the product forging was running was what eventually needed to go to the customer. We looked at it more on history, and we were scheduling based on history versus scheduling on what orders were. So we needed something to help synchronize the flow of product through the factory.

NARRATION (VO) :

to tie production scheduling closer to customer demand, the Brenco production scheduling staff are now part of customer service, where new orders originate. to schedule the large number of products with differing options, Brenco uses a new software application.

Ralph Carrell (ON-CAM) :

It's a program that's run every morning that shows all new orders that have come in and have been entered into our system. So I take a quick look through that each morning and see what might impact our near term, which I consider the first four weeks of the schedule, see what's going to impact that, and then we work through the other ones that come along. We basically know what we can run, and sales knows what they can put in. Any changes or any questions they have, they'll talk to me personally and we'll work through those issues.

NARRATION (VO) :

the logic for scheduling production in any theory of constraints software is based on the concept of drum-buffer-rope.

NARRATION (VO) :

in the case of Brenco, they were able to identify two different constraints, the machines that limited the output of their business.

Ralph Carrell (ON-CAM) :

We've only got two areas right now, two pieces of equipment that we have a constraint on. That means that of the other 80 work centers that we have, we have to make sure all those other 80 work centers run to the constraint. The constraint's a drum, then we tie ropes, what we call a rope, to the other one, which is really a time frame of release, and then we start that product through the factory.

NARRATION (VO) :

one of the constraints Brenco manages is the carburizing of tapered rollers. to keep the process running, buffers of parts are stacked next to the furnace, ready for carburizing.

NARRATION (VO) :

to exploit this constraint, they do whatever it takes to get as much production as possible from that process.

Ralph Carrell (ON-CAM) :

What ways can we do it without costing any money to make it run. That has to do with working through breaks and lunches, do we reduce our changeovers? If there are some long changeovers on our constraint, can we combine some batches and still not affect customer due dates, or is there some tradeoff that we can squeeze as much out. Cut out How do we maintain it?, what does our maintenance crew do when it goes down?, do we put all our resources over there?

NARRATION (VO) :

when Brenco began to schedule with the theory of constraints, the reasons for all the operational changes were not always obvious.

Ralph Carrell (ON-CAM) :

From the worker perspective, probably the biggest thing you'll hear is the amount of changeovers you have to do. That's a real biggie. We come from, in the past have been basically a one or two product company, and as we've expanded our product base, in terms of moving into export markets making different sizes and types of bearings, we can't make the long runs we used to. So changing over becomes an issue. Also, the equipment we have here is an older style of equipment, it wasn't made to change over, so you're looking at long changeovers.

Rick Louthan (ON-CAM) :

I used to run this whole lot of stuff that I need, and then I'd go to the next whole lot of things. Now you're telling me to run only part of that and then do this, and then right back to the thing I was running before. Why can't I run them together. It took a lot of working with mostly the team leaders on the floor and explaining why, so they could in turn talk to their team about this is why we are doing what we want to do.

NARRATION (VO) :

in some situations, the theory of constraints can idle equipment and workers until

more production is called for. not working at full capacity is contrary to conventional WISDOM and most workplace cultures.

Rick Louthan (ON-CAM) :

When you go into theory of constraints, there are times when pieces of equipment don't need to run, and if your total concern is equipment utilization, you can have policies that mess up what you're trying to do with theory of constraints. Policy constraints could be you're going to make a certain amount of this product and you're always going to do that. Different things on how you manage the different areas are what we tend to call policy constraints. They're not equipment issues, they're not people issues, it's just this is how we've decided to manage that, and you have to look at those things, and do they make sense. If they don't, you need to break that policy so that you can do things better.

NARRATION (VO) :

after six years of using the theory of constraints, Brenco knows the sometimes painful changes helped improve their FINANCIAL performance.

NARRATION (VO) :

to help FUEL the push for improvement, demand for Brenco products has increased 40% in the last 19 months. during the same period work-in-process inventory turns increased 90%, actual work-in-process inventory was reduced 29%, and on-time delivery improved from 95 to 98%.

NARRATION (VO) :

but just because Brenco has demonstrated improvement, they are not about to slow down.

Rick Louthan (ON-CAM) :

So if you're doing theory of constraints, you're constantly looking at improving your processes so that you can make more, be more responsive, or do it with less scrap or less inventory. We're going through a whole process of capitalization here at Brenco right now, where we're bringing in different equipment that will help us make more product. **Cut out** I think that's the kind of things theory of constraints can help with, if you manage in that manner; look at what's constraining your operation and then improve on it. As we go through, we are going to constantly be looking at areas to improve, and how we can improve, and do it with less cost, and be more responsive to the customers.

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NARRATION (VO) :

dixie iron works in Alice, Texas, serves as an EQUIPMENT repair shop, and a producer of valves and other COMPONENTS for the OIL and gas INDUSTRY.

Joe Merritt (ON-CAM) :

We were a historical, traditional, oilfield repair machine shop that did business

the way oilfield repair machine shops had done business forever. We worked the marketplace and business came in on a nonscheduled basis, and we just worked as a support for the oil patch on an emergency basis most of the time.

NARRATION (VO):

several years ago, dixie iron works was rated an American Petroleum Institute 6A facility. this certified them to manufacture specialized products including: high pressure equipment for the production, testing, and well stimulation systems used for producing oil and gas. a year later, Dixie started the process of getting their ISO 9001 certification. surrounded by the change that came with the new quality standards, management felt a need to rethink how they conducted business.

Joe Merritt (ON-CAM):

A friend of mine who is also a vendor of ours in West Texas gave me a copy of The Goal in late 1991. He was a TOC implementer in West Texas at that time, and was very involved in TOC, and recommended that I read it. I read it. I gave it immediately to my vice president and general manager of operations, Gerard Danos. He read it, and like everybody else that reads the book, we would have sworn that Jonah and Alex both had been at Dixie Iron Works.

NARRATION (VO):

the management at dixie felt that the theory of CONSTRAINTS was the right philosophy for them. It showed promise for lowering inventory and was easy to teach to the workforce.

Joe Merritt (ON-CAM):

I think obviously when you look at a new philosophy of operating a plant, you expect results, or you wouldn't implement it and you wouldn't make the kind of changes that TOC requires. Especially TOC. TOC breaks you out of your paradigm, makes you think in ways that you haven't been accustomed to thinking about. So we assumed just by reading the book and the basic changes we made that we were going to see results. We had no idea we would see the kind of results that followed in the years to come.

NARRATION (VO):

to speed up IMPLEMENTATION, dixie hired an outside trainer to teach the theory of constraint principles to the entire organization.

NARRATION (VO):

with the basics under his belt, Joe Merritt and the TOC trainer started a search for the physical constraints.

Joe Merritt (ON-CAM):

We basically went onto the shop floor and concentrated in our production shop where our CNC equipment was, and we just walked up and down the floor and found the machines where work was stacked up, and started figuring out that these must be our constraints.

NARRATION (VO):

with a CONSTRAINT identified, the next step was to exploit it.

Gerard Danos (ON-CAM) :

We actually changed the operator practice and break times, so that when one operator was on break, we would actually stagger the operators' breaks and shift an operator over for that 15 minutes, always making sure that the other operators understood that those machines need work, and if two machines are waiting in line for a forklift to deliver something, the constraint always gets his delivery first.

NARRATION (VO) :

other steps involved rerouting work to other non-constraint machines.

Joe Merritt (ON-CAM) :

We had a mill that was a constraint at that time, and we moved 20 percent of its work off just by going out and looking at it, watching it, and saying why are we doing this on this mill when we could be doing it on a drill press.

NARRATION (VO) :

instead of buying new machines, dixie chose to manage their constraints, and educate the workers on the theory.

Gerard Danos (ON-CAM) :

At the shop floor level we actually had very good acceptance of the theory of constraints. It was confusing at first for people to understand that they really didn't need to work when they didn't have any work, but they had some understanding, and our explicit reassurance that they would not be punished for not working.

NARRATION (VO) :

over the last few years, dixie has optimized their PRODUCTION scheduling by using a software application that is based on the same logic as the theory of constraints. it has given them the power to handle large orders, without disrupting the overall factory schedule.

Gerard Danos (ON-CAM) :

So if I, just because of the vagaries of the market, have a large batch of orders due on a Friday three Fridays' from now, I will see that a couple of days before that I have an extreme peak load on the constraint machine. I can do something now, three weeks ahead of time, to address that. Either start some of those orders much earlier than they should be started, or possibly commit some other resources to that particular order.

NARRATION (VO) :

the management at dixie learned they had more than just physical CONSTRAINTS.

Gerard Danos (ON-CAM) :

...the majority of constraints in any business in the United States, I would go so far as to say, are policy constraints. More often than not, the biggest increases

in your business are due to you sitting back and just changing your mind.

NARRATION (VO) :

when a constraint is a *machine*, the PEOPLE at dixie know what it takes to manage it.

Gerard Danos (ON-CAM) :

One of the other really big changes we made is that if a constraint needs maintenance, it is a number one, first priority. If the constraint breaks five minutes before the end of shift on Friday, Maintenance works until it's fixed to make sure it's up and running on Monday.

NARRATION (VO) :

as with any on-going CONTINUOUS improvement program, the dust never SETTLES at dixie before the next wave of change begins. but by practicing constraint management, they have BUILT a profitable operation that many customers now rely on.

Joe Merritt (ON-CAM) :

In the last four years, at Dixie Iron Works, the year ending June 30, 1998, four years back, we averaged 25 percent growth a year. We averaged doubling our profits every year. And we started at six turns on our inventory, and in June 30, 1998, we averaged sixteen turns. Obviously some of this is related to the fact that business was good generally in the oil and gas industry. But the significant impact was TOC.

Music up and out

--- FADE TO BLACK ---

NARRATION (VO) :

the Monroe company was established in 1908 in Colfax, Iowa. their product line includes folding banquet and display tables, platform staging and accessories.

NARRATION (VO) :

over the last few years, the Monroe company had been experiencing shrinking market share. to maintain revenue, they raised prices, but then market share would drop again. in 1995, Monroe stepped up their marketing effort to attempt to regain market share.

Bill Colville (ON-CAM) :

Our biggest problem was, as our business started to grow, we lacked the capacity to meet the demands of the market. (UM...) We weren't really sure what to change to. There's an awful lot of management philosophies for manufacturers out there, (UM...) and for a small company it can be daunting when the time comes to make the change to improve your processes or operation.

Bill Colville (ON-CAM) :

We hadn't changed anything at The Monroe Company in 50 years. Some of our machinery

is still the same machinery they used 50 years ago. They had their own system of manufacturing, and had been successful at it, and didn't see any reason why they ought to change.

NARRATION (VO) :

Monroe knew they had to be more responsive to customers, but that proved to be a difficult task.

Bill Colville (ON-CAM) :

Our lead times were stretching out because our demands were increasing. We had focused on increasing sales, but our manufacturing times were lagging behind those increased sales.

NARRATION (VO) :

while searching for solutions, the Monroe company learned about TOC through Iowa state university's outreach program for small manufacturers

Bill Colville (ON-CAM) :

For us, not having been involved in any of the modern manufacturing practices now in place, the theory of constraints was something we could easily grasp the concept of what it was trying to accomplish. Also, it seemed like the program that could most quickly get us to the point we wanted to be at.

NARRATION (VO) :

Next, the Monroe table COMPANY brought in an Iowa state university faculty member who is certified to lead others in implementing TOC. Fifteen people from every part of the company were given a week of training to learn how to adapt the theory of constraints at their plant.

Bill Colville (ON-CAM) :

In a small company, at least in our small company, the upper management level is pretty thin. We also knew it was going to be the people on the floor that were going to have to ultimately implement the theory of constraints, so it was most critical for us to teach them and have them understand what we were trying to accomplish.

NARRATION (VO) :

during the training, the group chose their final ASSEMBLY area as the CONSTRAINT to manage.

Bill Colville (ON-CAM) :

The major difference was, the final assembly now became the drumbeat for the whole factory. What we did was, all our scheduling was based on the capacity of our final assemblers. We subordinated our sales staff to their capacity, so they could only sell the capacity of the constraint, and then all the other processes were synchronized to the output of the final assembly.

NARRATION (VO) :

with the old way of making tables, the final assembly people went around and picked up components for each order.

Bill Colville (ON-CAM) :

Now all the orders are staged up in an area ahead of final assembly, and they are brought to the final assemblers, rather than the final assemblers going out and finding those component parts. So we increased their capacity by doing that quite a bit. We reduced that travel time, the movement of those materials throughout the factory. Prior to doing theory of constraints we were building about 140 tables a day. Today we build about 190 tables a day, with actually less direct labor hours than we used with 140 tables.

NARRATION (VO) :

to date, the management at Monroe has invested only a small amount of money into teaching and practicing the theory of constraints. a few additional machines have been purchased to increase output of other areas and keep the constraint at the final assembly process. in addition, Monroe has started to improve some of it's operations with new technology. But, the bulk of the capital freed up by reducing work in process inventories has been used to support their increase in sales.

Bill Colville (ON-CAM) :

In 1994 The Monroe Company didn't even have a computer in the whole company. Everything was manual, accounting systems were manual. We're now putting computers on the factory floor so they can track orders and monitor what they're doing. So it's a dramatic change from what they're used to, even four years ago.

NARRATION (VO) :

along with the physical changes happening all around them, the employees also Experienced their share of change. before theory of constraints, the Monroe company's wood shop and metal shop were two SEPARATE cultures.

Bill Colville (ON-CAM) :

Prior to TOC these two departments were constantly at odds with each other. The wood department would have an order that they wanted legs for, and the metal department wouldn't have legs, and vice versa. The two component pieces that make up the final product were rarely there at the same time. So our system was not synchronized well at all. (pause)

Bill Colville (ON-CAM) :

The two departments now communicate and get along, which is an extreme change from what we had prior to TOC. A side benefit that I don't think we expected is a change in our culture.

NARRATION (VO) :

since the change to constraint based management, Monroe has reduced work in process inventory by 40%. besides the IMMEDIATE improvement in cash flow, they NOTICED an

additional benefit.

Bill Colville (ON-CAM) :

Eliminating that work in process inventory in the system caused our cycle time for our products to be much quicker. We found that the cycle time of the product was directly proportional to the amount of work in process inventory in the system. The hardest thing for our people to get used to was that they couldn't build extra quantities of a particular item, and now we build just what's released into the system that day off of work orders, and no more. Anything else is contrary to what we're trying to achieve.

Bill Colville (ON-CAM) :

The people part of implementing TOC, and the cultural change you go to, is the most difficult one and the one that's hard to address up front, and you only understand some of that as you go through the implementation process and experience it.

NARRATION (VO) :

in the last two years since the Monroe company has focused on managing their constraints, their improvement efforts have had a positive effect on the BOTTOM line.

Bill Colville (ON-CAM) :

Our net income has increased tremendously from 1997 to now. It is a dramatic improvement, and it's primarily due to the implementation of TOC.

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NARRATION (VO) :

with the three examples in this video, each company faced production barriers and used their knowledge of the theory of CONSTRAINTS to overcome them and improve FINANCIAL performance.

NARRATION (VO) :

the changes were not always easy, but training helped the companies make the TRANSITION.

Ralph Carrell (ON-CAM) :

Theory of constraints was something it took us a long time to catch on to the concept and understand it. We had it in our brain and understood it conceptually, but to translate that down to the floor is where a lot of times there's a gap. So to begin to fill that gap, how are you going to transition into moving it to the floor. For us, a lot of training needed to take place at the management level so we could be prepared to move it to the floor.

NARRATION (VO) :

it takes time for a company to realize all the gains possible with constraint management. managers must stay alert for Procedures that need to be changed.

David Bergland (ON-CAM) :

People tend to behave the way that they're measured. If this transformation happens too fast, and the measurements don't track the change in the operations, our people know they're doing good for the good of the company, but if their measurement is on utilization or on particular standards that would tell them they should be producing more and the system is telling them they shouldn't, the conflict can be a problem.

NARRATION (VO) :

as questions like those are resolved, people find more ways to apply the toc principles, keeping their companies ahead of competitors.

David Bergland (ON-CAM) :

What happens is with most theory of constraints managers is that they become very restless in terms of what they have achieved, and want to go on and achieve more. In fact this is a process of ongoing improvement, and theory of constraints basically is iterative. Once you have identified the current constraint and you've managed it and broken it, then you have a new constraint. Sometimes the constraint moves from internal to external, to the market, or to your suppliers. We have to be ready and willing to go where the constraint goes, and to be able to overcome and manage that constraint as well. So no, it's not an excuse for just sitting idly, but it's basically an exciting trip, an exciting journey, that people on the theory of constraints actually enjoy.

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Manufacturing Insights wishes to thank the following organizations for there assistance in the production of this program.

Avraham Y. Goldratt Institute

Brenco

Dixie Iron Works

Iowa State University

Monroe Table Company

Thru-Put Technologies

TOC Solutions

Produced By

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