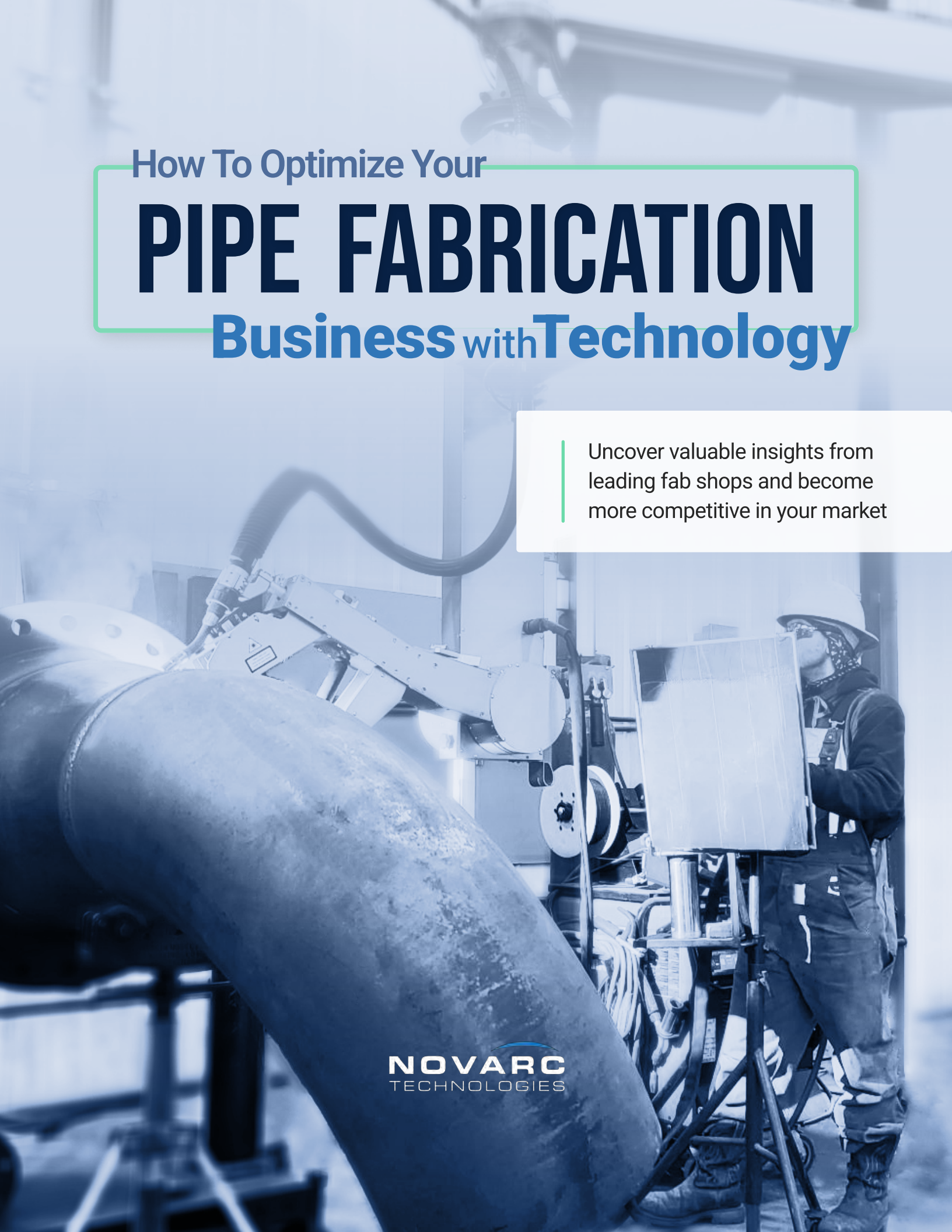

How To Optimize Your

PIPE FABRICATION

Business with Technology

Uncover valuable insights from leading fab shops and become more competitive in your market

NOVARC TECHNOLOGIES

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Introduction

Are you looking at ways to be more competitive in your industry?

Is your shop productivity less than 200 Factored Diameter Inches (FDI) per shift?

Are your repair rates over 1%?

Are you having a hard time finding and keeping quality welders?

If you answered yes to any of these questions, you'll want to read on.

We've witnessed pipe fabrication shops completely transform their business by introducing new technology and tightening up their operations. So, we decided to write a guide to help pipe fab shops optimize their operations and get ahead in an increasingly competitive market. The info provided in this guide is based on real data and direct feedback from fabrication shops in North America. These include some household names in their respective regions and industries ranging from construction, mechanical engineering, industrial contracting, shipbuilding and oil & gas industries.

We are a Robotics and AI company with welding expertise and we recently hit #79 on the Financial Times top 500 Fastest Growing Companies in The Americas. What allowed us to make this list is our relentless desire to help our customers get ahead in an increasingly competitive market.

We've gathered a treasure trove of insights from our customers, but the four elements that continually filter to the top as leading contributors to a thriving pipe fab shop are:

Productivity, Quality, Profitability and People.

Productivity

Increase Production

Production, Production, Production. When you produce at a high rate, you can finish projects quicker and increase the margin on the projects you've won. It also opens the door to bid more competitively on projects to increase your backlog because you are no longer confined by the productivity of your welders alone. If production capabilities are low, projects cannot become realized and existing projects cannot be completed on time, thus, problems cascade and client relationships can become jeopardized. Opportunities can be missed when you can't increase capacity and those big ticket projects turn into pipe dreams (pun intended).

The average pipe welding productivity in North America is around 60-80 Factored Diameter Inches (FDI) per shift per person. In very productive shops, the average can be 85-100 FDI per shift. But it's difficult to hit these numbers consistently because pipe welding is a difficult skill and can expose flaws even in the best human welders. Human welders take breaks and suffer fatigue and over time: productivity, quality or both can suffer. Companies are choosing to break down this productivity brick wall by investing in technology.

Since 2014 Novarc Technologies has been hard at work trying to revolutionize the pipe welding industry. Today, some of the top companies in the building construction, engineering, energy, off-shore and shipbuilding industries use our invention, the Spool Welding Robot (SWR™). The SWR™ is a welding cobot designed specifically for pipe, small pressure vessels, and other types of roll welding.

Figure 1: Image of the Spool Welding Robot (SWR™)

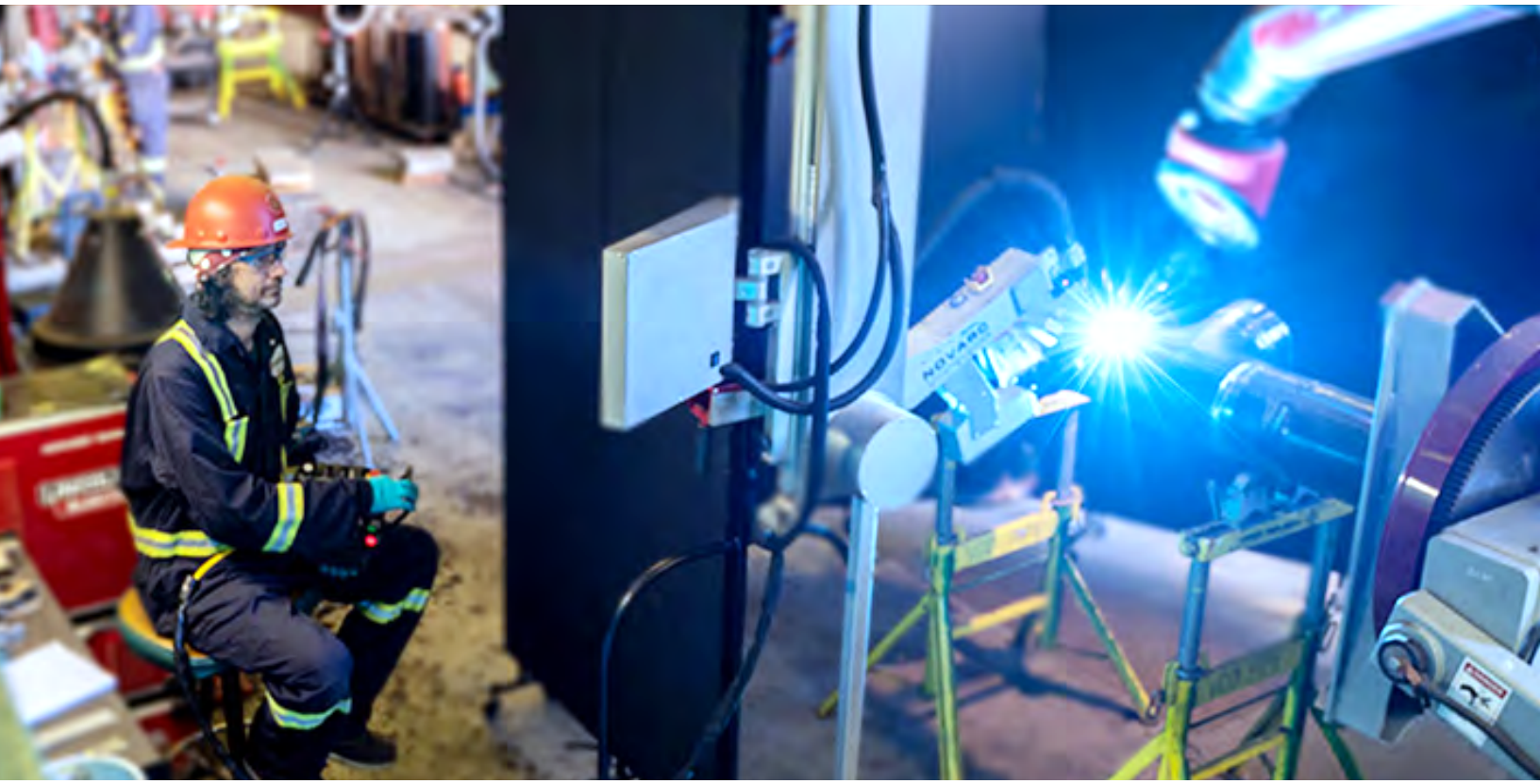

Figure 2: Image of the SWR™ in action

Below is a performance screenshot showing a month of welding for one of our top performing customers using the Spool Welding Robot. We pride ourselves on being transparent with our customers and wanted to show you that these numbers are real.

Based on a 22-day work month, our customer (SWR™ 2141) is achieving an average of 660.5 Factored Diameter Inches per day (May 2022). This example is higher than the others as they use Lincoln HyperFill® with this SWR™ and this results in much higher deposition rates. On average our customers are seeing 200-350 diameter inches per shift on carbon pipes, and 569-998 diameter inches per shift on stainless steel. This would be a 3-5x increase in your output for carbon and up to 12x for stainless with a minimum of 3 positioners.

For shops to be able to hit these numbers consistently, it's not really possible without some form of collaborative robotic welding. Unlike human welders, The Spool Welding Robot performs non-stop root to cap welding without the need to shut off the arc. So while the operator runs the robot because of superior ergonomics, they don't get fatigued. Human welders and operators are then able to focus on tasks to maximize shop productivity like more specialized welding and moving around pipe and equipment. Another aspect that adds to higher productivity is the ability to integrate with two to five positioners, which allows for less downtime.

What our customers are saying:

"Depending on pipe size, we can hit inch counts anywhere from 200-275" on a regular basis with the SWR™,. Also, the fact that we can weld slip on flanges is probably one of the most impressive tasks that the Novarc SWR™ is capable of. We have gotten really efficient at welding stainless steel fabrication with the SWR™ and this is helping tremendously with our efficiency. We have gained a lot of ground on everything that we weld on the SWR™ but one that stands out is the welding of stainless steel. Our old way of welding stainless would be to TIG weld with using an ID purge. A 16" schedule 10 weld would take 2-1/2 hours or so to get a purge set up and then weld out. We now can do a 16" schedule 10 weld in 12- minutes that will pass RT."

David Ray, Pipe Shop Foreman, W.W. Gay Mechanical Contractor Inc.

"We were able to increase efficiencies on the project with Novarc's Spool Welding Robot. We were very impressed with the ability to maximize productivity, while providing a quality product to our client", says Jamie. "For example, in the case of a 24" XH (0.5" pipe thickness) weld, Novarc's Spool Welding Robot outperformed our welders by 3 times!"

Jamie, PM at Anonymous Co., EPC Industry

Shopflow and Footprint Optimization

You can optimize workflow by organizing the floor space, simplifying procedures around the shop and assigning the right people to the right tasks. It's difficult to optimize your fabrication process without a deep understanding of your workflow. To get a clear picture of your operations, identify the necessary pipe fabrication aspects when it comes to the physical layout of your shop. This includes the processes, people, and technology. Then you can ask yourself how all these things interact with one another in the shop.

The first step is having a cohesive team where clear roles are defined. In terms of technology and how that integrates with shopflow it's important to have the shop foreman, lead pipe-fitter, tech operator and welders all on the same page.

In terms of optimizing shopflow, setting up dedicated stations, and simplifying flow between stations is critical. Let's look at the actual process. First the pipe comes off the truck to a rack, then to a profiler, from there it's moved on to pipe stands. The key station is the fitting station, and the closer the fitting station is to the profiler your workflow between welding and fitting will be much faster.

To assist with moving large pipes there are typically three ways to do it: a crane, forklift and pipe stands on wheels. If possible, rolling the pipe on pipe stands will give you more speed and flexibility. However, in order to use this method you need a clean floor devoid of cables (using cable tracks in the right places) and preferably smooth concrete.

Having a small footprint for production and being able to increase your pipe production per square foot will help your shop flow much more freely. Also, when you have a highly customizable layout, you can place positioners in optimal places, and utilize other areas of your shop.

The SWR™ has the smallest footprint in the industry of only 4' x 4'. It is small enough to give you many options to install in your shop and can drastically improve your workflow as newly freed up space can be used for other tasks and/or material organization. You can also make better use of your welders and fitters. Our team works directly with fabrication shops to go over the best layout and workflow.

Figure 3: Example using a three positioner layout

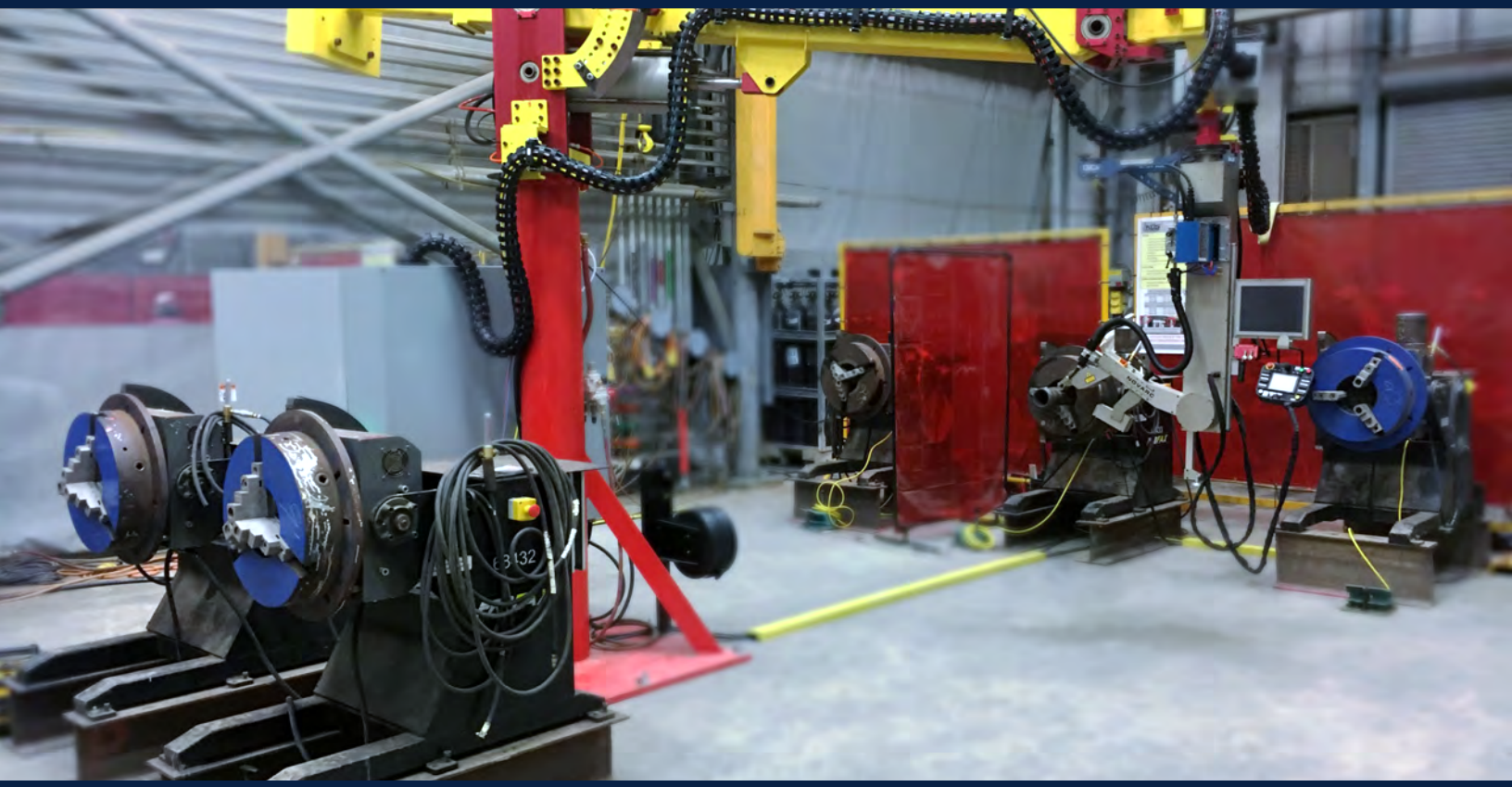

Figure 4: Example using a five positioner layout

What our customers are saying:

"We looked at a few other options when looking for welding solutions. The edge that Novarc has is the footprint of the equipment, we have a lot more flexibility with the SWR™. If the average pipe size of the shop is really small, we can just park the equipment and it does not take a lot of square footage".

Martin Cartier, Director of Ganotec-Muga Fab, Heavy Industrial Contracting Industry.

"You kind of get a triple effect when you look into the ROI situation in that I'm using Lower cost labor, building it faster, and my overall cost is cheaper. Essentially I can produce more units in the same footprint."

Anonymous Co., Facilities Equipment Superintendent, Offshore Industry

Quality

Improve Repair Rates

Pipe welding is a difficult task that requires focus, endurance and skill. To complete x-ray welds that adhere to ASME B31.1, ASME B31.3 standards it's important to focus on quality closely. Most pipe fab shops that are doing projects that require the welds to be x-rayed, have a repair rate of 3-5% with highly skilled human welders.

The reality is, robotics and automation are required to optimize your accuracy and lower repair rates. If you were able to get your repair rate under 1% the impact on your bottom line will be huge. For example, some of our customers are seeing 0% - 0.5% repair rates with Novarc's Spool Welding Robot.

Let's do a simple math equation to determine how this can affect your bottom line:

6,000 welds per year with a 3% repair rate = around $180,000/year in repair costs.

Reducing the repair rates to 0.5% = recover around $150,000/year back onto the bottom-line.

Even the best welders aren't perfect, they can have their off days. The SWR™ improves quality with precision and non-stop consistency. This will effectively minimize or completely eliminate human error. Having this kind of consistency can do wonders for your business as you're able to predict timelines better and forecast financials more accurately.

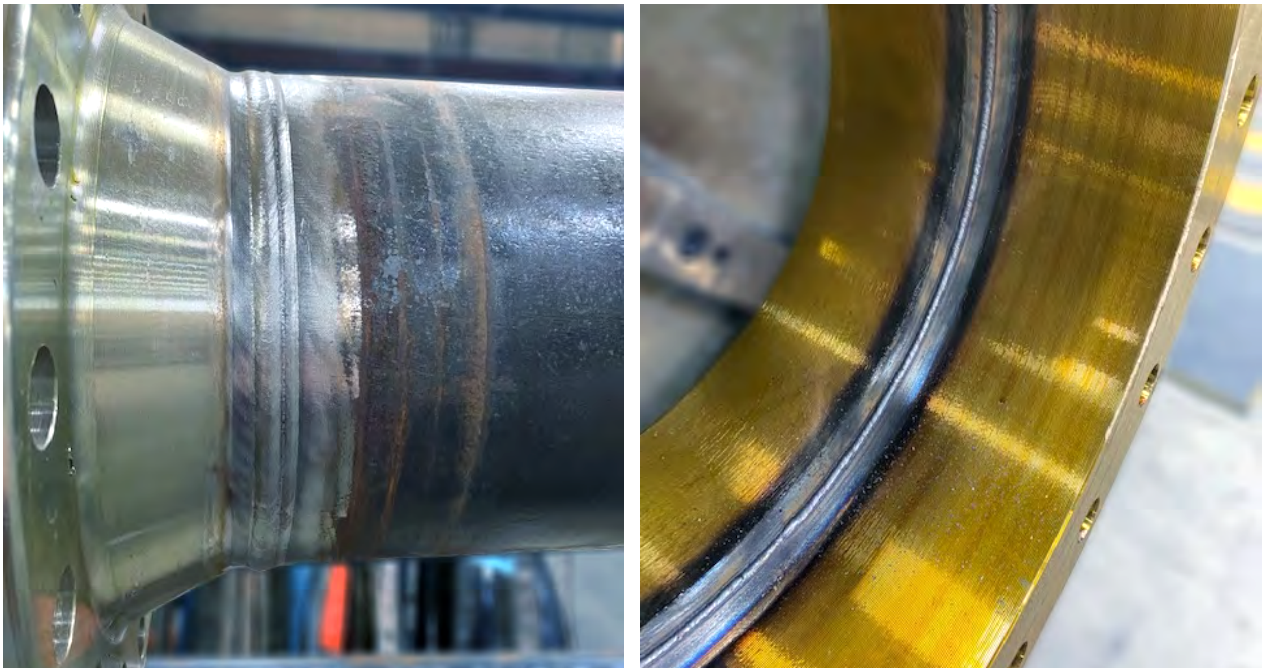

Figure 5: X-ray quality welds performed by the SWR™

Figure 6: X-ray quality welds performed by the SWR™

What our customers are saying:

“The thing about the SWR™ is that it is a start-to-finish weld, once you hit the go button, it welds the root, fills and cap without stopping, which makes doing a weld that has to be RT’d a bit of a cake walk since there is no in between pass clean up and prep. We currently have a 100% pass rate with our RTs on the SWR™.”

David Ray, Pipe Shop Foreman, W.W. Gay Mechanical Contractor Inc.

"Novarc’s machine brings a new level of quality and consistency with every weld as well as an embedded video of the weld into the BIM model.”

Pitt Meadows Plumbing & Mechanical Systems Ltd.

Using Tech and Data For Quality

In order to consistently hit x-ray quality welds, technology and automation must be utilized. It's also critical that pipe fab shops keep track of their welding performance pertaining to quality. By doing this, shops can see how quality can impact the bottom line. And, it’s not one-sided technology working in a silo that can achieve optimal long-term quality. It requires a mix of hardware and software that communicate and work with one another seamlessly.

In terms of weld data there are five critical parameters that come into play during the weld. These parameters should be adjusted based on the pipe size, schedule, and type of metal to achieve the optimal weld.

Wire Feed Speed

The speed at which the filler metal is fed into the arc which is directly correlated to the amperage output

Voltage

Dictates the arc length, which changes the amount of penetration into the weld joint and heat input

Weave frequency

The rate at which the weave action occurs in hertz. This controls how the puddle flows into the joint

Weave amplitude

The distance the weave axis covers during each weave cycle. This dictates how big weld puddle becomes and controls fusion along the edges of the weld

Speed

The speed at which the arc traverses across the surface of the pipe. Dictates a lot of things, penetration, deposition, heat input

With technology, we have the ability to use exact weld parameters and view a clear video of the groove to assist in making the necessary corrections – in real-time – during the weld. The ability to view and record weld video will enable you to see where errors can occur. This video can then be analyzed in parallel with the weld data to get a clear picture of what’s required for accurate troubleshooting and to make consistent, x-ray quality welds over time. By understanding this, you’ll be on the same page with your QC/QA Manager.

At Novarc we’ve developed a software to easily provide visibility for welding performance. The NovSync™ dashboard helps you to track production and machine trends over time by giving you centralized and secure access to weld videos, daily reports and data logs. Novarc’s comprehensive production monitoring software, NovData™, brings further traceability into your production by automatically creating in-depth production reports for enhanced quality control practices with the log reports automatically generated for each weld.

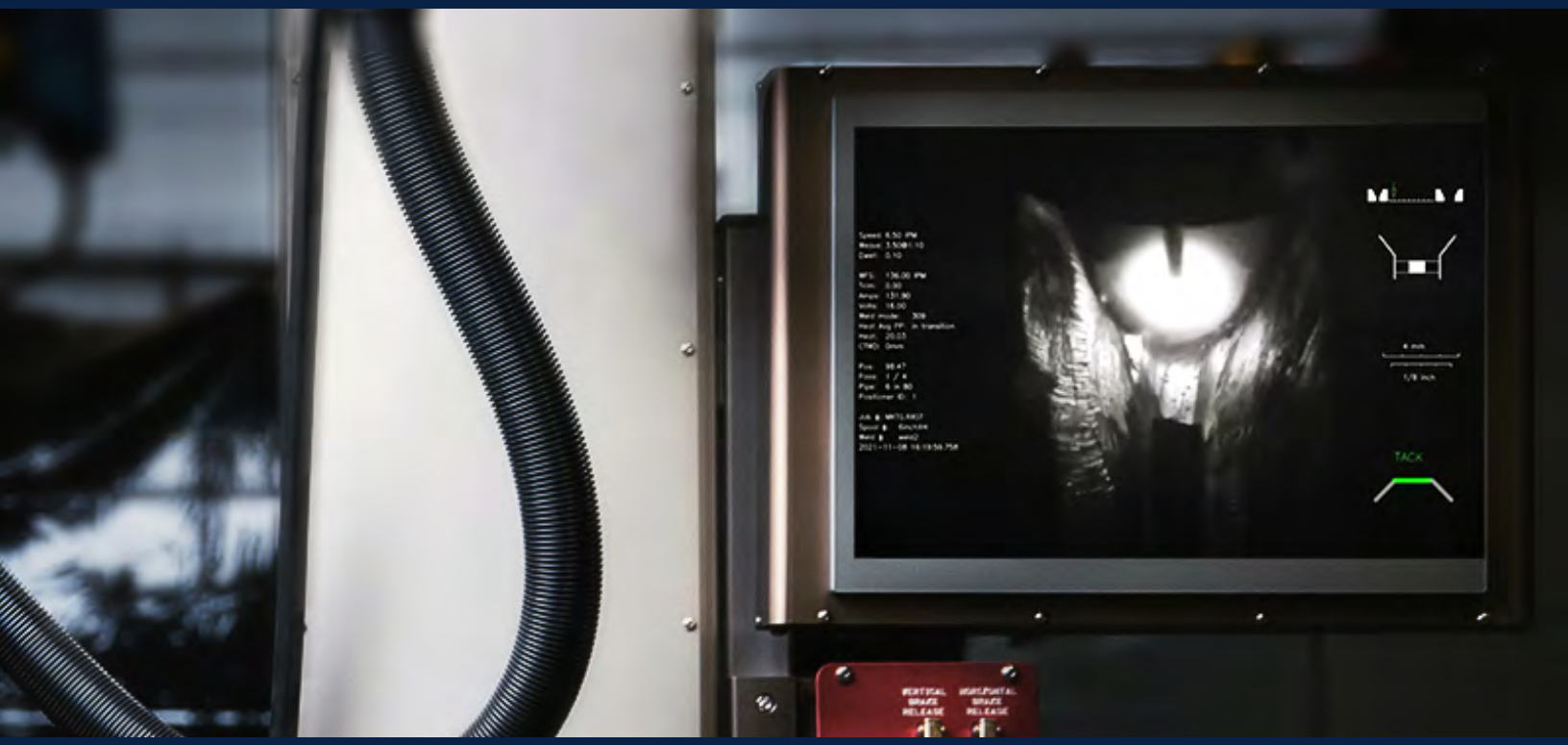

Figure 7: Novarc's SWR™ HMI showing the weld

What our customers are saying:

"The quality side of it is definitely the data aspect; the ability to tie in the weld data and video logs with our BIM information was a very big bonus. Being able to go in and have that level of inspection is really not achievable with the conventional methods."

Wade Eno, CEO of RoboFab, Energy (Oil & Gas)

"We're always looking for better tools, better means and methods. So we looked at a variety of mechanized and automatic weld equipment. It came down to a decision between Novarc and another pipe welding machine that we had seen at FABTECH. What made the Novarc machine stand out was the quality of the root pass, the laser and the technology..."

Mike Nastari, QA Manager, Mechanical Engineering, Harder Mechanical

Profitability

Bidding Process and Improving Margins

The competition for prefabrication is growing, but the good news is, demand is also in full-effect. Studies show that in the past 15 years prefabrication has grown from 15 to 40 percent for pipe welding. This means that opportunities are being identified and shops are aggressively trying to capture the increasing market share. In order to keep up with competition, shops are finding ways to improve lead times, capacity and margins on projects.

By using the SWR™ you're able to prove without a doubt that you can deliver projects faster, at a lower cost per inch, and with better quality. In turn, you're also able to go after those bigger projects or improve delivery timelines and avoid outsourcing. Also, due to unforeseen circumstances relating to supply chain issues affecting lead times your timelines will become more predictable. In the fabrication world, time is money and your margins will drastically improve. Another direct benefit to automation is addressing unpredictable human welder performance and welder availability (we discuss the welder shortage in the next section: "People").

When you have the ability to speed up production and bid on bigger projects it can make a world of difference for your business. It takes forever to build your reputation and only a second, or a project, to lose it. The goal for most companies is to win business without having to be in a competitive situation with others. Delivering projects on time, or early with world-class quality can lead to this. Sometimes, winning and delivering one big project can lead to your company becoming a household name in the market. You can raise the ceiling on your earning potential and your business can grow exponentially.

Figure 8: Finished portion of a customer's project

What our customers are saying:

"We're now going after projects that we were shying away from because of the size. Since we have implemented the SWR™, we have been spooling a lot more and we are also taking on bigger projects, knowing that we have the capabilities of the welding in place. So it's actually helped us go after some projects that we were not going after before"

Cyrus Patel, Piping Superintendent, Western Allied Mechanical, Mechanical Engineering

"We compete for and win work in three ways: price, quality, and time. For our customers, the daily service costs are tens of thousands of dollars a day, so two to three days saved is a huge return,...We wouldn't have been able to make the lead time on the current project we are doing without the SWR™ – we would have probably had to outsource some of the pipe fabrication..."

Paul Hebson, VP & General Manager at Vancouver Drydock, Shipbuilding Industry

Technology Adoption

Technology adoption is a great way to stay ahead of the curve, and as time passes it will eventually become a necessity. Adopting new technology can be a daunting undertaking, but it doesn't have to be. That's where finding a good technology partner is key, they can help you overcome barriers to integrating technology in the shop. Integrating a new system includes installation and can involve training for users and will probably require some sort of maintenance over time. That further stresses the importance of having a technology partner that can help ensure everything runs smoothly from start to finish of the initial integration as well as for the entire lifecycle of the system. When you have a piece of hardware with many components with built in software, it's important that the technology partner provides support for all these components and systems that communicate with each other. And, it's an added benefit if the same company that supports the technology also developed it.

To get a head start, show the market and your clients that you are up to date with technology that most of your competitors don't have yet. We've heard from many of our customers that mentioning the SWR™ in the proposal process, or better yet, giving the client a tour of your facility and equipment can build huge confidence in your shop. Showing off a technology that can save money for their customers and deliver projects faster, at a better quality and at a lower cost can speak volumes.

Figure 9: Operator and the SWR™

What our customers are saying:

> *"We've had a lot of clients come to see our shop during the bid process and they go crazy when they see the robot. They love it! They love the videotape capability. We play back the welds for them and they are absolutely gorgeous welds".*
>
> **Anonymous, PM, Mechanical Contractor**

> *"We have shown more than half a dozen of our customers around the machine. It's a powerful message to our clients that we are investing in a piece of technology that's going to make the work we do for them less expensive, higher quality, and take fewer hours."*
>
> **Paul Hebson, VP & General Manager at Vancouver Drydock, Shipbuilding Industry**

People

Labor Savings

We aren't in the business of replacing welders with technology, what we're aiming to do is to help shops better utilize their talent, so their top welders can work on the right tasks.

The dwindling supply of qualified labor in the welding industry is a significant issue for pipe fabricators, which is accelerating the need to automate. More automation can free up skilled welders from doing repetitive work, enabling them to do the more difficult welds.

The average salary for a welder in the US is close to $50k per year. However, pipe welding tends to demand higher wages due to the difficulty, experience and skill required. In some states experienced pipe welders can demand up to $125 per hour. Because of this fluctuation in different industries, and new projects popping up in certain regions, fab shops are always at risk of losing their best welders due to higher wages even if it's only a few more dollars per hour.

On average our customers say that one SWR™ can achieve 3-5X what a skilled welder achieves. With this type of productivity project timelines can be drastically shortened. Depending on your operations, one SWR™ can easily save you upwards to $150,000 or more right off the bat.

There is a welder shortage crisis. Pipe welding is particularly difficult and requires more skill and experience than other forms of welding. To add to the challenge, the welding industry is seeing a big decline in welders available to fill jobs. The National Association of Manufacturers states that nearly 81% of manufacturers are unable to hire the number of welders they need. In addition to this, the average age for a welder in the United States is 55 years old, indicating that the majority of skilled welders will retire in the next 5-10 years. The American Welding Society (AWS) also predicts that there will be a shortage of 314,000 welders in the United States by 2024. These data points give us significant insight into the trends facing the fabrication industry.

This is where robotics and AI can come into play to address the looming welder shortage crisis. Being that the average age of welders is in the 50s, this problem will only become worse. Every region is different when it comes to welder shortages, however, since demand and projects can instantly disrupt job markets, it's the perfect case for businesses to act now.

Figure 10: Image of welder

What our customers are saying:

> *"The best investment that we have ever made! Our Novarc SWR™ has reduced operator fatigue, increased productivity and increased the overall quality of work produced. The beauty of the system is the input the welder has to maintain the standards of the craft."*
>
> **F.W. Sims, Mechanical Engineering**

> *"Novarc did some testing for us and we fell in love.The first project we did we cut off 4.5 man weeks of shop welding, so we saved around $114,000 on that project, and it made us competitive and added value to the end user."*
>
> **Jim Jeffrey, Operations Manager, Western Allied Mechanical, Mechanical Engineering**

Welder Safety

Welding is a hazardous workplace activity and according to OSHA at least half a million welders are exposed to health and safety risks and 4 in 1000 risk being fatally injured. Pipe welding is challenging, and can be high-risk work. The risks range from injuries due to UV light, radiant and excessive heat, arc flash and carcinogenic fumes. We want to help shops take care of their people by improving welder ergonomics and avoiding unnecessary exposure when possible.

Safety is a huge concern for some industries. It's possible that work can be awarded to fabrication shops that have a clean record and adhere to strict safety standards, but more importantly shops can be at risk of violating health and safety standards due to welder complaints to OSHA. By using the SWR™ the operator is at a safe distance from the weld. This lowers the risk of short-term and long-term injury and health issues for your welders and operators. The SWR™ can actually extend the careers of your welders by limiting wear and tear.

Figure 11: Operator safely using the SWR™

What our customers are saying:

"Another benefit of the Novarc machine is the safety factor. You don't have welders hunched over, breathing fumes; they are standing back behind a weld screen, looking at the HMI, recording it. They really don't need to get near the weld except for when they start it and when they stop it"

Mark Nastari, Quality Director, Harder Mechanical, Mechanical Contractor

"Black and Mcdonald invested in the SWR™ because we wanted to safely improve the productivity of our welding processes...We are very pleased with the high level of safety for our workers".

Peter Tuck, Regional VP, Black and Mcdonald, Construction

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