

A man in a grey t-shirt, blue jeans, safety glasses, and a green bandana is operating a large industrial machine in a foundry. He is wearing work gloves and is focused on his task. The machine has a large circular component with the text "HYDAC" on it. The background shows various industrial equipment and a blue wall.

tobii pro
/insight

A Tobii Pro Insight eye tracking study

Visual Performance in the Foundry

How to reduce accidents and increase
efficiencies in an industrial setting

The visual skills behind operations at a metal foundry



Training and safety are imperative to any workplace, but this is especially true for the manufacturing and industrial sector. According to the U.S. Bureau of Labor Statistics, 4,836 workers were killed on the job in 2015. On average, workplace accidents cause more than 13 deaths per day. Human error is responsible for 80 percent of all of these accidents.

At the same time, having efficient processes on the production line is key to running a successful industrial operation. In these kinds of workplaces, inefficiencies have major performance repercussions.

To combat these trends, eye tracking has arisen as a powerful research tool. This technology allows businesses to see their workplace and processes through the eyes of their employees, providing insights that improve training, productivity, and safety.

According to the U.S. Bureau of Labor Statistics, 4,836 workers were killed on the job in 2015.

Attention is a key indicator of situational awareness, which helps us understand how and why human errors occur. With access to those insights, companies can mitigate risks and avoid accidents in the workplace.

Tobii Pro Insight and H&H Castings

To determine methods that result in fewer accidents and increased efficiency in the high-risk environment of industrial manufacturing, H&H Castings, a premier supplier of aluminum castings, partnered with Tobii Pro Insight to conduct a qualitative eye tracking study in a foundry in Pennsylvania, U.S. Using wearable eye tracking technology, which tracks and records where somebody is looking at a given time, the visual skills behind the operations of the foundry could be analyzed.



In this paper, we will walk through the approach of the eye tracking study, its key takeaways, and applications for the industrial sector.

H&H Castings was founded in 1965 and offers a full range of aluminum molding services with capabilities to produce castings from a few ounces in weight to over 4,000 pounds. The 100,000+ square foot facility has the potential to melt nearly 75,000 pounds of aluminum daily and employs 100 people.

Traditionally, the direct study of professional tasks within an active foundry has been difficult to achieve for precautionary reasons. H&H Castings trains a new employee or temporary worker in the melt department twice a month, on average, as it's one of the most demanding and the most volatile positions in the factory.

“When you’re trying to train someone in the metal-pouring department, you have a lot of stuff moving around at the same time, you have ladles filled with molten metal,” said Jacob Hammill, Systems Management at H&H Castings. “It’s a very dangerous environment.”



What is eye tracking?

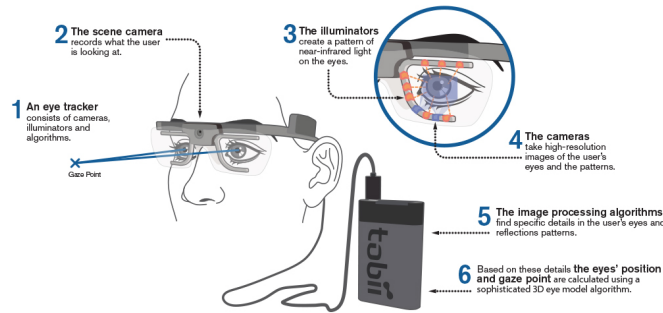
Eye tracking technology very accurately tracks and records where somebody is focusing their attention and how they visually experience their surroundings. As a research tool, eye trackers collect objective behavioral data providing businesses an understanding of workers' cognitive workload, situational awareness, visual skills, and the environment and processes they work in.



How the study was conducted

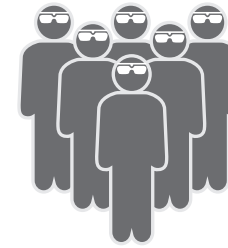
Working with fire and molten metal is a physical hazard to the workers. Safety restrictions make the close-up supervision of procedures more difficult, which causes the training of new employees to become both complicated and dangerous. For this qualitative study, a sample of six foundry workers were recruited to participate and each employee wore Tobii Pro Glasses 2 fitted with protective glass during the test.

The glasses unobtrusively collect precise and objective data in an unobtrusive way without interrupting the job performance. The employee was asked to complete their work tasks in the foundry, just as they normally would. Each employee completed filling, cleaning, transporting, and pouring tasks, as the eye tracker recorded their attention throughout these processes.



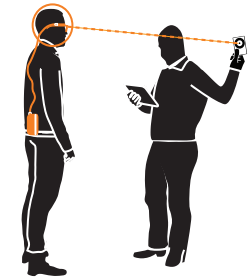
The behaviors that are intuitive to the skilled performer can be difficult to articulate to the novice. Here an H&H Castings employee is watching a replay of his eye tracking video together with a researcher from Tobii Pro Insight

Methodology



6 Foundry workers were recruited to participate in the study

- After a brief calibration, the eye tracking recording was turned on, and the employee was asked to complete their work tasks in the foundry, just as they normally would.



15-30m

- Each employee wore the eye tracking glasses for 15-30 minutes and completed filling, cleaning, transporting, and pouring tasks.

- An instant replay of the eye tracking videos was shown for quick and actionable insights.



- Post analysis was conducted using Tobii Pro Lab software.

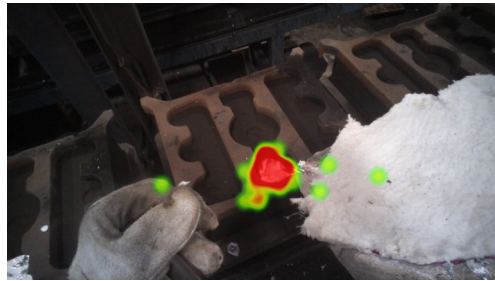
Key Takeaways



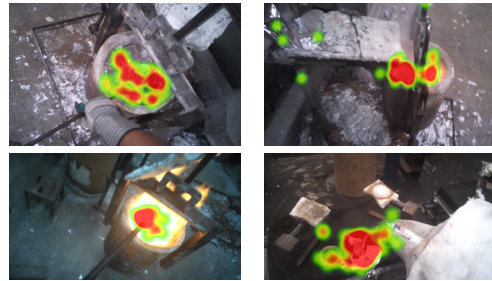
Steady Eye: One to three seconds before the pour begins, focus is on target and stays there- the pouring period had longer fixations (>800ms). Heavy focus was exhibited by all workers during correct performance.



Heavy Focus: Workers needed to remain vigilant in their attention as most of these dangerous tasks require a sustained gaze (30+ fixations) of a longer duration (300+ ms) during performance- this vigilance remains between tasks to avoid accidents.



Heat map for an expert worker while completing a sequence of several of pours. Attention is almost exclusively focused on the target of the pour.



Heat map for an expert worker during several different tasks, very little attention paid to the surrounding areas.



Head Positioning: Maintaining steady focus on the target and visual contact with the spout of the ladle is critical to managing speed and avoiding spills. Workers orient their heads, so that they do not have to continually shift from target to spout.



Physical Stillness: As demonstrated by the gyroscopic data, the most successful workers kept both their head and body immobile throughout the pouring process.



The screen captures above show the visual angle and an approximation of parafoveal vision during six different pours. The consistency of visual angle across workers throughout the process is notable.



Notice how little head and body movement is apparent in the video above. During the process of pouring the metal, the employee keeps completely still to ensure minimal spillage.

- The eye tracking videos will serve as valuable training aids for new hires without previous experience.
- Poor attentional strategies (suboptimal head position, failure to set focus on target) were associated with errors in metal pouring.



- Given the high attentional demands of the tasks observed, it is important for workers to take visual breaks regularly to relieve attention strain.
- A pattern of attentional and physical stillness during the metal-pouring process was found to be associated with high performance.

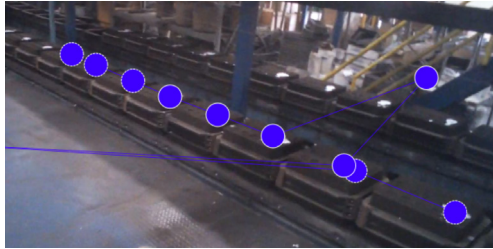
- In some cases, visual awareness of surroundings is lacking during tasks that require high levels of concentration.
- The foundry is a highly dynamic environment, in which sustained attention is crucial to successful performance.
- Given the dangers, supervisors must ensure that pathways are clear and workers practice routine checks of their surroundings.



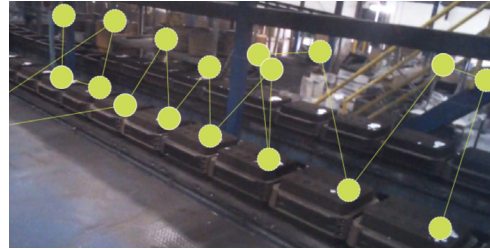
Participants were fitted with glasses and any required safety equipment

Identifying Visual Strategies

The tasks in the H&H foundry require a high level of skill and discipline. Through the analysis of different visual strategies, knowledge can be transferred to new employees.



Efficiency Example: The gaze plot shows the points of focus of one worker across 8 metal pours. Only twice during this 90 seconds of completing the task did the worker look at his surroundings.



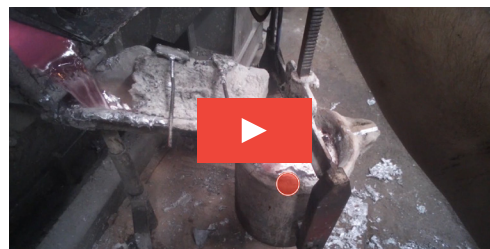
Awareness Example: The gaze plot shows the points of focus of one worker across 8 metal pours. This worker remained focused throughout the pouring process, but looked around at his surroundings in between pours.

Optimize Training

Using the firsthand perspective videos captured with eye tracking, H&H Castings is able to actually show a novice what the work environment is like from an expert's point of view in a way that couldn't be safely done before (See video examples below).



In a normal training, the trainee must stand at a safe distance to observe hazardous aspects of the process. The level of detail that they can see from this frame of reference is inadequate for efficient learning of job tasks



Using eye tracking video footage of an experienced worker, a trainee is able to observe the tasks on which he/she is training literally through the eyes of the experienced worker, which provides rich detail on the process.

Conclusion

The eye trackers provided a close-up perspective on how the processes were conducted through the eyes of experienced workers. With the attention data, Pro Insight was able to help H&H Castings understand behaviors that are intuitive to a skilled performer but difficult to articulate to a novice.

“The average training time is one full week, and we hope these study results and video will save us two days per employee. Ideally, this would save us about 400 hours of training time per year in that department,” said Jacob Hammill.

The attention data showed that foundry work requires an extreme amount of concentration and focus - any sudden break in that concentration could have a disastrous effect on how workers poured liquid metal into the casting molds. The analysis identified what was happening immediately before an error on the line occurred that would negatively impact efficiency, and it provided insight on how to improve the work environment and the processes in place. The findings will contribute to the quicker onboarding of new workers, new efficiencies in the foundry's operations, new training guidelines, and the reduced risk of accidents.

Further discussion

To help mitigate the risks and ensure quality, employers need to fully understand their work environment and processes and have training programs in place to prepare their teams for the worst-case scenarios.

With this technology, missed steps and distractions are identified by knowing exactly where a worker is focusing their attention in order to determine where human errors are occurring, as well as the underlying factors that cause them. By viewing the work conditions through a worker's eyes and evaluating protocols for handling dangerous equipment, businesses can bridge the perception gap between managers and workers to help create a safer environment for years to come.

In addition, a 2016 Accenture survey, 55 percent of manufacturers reported a skills gap between laborers and the advanced digital machinery they are required to use, up from 38 percent in 2013. Many companies are struggling to fill this digital skills gap and accommodate an aging work population currently holding on past the retirement threshold. Using attention data is a powerful means of streamlining processes and reveals if the work environment is optimized for the functions being performed there. By mapping the visual strategy of an expert the individual skills of the best and most experienced employees can be turned into assets for a company's knowledge base in order to be transferred to new and future employees.

About Tobii Pro Insight

Tobii Pro Insight is an agile partner that works in an iterative and flexible way at any or every phase of research. The global research team have the tools and expertise to capture authentic human behavior. They work in the industrial sector on research projects such as skills transfer, safety, quality assurance, training, and ergonomics.

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Tobii Pro provides eye tracking research solutions and services designed to deepen understanding of human behavior. Headquartered in Sweden, with local teams active on six continents, we help business and science professionals to further their research.

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