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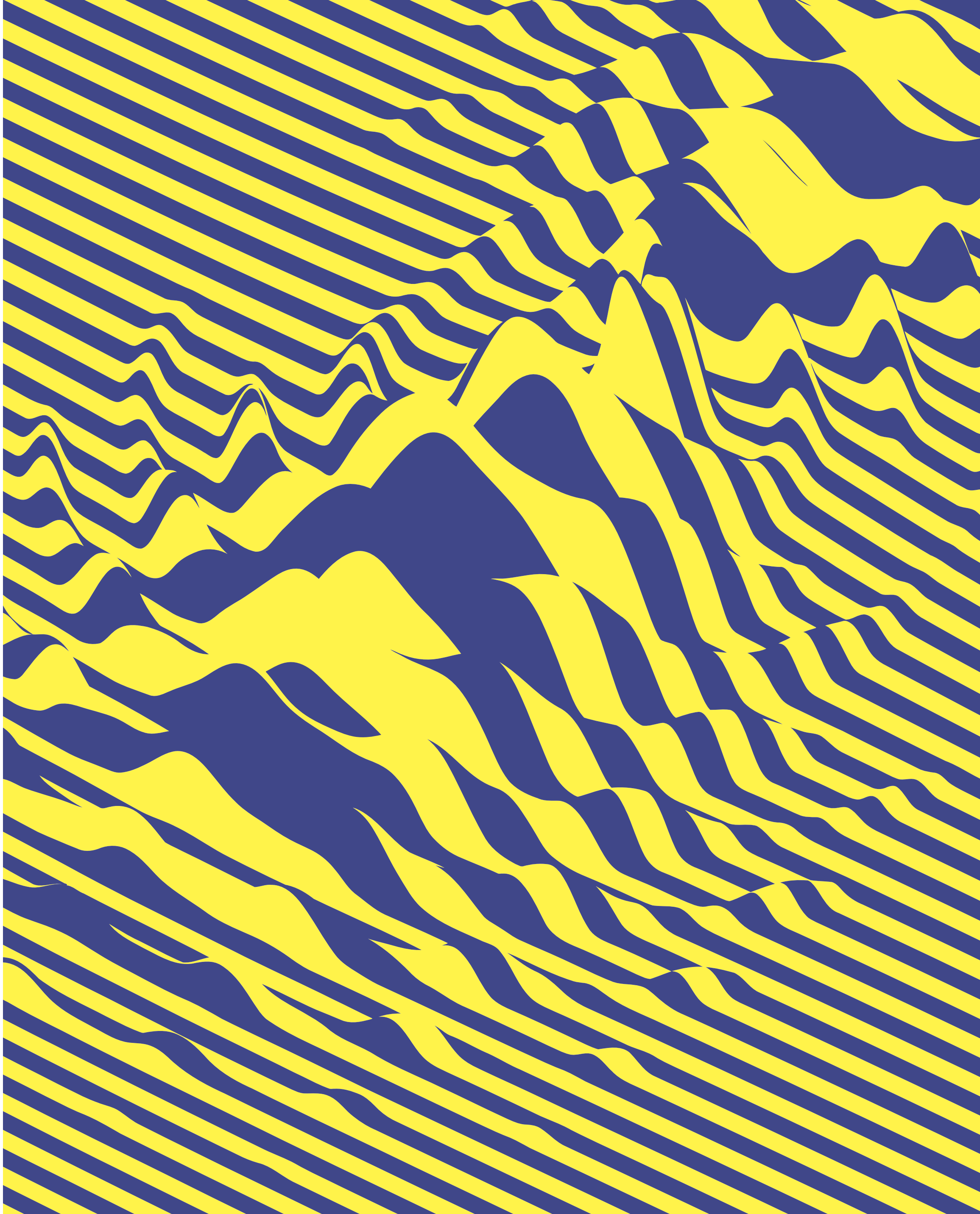
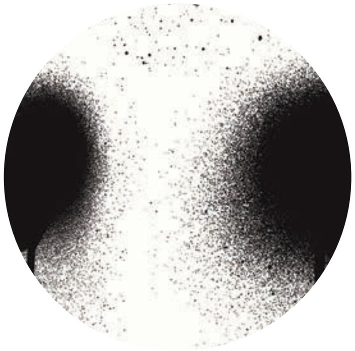


Visual Literacy: How "Learning to See" Benefits Occupational Safety

NATIONAL SAFETY COUNCIL®

Visual Literacy Background



The concept of visual literacy has been around for decades, and has typically been used in developing better teaching and learning techniques in the classroom. Recently however, visual literacy has been gaining traction in the workplace as a skill and tool to better identify occupational hazards that could lead to safety incidents. The following is a brief summary of what visual literacy is and how it can benefit occupational safety. Additionally, this document includes an outline of a new research project on visual literacy involving the Campbell Institute, its members and partners, and the Toledo Museum of Art.

Visual literacy has a variety of definitions. For instance, the Toledo Museum of Art (2016) states that visual literacy is “being able to read, comprehend, and write visual language” (Visual Literacy webpage). Being able to think visually is to be able “to interpret visual messages accurately and to create such messages” (Heinrich, Molenda, Russell, & Smaldino, 1999, p. 64). Another definition includes “the ability to both understand and make visual statements” (McLoughlin & Krakowski, 2001, p. 13-2). A longer definition describes what a visually literate person should be able to do: “(a) discriminate, and make sense of visible objects as part of visual acuity, (b) create static and dynamic visible objects effectively in a defined space, (c) comprehend and appreciate the visual testaments of others, and (d) conjure objects in the mind’s eye” (Brill et al., 2007). What all of these examples have in common is that visual literacy, like verbal literacy, is being able to “read” pictorial or graphic images and communicate the information those images convey.

The Architect's Dream.
Thomas Cole
Oil on canvas, 1840
Courtesy of Toledo
Museum of Art

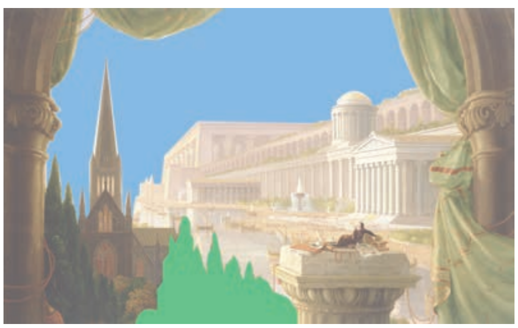
Even twenty years ago, scientists and educators recognized the world was becoming increasingly visual with the advent of the internet and exposure to a myriad of visual forms. Kellner (1998) stated that multiple literacies were needed in society, including visual, aural, and print literacy. Stokes (2002) explains that when complex information is presented graphically or visually, it allows for deeper comprehension and can enable individuals to better communicate the information. Visual literacy therefore can help achieve two major objectives: (1) helping people learn to "read" or decode visual information, and (2) helping people write or create visuals to convey information.

An interesting way on how to approach the teaching of visual literacy is revealed through an analysis of language. Benoît (2015) notes that in French, there are two words that can be roughly translated as "illiteracy" in English: inalphabeté and illettré. The former means lacking the tools of language, such as an alphabet, syntax, etc. The latter, however, implies that a person possesses these language tools, but is unable to put them together in a way that is considered functional. Applying this to visual literacy, we could say that by helping individuals increase their visual literacy, we assume they already have the tools to perceive, but we are enabling them to obtain a greater understanding of their surroundings through visual means.

Tuckey and Selveratnam (as cited in Chanlin, 1999) state that visualization skills can be developed through practice. Those who have had a lot of experience and training in the visual arts, such as professional artists and art critics, consistently score higher than average on local and global eye scans. This indicates that these highly visually literate individuals have an increased ability to see more of a visual field and take in more detailed and contextual information (Dake, 2007). In addition to being able to see more in a picture or visual scene, Giesen and Robinson (2007) argue that being visually literate is also being able to perceive individual details, understand how these details relate to each other, and synthesize these understandings into a broader comprehension of the entire visual field.

L I N E

S H A P E



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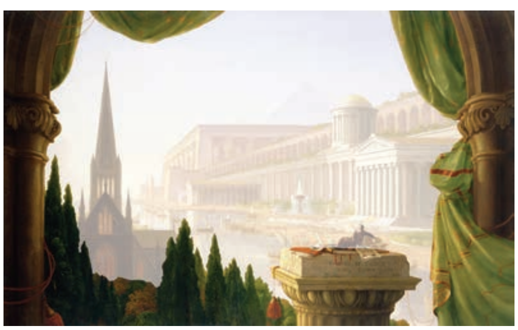

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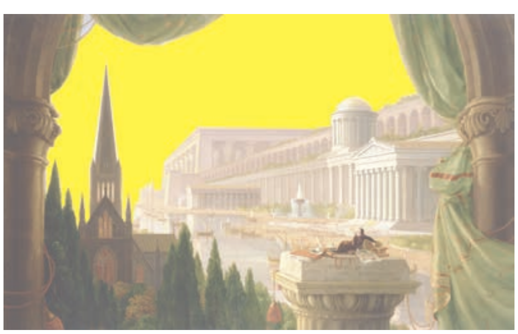


S P A C E

When teaching visual literacy and providing instruction on how to describe visuals and convey information, the Toledo Museum of Art asks students to focus on five essential elements of art: <u>line</u>, <u>shape</u>, <u>color</u>, <u>texture</u>, and <u>space</u>.

These are important elements for describing not only pieces of art, but also work environments. Being able to scan and describe a workplace environment in a systematic fashion can aid in pinpointing potential hazards and using a common language to convey observations to others.

Connection to Occupational Safety

The previous studies and research citing visual literacy make it clear that the concept of visual literacy hails from the world of art and education with applications that relate most closely to the cultural arts and training, not occupational safety. Yet Erickson (2016) argues that an interdisciplinary approach is necessary to improve occupational safety and health (OSH). She argues that the best method for continuous improvement in OSH is the incorporation of the so-called “soft” sciences – organizational behavior, management studies, social psychology, learning theory, and training. Visual literacy can be another critical piece for improving and maintaining excellence in OSH through cultural and behavioral changes.

The need for intersectionality aside, these analyses may still beg the question of how visual literacy relates to occupational safety. The argument here is relatively straight-forward – being more visually literate allows individuals to perceive and understand more about their work environment, enabling them to see hazards and imagine the potential consequences that can result from those hazards. Having this heightened ability enables workers to be proactive about their work environment and take measures to mitigate hazards before they can cause an incident. The main point is that visual literacy sensitizes us to our world and environment, helping us to become hyper-aware – and safer (McLoughlin & Krakowski, 2001).

Here we turn to the areas of hazard recognition, risk perception, signal detection theory, and human performance to inform how the ability to visually perceive is tied to increased workplace safety. Those who are versed in the field of human performance and cognition can tell us that it is difficult to “see” safety or the presence of safety because it is considered the status quo. In other words, we are used to seeing safe conditions and perceive them as “normal” (Hollnagel, 2017).

These “normal,” status quo conditions are what researchers in signal detection theory deem the “noise” to a potential hazard, which can be classified as a “signal” (Albert et al., 2017; McNicol, 1972). Being able to discern the signal from the noise is crucial to making decisions about what poses a hazard and which conditions require mitigation. In a work situation, it is possible that workers can be blinded by the “noise” of safe conditions, and this prevents them from accurately perceiving the “signals,” or unsafe conditions. The ability to “see past” the safe conditions and pinpoint the hazard(s) is what visual literacy for OSH is intended to teach.

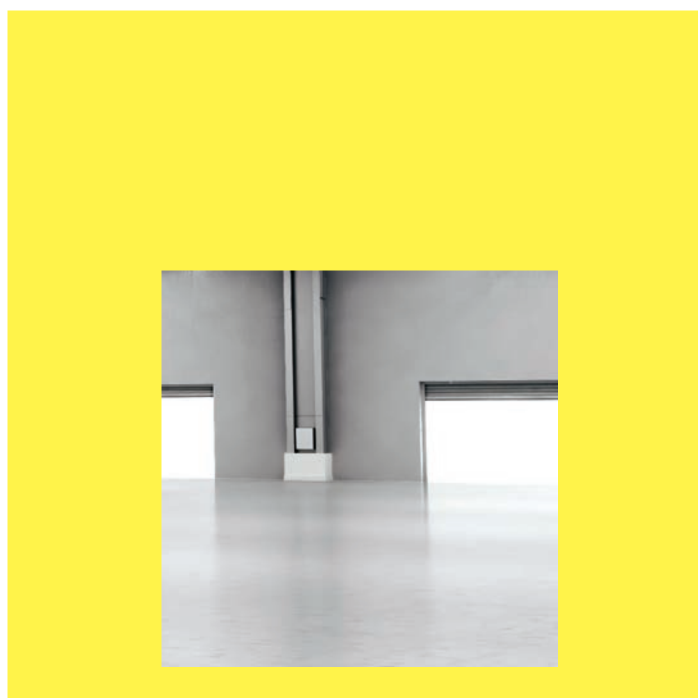
To explain worker behavior and why workers sometimes exhibit incompliance, Gantt (2017) encourages supervisors and safety managers to consider that so-called acts of “negligence” or “incompliance” may actually be a result of intricate decision-making

around risk perception and hazard recognition. For instance, Adams (1995) states that worker action involves a complex interaction of perceived danger, potential rewards, and propensity to take risk. When the potential reward or benefit of an action is high (in terms of time saved, for example), then workers tend to perceive the situation as lower in risk. Our argument here is that increased visual literacy skills can enhance the ability to perceive hazards and risks, even in light of potentially high rewards. Visual literacy can therefore give workers a greater sense of subjectivity when assessing work situations.
The Job Hazard Analysis (JHA) or Job Safety Analysis (JSA) has been in use for many years as a primary tool to identify and mitigate hazards before work commences (Glenn, 2011). It should focus on the relationships between the worker, work tasks, tools, and work environment to determine what hazards could potentially exist at each step of the work process (Zhang et al., 2015). The U.S. Occupational Safety and Health Administration (OSHA) specifies that a proper JSA will not only identify all hazards, but should also lead to decisions on how to mitigate those hazards (U.S. Department of Labor, 2002). While a well-written JSA on its own cannot prevent all incidents or injuries, it can define expectations for behavior while performing work tasks (Glenn, 2011).

Although it is seen as a foundational tool for hazard control and hazard identification, safety professionals acknowledge that the JSA is not without its flaws or opportunities for improvement. Albert et al. (2014) point out that JSAs and similar task-planning tools are methods of predictive hazard recognition that may not be as effective when dealing with unpredictable environments, sudden changes in conditions, or non-routine work. JSAs are also a retrospective method for hazard identification that is easily influenced by prior experience. This does not mean, of course, that JSAs are ineffective at identifying hazards, but rather that we can become accustomed to seeing a familiar situation and therefore may gloss over details that indicate a changed situation or a potential hazard. This failure to accurately perceive all pertinent factors can lead to JSAs that are incomplete or not reported in sufficient detail, which can inhibit the learning from them and lead to incidents (Albert et al., 2014). Becoming more visually aware can help workers to not automatically "fill in" details from prior experience and view a situation with fresh eyes.

The connection between hazard recognition and safety is clear, because workers cannot behave safely if they do not perceive hazards (Wilson, 1989). The inability to recognize hazards can lead to incidents because situational awareness is compromised (Carter & Smith, 2006). And while JSAs and safety checklists are still effective means to increase the identification of hazards, many hazard recognition methods wrongly assume that workers have adequate hazard recognition to begin with (Fleming, 2009). Training in visual literacy is intended to equip workers with the hazard recognition skills necessary to accurately complete a JSA prior to work.

Researchers have investigated various means to improve hazard recognition, such as through computer-assisted game applications, or virtual reality (Albert et al., 2014; Golparvar-Fard et al., 2009; Lin et al., 2011). In these cases, a virtual three-dimensional environment is used as an interactive training field to reinforce hazard recognition skills and learning. Another method that can be used in conjunction with VR technology is cognitive retrieval mnemonics, which is a technique for translating and organizing information. For instance, the mnemonic device used in research by Albert et al. (2013) teaches subjects to look for hazards based on specific energy sources (e.g. motion, gravity, radiation, mechanical, electrical, chemical, etc.). With this proposed research, we seek to add the concept of visual literacy to the list of effective methods for hazard recognition and improved occupational safety.



Research Methods

The methods for evaluating hazard recognition skills are many and can provide good context for how the Campbell Institute should evaluate visual literacy interventions for hazard recognition. Based on the maturity model suggested by Albert et al. (2013), hazard recognition skills could be evaluated by looking at:

- **Completion of the pre-job (JSA) form – How accurately is the form filled out? Is the JSA filled out completely with no missing fields?**
- **Review of the pre-job (JSA) form – Has the form been reviewed by each crew member? Has it been reviewed by a supervisor or lead?**
- **Proper identification of mitigations after stop work authority – After a stop work authority has been filed, were the proper steps taken to mitigate the hazard(s)?**
- **Number of stop work orders filed**

In a draft of a fictional course for hazard analysis and risk assessment techniques, Wilbanks (2015) suggests that workers should be evaluated also on their ability to know and apply a basic vocabulary for hazard analysis. This convergence of vocabulary and use of shared terms could be used as indication that a hazard recognition/visual literacy training is having a mass effect.

While researchers argue that visual literacy can be developed and refined through training and practice, there is no formal teaching strategy to guide individuals from unsophisticated viewing to a state of heightened visual literacy (Santas & Eaker, 2009). This is where the Toledo Museum of Art (TMA) has some insight and answers. For the past couple of years, TMA has been working with several companies in the Toledo region, including Owens Corning, a Campbell Institute member. TMA has developed and implemented visual literacy workshops for Owens Corning employees to increase their powers of perception and hazard recognition, keeping them safer on the job. In early 2015, approximately one year after developing the framework and curriculum, the TMA team finished road-testing the curriculum with 300+ staff and volunteers. At this time the museum was contacted by Doug Pontsler, vice president of EHS and sustainability at Owens Corning (OC), to see if there would be an application of the museum's curriculum to hazard recognition in a manufacturing setting. Regarded as an industry standard-bearer, OC was in the beginning stages of developing their global hazard recognition 2.0 training program and wanted to leverage news ways to approach their work.

After some initial conversation between OC and TMA, the museum piloted a six-hour visual literacy session with OC's key EHS team based out of their world headquarters in Toledo, OH. After this initial contact with the EHS team, the museum was put into contact with leadership at the Campbell Institute, the research arm of the National Safety Council (NSC), to discuss broader application to the EHS field. In fall 2015, a team from TMA was invited to present at the Campbell Institute's executive keynote session at the NSC Congress in Atlanta.

Concurrent to the work with the Institute, the TMA team continued to work with the EHS division at OC and hosted a workshop for the global EHS team at OC, with team members representing plants in the United States, China, and South America, among other regions. Key takeaways from this group included a connection of visual literacy to hazard recognition and incident investigation. This team was interested in how people can "see better" in their environment and improve their ability to describe hazards to their team.

One immediate result of these sessions between TMA and OC included a revision of their hazard recognition training, which now includes a clearly defined visual vocabulary – playing on the museum's use of the elements of art and principles of design. OC now breaks down visual assessment of an area in key types of hazards and trains employees on these specific hazards, one at a time. Each team member then focuses on said hazard for a period of time and then moves onto the next visually identifiable hazard. This scaffolded approach allows the hazard recognition team time to fully develop their visual acumen before taking on the "full picture."

The Campbell Institute, in partnership with the Toledo Museum of Art, has started a multi-year research project to determine the effects of implementing visual literacy training on increasing hazard awareness and recognition in the workplace and expand upon the work that has already taken place at OC. The Institute has enlisted the participation of four Institute members – AES, Cummins, Owens Corning, and USG. Directors of TMA are responsible for designing and delivering the visual literacy training. Researchers at the Campbell Institute are responsible for determining the effectiveness and/or associated outcomes of the training.

The stages of the research include:

- **Understanding the current state of hazard identification programs and processes in the companies studied**
- **Determining a baseline for hazard identification/visual literacy "competency" in the companies studied with help from TMA**
- **Monitoring the training/intervention program as it takes place and then periodically assessing key learning/ retention as well as hazard identification activities for the next 12 months**
- **Undertaking a post-intervention assessment in the companies studied, including both qualitative (employee hazard identification quality and concept retention/interviews) and quantitative (lagging outcome) components**
- **Offering suggestions toward the improvement and/or further refinement of the intervention**

TMA and the Institute propose a "train-the-trainer" model for conveying the visual literacy training from subject matter experts at the art museum to worker populations at research participant sites. In this model, each organizational research participant sends no more than three individuals from their sites to the Toledo Museum of Art in Toledo, OH to receive training in visual literacy. These individuals will then return to their respective companies and sites to train their own teams. The individuals that are being set up as "master trainers" for their respective companies/ sites will generally be the following: (1) the site EHS lead, (2) someone responsible for a specific safety initiative, such as hazard recognition, and (3) the site human resources lead, or someone responsible for training in general.

Proposed Evaluation Metrics

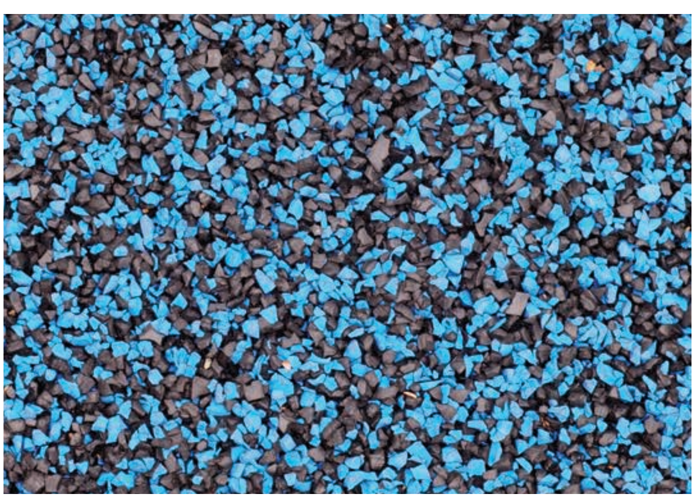
Evaluating visual literacy's effect on hazard recognition skills is generally two-fold – quantitative and qualitative – with several metrics for evaluation under each. The most obvious quantitative metric is the number of proactive hazard recognition or near miss reports filed. Another quantitative metric discussed among research participants for inclusion is the number of stop work orders filed. As mentioned in the previous section, this can be a good method of determining if workers are becoming more attuned to potential hazards – the more sensitive workers are to potential hazards, the more justified they will feel in issuing a stop work order.

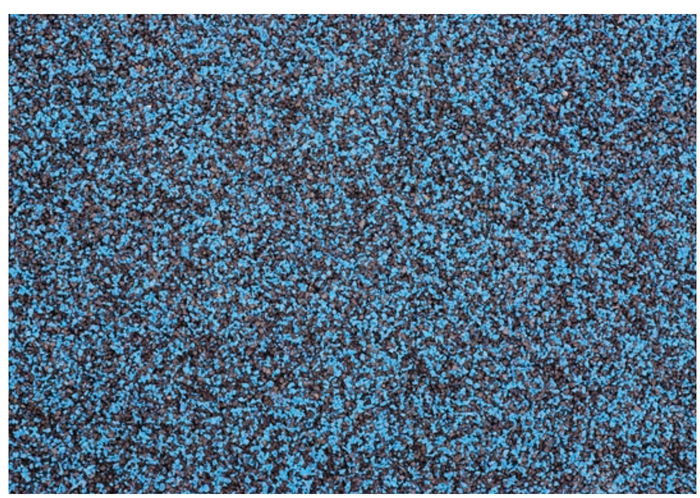
Other quantitative metrics could include how frequently JSAs are filled out and the number of JSAs completed by the full work crew. Additional important quantitative metrics are the number and percent of "all clear" JSAs submitted. These are interesting metrics to consider, namely because if the number and percent of "all clear" JSAs is high or close to one hundred percent, this could be evidence of pencil whipping and non-compliance with safety procedures.

Qualitative metrics generally revolve around the quality of the JSA report. How completely is it filled out? Has the JSA report been completed by the entire work team? The quality of hazard recognition reports can also be evaluated through the consistency of language used in the reports. Do people describe hazards in the same way, and in a manner that is understandable to others? The consistency and comprehensibility of language is essential to ensuring that hazards are addressed proactively.

Other qualitative metrics to consider are a record of the type of hazard recognition reports received. How novel are these reports? A greater number of new, novel reports can be indicative of heightened visual literacy and hazard recognition skills – workers start to notice different types of hazards that they may not have been sensitive to in the past. Additional qualitative metrics are the ability of workers to recognize upset conditions and, relatedly, the ability to recognize the hazards in upset conditions.

Time permitting, TMA and the Campbell Institute would also like to gather data relating to the visual literacy training and the JSA tool itself. For instance, we would like to evaluate worker satisfaction with their company's current JSA tool, and perhaps use the principles of visual literacy training to create better JSA tools with photographs, drawing, or videos. Another area for data collection can be an evaluation of the visual literacy training itself – how memorable is it? Can workers still apply the concepts from the visual literacy training weeks and months after initially receiving it?





Implementation of Visual Literacy at Research Sites

The first research site established is a USG location that manufactures cement board. Two Cummins locations will be included in the study, the first a distribution site and the second a manufacturing site.

Roughly three representatives from each of these USG and Cummins sites will participate in the two-day train-the-trainer workshop in Toledo, tentatively scheduled for October of 2017. Examples of the visual literacy curriculum to be delivered at the train-the-trainer workshop can be found in the Appendix.

Upon return to their home sites, the newly trained representatives will have a workbook with daily five-minute visual literacy talks to be delivered during the pre-job safety meetings that already occur as part of the day's regular work routine. The inclusion of visual literacy principles in these pre-job five-minute safety talks is a convenient and unobtrusive way to implement visual literacy training. As a clarification, these five-minute talks on visual literacy are not intended to replace the content of regular toolbox talks, but to be a component of those toolbox talks. The researchers from the Toledo Museum of Art will follow up with all research sites on a quarterly basis to reinforce the visual literacy training and collect information on the metrics described in the previous section.

The plan for visual literacy implementation at AES is different, as this involves the inclusion of visual literacy as a module in AES' e-training for all employees. Implementing visual literacy in this way means that the entire organization has the potential to receive visual literacy training rather than a single site or location. Researchers from TMA will be working with e-training staff at AES to develop the visual literacy module as a component of overall safety training at AES. Examples of the visual literacy curriculum to be included in the e-training module can be found in the Appendix. TMA researchers will follow up on a quarterly basis to provide guidance on the visual literacy training module and make adjustments for improvement.

Owens Corning has already been working with the Toledo Museum of Art for the past two years to incorporate visual literacy to aid in hazard recognition. TMA has trained people from Owens Corning to deliver the visual literacy curriculum as part of the standard safety training. In this way, Owens Corning is one step ahead in the implementation process, yet they have not yet been evaluated to the same level or scale that has been proposed for this research. Evaluating visual literacy training on hazard recognition in the same way as the other organizational participants will allow us to see the potential longer-term effects that the training can have on leading and lagging safety metrics.

In sum, the Campbell Institute and the Toledo Museum of Art hope to demonstrate the beneficial effect of visual literacy training on hazard recognition skills, and in general, to forge this connection between the fields of art education and occupational safety and health. We expect to have further updates and publications on this research project as each of the stages launch and as the initial evaluations are completed. The Campbell Institute would like to gratefully acknowledge the Institute members participating in the project and the Toledo Museum of Art for their partnership and collaboration.

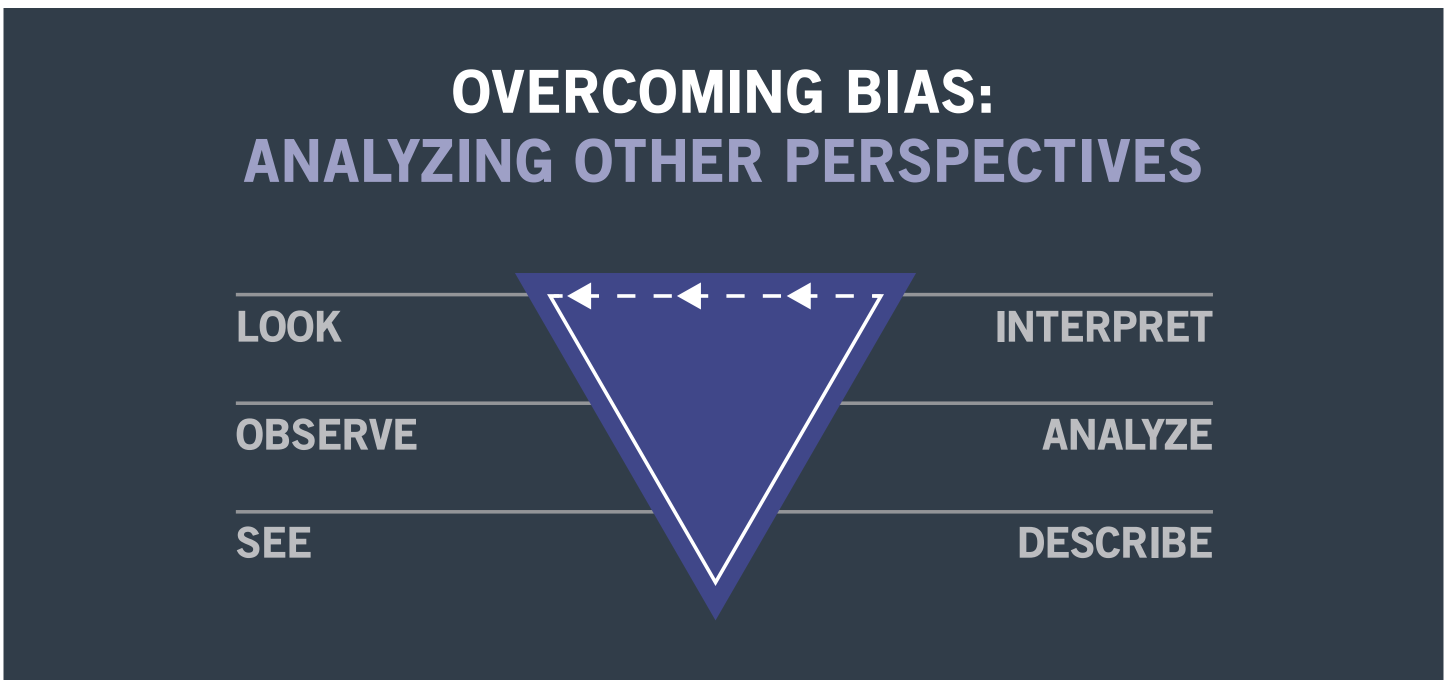
Appendix Part 1:

Visual Literacy Framework

In 2010, the Toledo Museum of Art (TMA) established teaching visual literacy as a strategic objective and in support of the Museum's purpose: art education. Building on the work and leadership of the museum's director, Brian Kennedy, the museum has developed a number of initiatives to support this aim including a website devoted specifically to visual literacy, www.vislit.org, hosting the 47th annual International Visual Literacy Association conference, as well as producing a number of museum publications related to the topic.

As part of the evolution of visual literacy at TMA, in 2013 the museum developed a framework for teaching visual literacy. The first step of the framework included developing a clear and concise definition, the ability to read, comprehend, and write visual language. This definition, which closely mirrors that of textual literacy, centers on sensory input (read), meaning making (comprehend), and action taken (write). In short, TMA defines visual literacy as: "what do you see, what does it mean, and what do you do about it?"

Looking, according to associate director Adam Levine, is akin to skimming in reading, while observing is identifying key details. Once these two actions have taken place then one can see the entire picture. The next step is then to objectively describe the visual information presented before you. After description, you can begin to make meaning by analyzing key visual and contextual information. Culmination of this process includes interpretation as described through four visual languages – step three in the framework. These visual languages include form (the formal properties of a work of art as manifest through the elements of art and principles of design), symbols (interpretation as manifest through personal signs and symbols as associated through prior knowledge and experience), ideas (society's interpretation and understand of visual imagery), and meaning (the summation of all modes of interpretation). These visual languages serve as a metacognitive process in reflecting on how and why we land on interpretations in the visual world.



Once the definition was solidified a museum team of educators, curators, and marketing staff worked through key elements of the teaching framework. Step one is establishing a visual vocabulary through the elements of art and principles of design. This vocabulary lays the foundation for being able to objectively describe visual information, including but not limited to works of art. Step two is the introduction of a thinking routine as a means of looking at and discussing visual information. This thinking routine maps nicely onto the museum's definition of visual literacy by walking participants through a six-step process. Look, observe, and see (reading visual language) to describe, analyze, and interpret (comprehending visual language) and then repeating the cycle (writing visual language).

The last step in the thinking routine framework is writing. This act is about the action one takes upon completing the process. It is not enough to develop an understanding of the visual world, but you will now be equipped to approach it in a new way and respond to the world around you. As TMA finalized its framework for teaching visual literacy, an in-gallery curriculum was developed to teach the above concepts through activity-based and gamification principles such as play, group work, and challenge-based prompts.

Appendix Part 2:

Understanding Visual Biases

Becoming more visually literate and being better able to observe, see, and interpret our environment depends on becoming aware of our visual biases. TMA describes visual biases in three ways:

- **Sometimes you cannot see what is in front of you, even if you know it is there**
- **Once you see something, it is impossible to "un-see" it**
- **You are always filling in the blanks based on what you expect to be there**

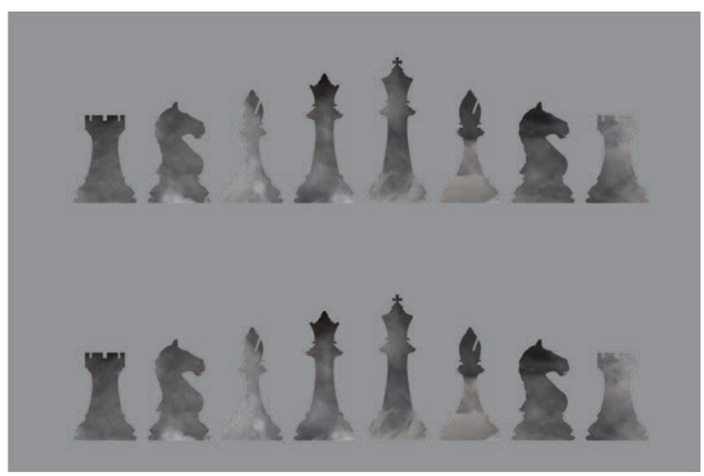
For example, take this image. Can you see it? By the nature of this question, you know that there is something there to see, but what is that supposed to be?

When the color of the image is changed, it becomes clear what you are supposed to see:

Looking back at the first black and white image, you can still see the leopard, even when you didn't see it previously. Once you see something, it is hard to remember what it was like not to see it.

Another example of not being able to discern something even though you know it's there can be demonstrated through the following image. What if you knew that the chess pieces in the top half of the image are the same color as the chess pieces in the bottom half of the image? Can you actually see that?

Everything we see is based on context. We can't see that the chess pieces are the same color because of the two different backgrounds. What happens when we make the backgrounds behind each set of chess pieces the same?



Now we can clearly see that both sets of chess pieces are the same color. Our ability to "see" things depends on other things that are occurring visually in the environment or background.

A final example of visual bias is that our minds constantly fill in "blanks" depending on what we expect to see. Take for example this first image:

Can you read this?

Even when some letters are removed from the image, it's still possible to read:

Can yo rea thi ?

It's still possible to read other phrases with letters missing, even if you haven't seen the full phrase previously:

You are no readin thi

Wha ar yo readin ?

These examples have hopefully explained our natural visual biases, and have also demonstrated that our visual literacy skills are improved when we can move beyond these biases. We are more likely to pick up anomalies and potential hazards in the workplace when we make a concerted effort to see the work environment (typically a very familiar place) with "fresh" eyes, and take care to not "fill in" visual details that we are accustomed to being present.

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