HUMAN TALENT: THE GLASS INDUSTRY'S INDISPENSABLE ASSET

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In 2024, PaneraTech interviewed executives around the world. Our interviews focused on three critical questions:

1. How are you currently measuring success?
2. What do you believe are the greatest contributors to achieving that goal?
3. What challenges are you facing with those contributors?

While we received many different insights and perspectives, there were a few core elements that were discussed in almost every conversation. We found that even as customers articulated their goals in different ways, their biggest challenge to reaching those goals was the same: the changing workforce. We also learned that manufacturers are trying to manage this challenge in creative ways.

A consensus among the people we talked to was this: It is hard to attract and retain engineering talent because glass manufacturing is a dirty, low-profile industry. However, we did some research and found that this is not actually the case. We would like to challenge this idea and share what we have learned about attracting and retaining talent.

Glass Industry Headwinds

The end goal of any commercial industry is to make a profit and maintain a competitive advantage. While these primary goals don't change, the outcomes on which an industry focuses to achieve those goals can change according to the business environment.

The glass industry is currently facing multiple headwinds that are impacting both profit and competitive advantage:

- Declining consumer demand
- Packaging shift to lower-cost substitutes
- High cost of capital
- A challenging labor market
- Customer demand for sustainability

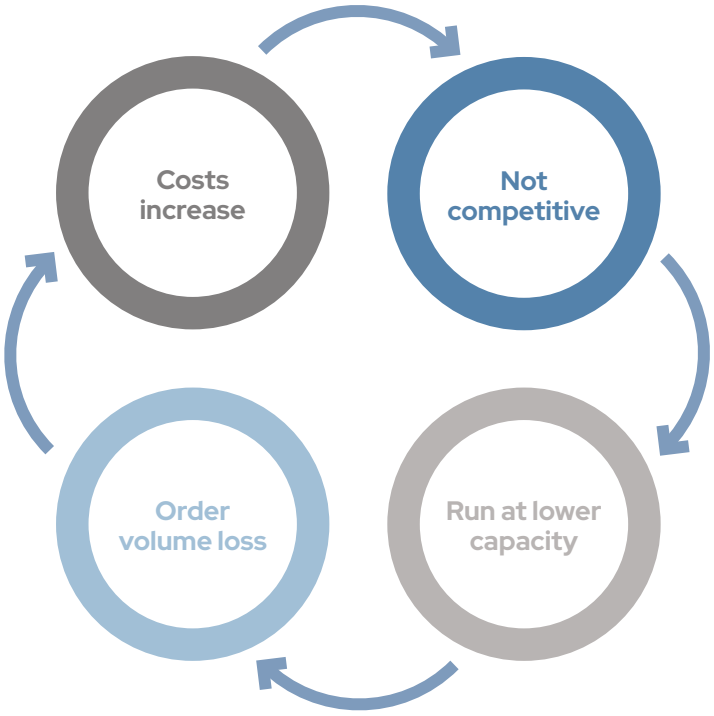
Staying Competitive

While margin can be addressed through the mathematics of sales and costs, the ability to remain competitive can be more complex. For example, growing customer demand for environmentally-friendly products has made sustainability a high

priority. Most glass manufacturers are working to increase the use of cullet to reduce energy use, emissions, and raw material consumption. New melting technologies that reduce CO2 emissions are also being adopted across the industry.

However, customers are also price-sensitive, and sustainable products incur a higher cost. Decreasing consumer demand has created additional upward pressure on prices. The shrinking construction and automotive sectors, paired with lower demand for household products like mirrors or glass tables, have impacted flat glass production. Container glass manufacturers are working against declining alcohol consumption and a shift in packaging to other materials.

This pressure on pricing creates a cycle that is difficult to escape. High costs make glass less competitive, resulting in lower volume demand. This causes manufacturers to run at a lower capacity, which decreases the return on capital investment. Costs must increase once again, further damaging the competitive advantage of glass products.



The Cost of Capital

Glass is a capital-intensive industry, and elevated interest rates have intensified the cost of manufacturing. Traditionally, running at full capacity helps to off-set these costs; however, the spiraling cycle of increasing costs and declining demand has made it difficult or even impossible to maximize production. While capital investment used to be viewed as a necessary cost to support furnace operation, it is now considered to be a significant investment that must receive a return. Therefore, asset life carries high importance, and efficiency is the outcome that receives the highest focus.

Gaining Control through Efficiency

Because glass manufacturers must deal with multiple factors that they cannot control, the factors that they can control are receiving greater scrutiny. There is little that can be done about interest rates or the economic impact on demand. Sales are hard to adjust given the current headwinds. However, efficiency is one area of glass production in which the manufacturer has a reasonable degree of control.

Therefore, most manufacturers are focusing on efficiency to improve profitability. Ironically, these same manufacturers report that efficiency is down across the industry. How is efficiency down at a time when it is receiving the most attention? Executives pointed us to one culprit: the shortage of seasoned, knowledgeable workers.

The Impact of Worker Knowledge

The primary contributors to efficiency of glass production are worker knowledge and experience. This is because the actions of the plant staff impact two components of efficiency: furnace downtime and stability of processes.

Limited Downtime

Limited downtime reduces non-productive periods, ensures quick recovery of glass quality, and stabilizes pull rates. Frequent downtime increases rejection rates, lowers pack-to-melt ratios, and extends production lead times. Consistent operations improve efficiency and product quality.

Glass manufacturers are working to limit downtime through:

- Preventive Maintenance
- Predictive Maintenance
- Improved Discipline

Preventive Maintenance is usually paired with predictive maintenance, rather than strictly using one or the other. There is a financial benefit to monitoring certain assets to perform maintenance based on real-time data. However, some equipment returns lower value from this method, and a regular schedule makes more sense. This keeps the process

simple so that the focus can be placed on assets that generate the most return on the investment in predictive data.

However, adherence to these maintenance plans requires discipline from the workforce. Lack of discipline, or a habit of not following company standards, is of high concern to glass manufacturers. Many have established practices to maintain their furnaces, but those practices can be forgotten or ignored. This is just one of the effects of a workforce that has less experience with the long-term consequences of missed standards.

Stable Processes

Production of glass with consistent quality requires consistent, stable processes. Seasoned engineers are careful to establish successful parameters and work to keep the process in range of those parameters. They can predict issues and know how to react when they start to see a change. The ability to do this well develops as knowledge and experience are gained over time.

However, glass manufacturers report that engineers are not staying long enough to acquire and benefit from this knowledge. It takes about two years to train an early-career engineer, and many are gone within a year to a year and a half.

The Changing Workforce

There was a time when furnace managers worked in one plant for decades. Glassmaking was often a generational career, and engineers were proud to master the art and science of the process. This experience led to consistency in production.

Today's workforce is more transient, and glass executives reported that they often can't keep engineers long enough to complete their training. A constantly changing workforce, combined with changes that happen from shift to shift, has made it more difficult to maintain stability. Knowledgeable workers are the foundation of efficient glassmaking. When that foundation begins to crumble, stability falls with it, disrupting efficiency.

The Hidden Cost of Lost Expertise

The crumbling foundation of expertise carries a high cost. Decisions made in both operations and maintenance take years off the furnace campaign and increase energy and repair costs. Furnace operators are using higher temperatures than needed, mixing the batch with improper moisture, making errors in electrode operation, and using subpar raw materials. They are overlooking flames impinging on the refractory and cooling that is insufficient, blocked, or misaligned. Observations are left unrecorded and therefore no action is taken. The maintenance team is overcoating years too early and implementing repairs with larger scopes than necessary. This reactive approach leads to disruptions due to glass leaks and emergency repairs.

The average total hidden cost over the entire course of a furnace campaign is

$3.1–$5.6 million USD
for a container furnace

and

$7.1–$12.5 million USD
for a float furnace.

This cost excludes hidden OPEX costs.

Attempted Solutions

While most manufacturers are experiencing issues with turnover and worker knowledge, they are addressing this issue in two different ways. Some are investing heavily in training, while others are automating as much of the process that they can.

Training

Many manufacturers reported that they are training technicians for supervisory roles that are traditionally held by engineers. When hiring, they look for candidates with a strong work ethic who are willing to be trained. While this has resulted in less turnover, it has not inspired confidence in technicians to make critical judgement calls that engineers can make. In other words, they can learn to follow directions well, but they are not able to add value to the process. Manufacturers have also found that the investment in training has only produced minimal improvements in efficiency.

The dream of the dark factory

Some glass manufacturers are focused on automation, with an aspiration to achieve the "dark factory." This can make sense when considering the diminishing talent pool and the importance of stable processes in making high-quality glass. However, research has shown that automation increases the need for humans in the manufacturing process. This was discovered as early as the 1980's.

In The Ironies of Automation, a study by Lisanne Bainbridge published in 1983, the issues with automation are outlined as a paradox.[1] Bainbridge explains that when humans are regularly involved in an entire process, the result is experienced operators who are knowledgeable enough to make quick corrections. These workers know how to accomplish tasks with the minimum number of actions. However, when operators are removed from the daily process, there is a deterioration of this knowledge and skill. A human is always needed to oversee the automation and respond to anomalies, but automation creates a human who is less familiar with the process and underequipped to handle the task.

Bainbridge suggests that irony exists because as control systems become more advanced, the input of the human operator becomes more essential. This was confirmed in 2017 by Micah R. Endsley. In *From Here to Autonomy: Lessons Learned From Human–Automation Research*, Endsley describes this same concept, describing it as a conundrum: human situational awareness diminishes as a result of increased automation.[2]

> For glass industry automation to be successful, it should support, rather than replace, engineers.

In his 2022 book, *Human Centered AI*, Ben Shneiderman asserts that the goal should be to increase high levels of both human control and automation.[3] Humans are an indispensable asset.

These studies suggest that the approach to automation should focus on human-computer collaboration rather than human replacement. For glass industry automation to be successful, it should support, rather than replace, engineers. Technology such as Artificial Intelligence should act more like an assistant or copilot to the operators and a reliable source of information to support data-driven decision making by the engineers.

Insights from young engineers

The right use of technology may support the furnace team to improve efficiency, but this does not solve the current labor market challenges. There is still a problem with retaining engineers who can make the judgement calls that are necessary for a successful operation. Manufacturers overwhelmingly reported that engineers leave the glass industry because it is a dirty, low-status job that does not attract young talent. However, we found evidence that contradicts this assumption.

First, we noticed that these engineers were taking the jobs to begin with, fully aware of the job responsibilities; this led us to research further. We found interesting answers in a survey of young Australian engineers.

[1] Bainbridge, L. (1983). Ironies of automation. Automatica, 19(6), 775-779.

[2] Endsley, M. R. (2017). From Here to Autonomy: Lessons Learned From Human–Automation Research. Human Factors, 59(1), 5-27.

[3] Shneiderman, B. (2022). Human-centered AI. Oxford University Press.

Despite the fact that Australia was not hit hard by the global financial crises, it experienced the same labor market challenges that were found across other continents. Michelle Wallace, Neroli Sheldon, Roslyn Cameron, and Ian Lings conducted the survey of these engineers who were about to enter the labor market, which was published as *What Do Young Australian Engineers Want? Strategies to Attract This Talent to Less Glamorous Industries*.[4]

The results of this survey pointed to a very different problem than the consensus of our interviews with glass manufacturers. The engineers marked the following factors, among others, as "unimportant" in their job search:

- Working for an organization that has high status
- Working in an industry where the workload is not too heavy
- The opportunity to work for a high-profile organization

Among the many factors that the engineers marked as "Important" were:

- Support from their organization for their continued learning
- The opportunity to work on interesting projects
- The opportunity to use cutting edge technology

These answers suggest that engineers are not as worried about a hot, dirty environment as they are about growth and the ability to solve interesting problems.

Our own experience with glass manufacturers reveals that many engineers who are hired to optimize furnace operations are instead responding to constant emergencies. This focus on "firefighting" doesn't allow them time to be proactive with their younger furnaces, leading to tomorrow's emergencies.

> "When you STOP damage control and START doing the job you were hired for (optimization), then the job becomes interesting."

The Real Problem: Discouragement

The data suggests that furnace managers are not leaving because glassmaking is less glamorous than other opportunities. Instead, it shows that engineers look forward to solving interesting problems (such as optimizing furnace processes) and instead work in constant reactive mode. This leads to discouragement.

This concept can apply to almost any industry. When someone is hired for a job that they are excited about, but the tasks that they do are far from their expectations, they will burn out. This doesn't mean that the worker is not willing to work hard during an emergency or do occasional menial tasks; the problem is when the "exception" becomes the normal daily job. For engineers who are passionate about making improvements, the despondency from constant firefighting can be great.

The Solution

There is good news: if the emergency cycle can be stopped, then the talent drain can be mitigated. Consider, for a moment, how things would change if engineers:

- could stop the constant firefighting and become proactive problem-solvers
- could collaborate with a seasoned furnace expert who shares best industry practices
- could access the latest technology and guidance for data-driven decision making
- could work on the interesting project of process optimization.

As one former furnace manager explained, "When you STOP damage control and START doing the job you were hired for (optimization), then the job becomes interesting."

[4] Wallace, M., Sheldon, N., Cameron, R., & Lings, I. (2014). What do young Australian engineers want? Strategies to attract this talent to less glamorous industries. Workforce development: strategies and practices, 33-44.

Digitalization combined with expert guidance from humans can help to break this cycle. We know from the survey of students that engineers want to work with technology; the study by Bainbridge shows us that technology must be supportive of humans. How do these things point to technology's role in attracting and retaining engineers?

The Role of Technology

Technology that is designed to support humans can help glass manufacturers become proactive; however, if it is not implemented in the right way, it will fail. Technology adoption can fail for multiple reasons:

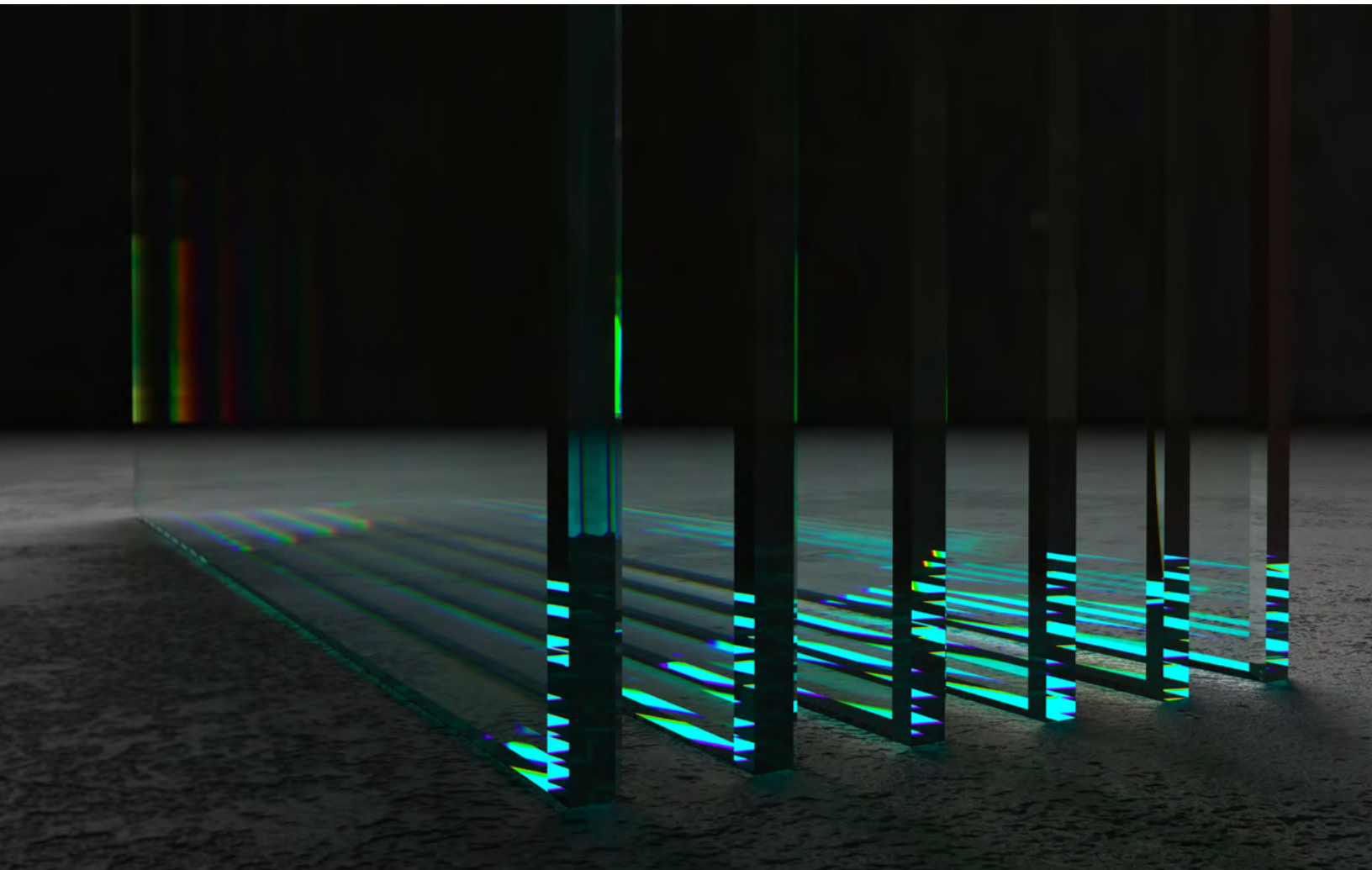
- Poor data
- Lack of trust in technology
- Algorithms that learn from sub-standard practices
- Inadequate change management practices

Therefore, specific steps must be taken to ensure that implementation is successful. For example, AI algorithms that are based on poor furnace management practices will only encourage more substandard operations. Best practices must be implemented in the plant before machine learning happens, and workers need to begin working with data to build trust. There are three steps to successful digital transformation:

1. Acquire data (collect the best data with advanced sensors)
2. Engage workers with data (human guidance for data-driven decision-making)
3. Implement worker-data collaboration (workforce Co-Pilot)

Taking the time to work through this process increases the chances of success in digitalization, and success is essential for the future of glass manufacturing.

PaneraTech has developed a program that addresses this issue. We combine the best sensors available, furnace experts with decades of experience, and top data scientists to help customers implement successful human-data collaboration. Our customers are guided through each step so their workforce can implement best practices and develop the habit of data-driven decision-making. It is only after these steps are successfully taken that we implement human collaboration with AI. To learn more, visit PaneraTech.com. ▌



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