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Market Milestone

The Brain Science Behind PTC's Vuforia Expert Capture™: Why It Speeds Time to Productivity While Reducing Training Costs

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EXECUTIVE SUMMARY

Key Stakeholders:

Product Lifecycle Managers, Industrial Learning Officers, Manufacturing Learning Officers, Industrial Managers, Manufacturing Managers, Product Scientists, Product Development Managers, Manufacturing Process Managers, Field Service Managers, Field Service Representatives.

Why It Matters:

The workforce skills gap is growing in the manufacturing and industrial sector, and is exacerbated by the exodus of highly talented and knowledgeable retiring workers. These subject matter experts' knowledge needs to be tapped, curated, packaged and delivered to new workers in a way that speeds time to productivity while reducing training costs.

Top Takeaway:

The brain science of learning suggests that the most effective workforce training tools engage the worker in a way that directly and naturally maps onto the relevant learning and memory systems in the brain. PTC's Vuforia Expert Capture™ uses augmented reality technology to meet these needs by curating subject matter experts' knowledge and presenting that information to workers in a way that minimizes cognitive load while simultaneously engaging experiential and behavioral skills learning systems in the brain. This speeds time to productivity, trains subject matter and behavioral skills expertise, all while reducing training costs.

THE PROBLEM

A major workforce skills gap threatens the manufacturing and industrial sectors. The [Manufacturing Institute](#) predicts that while nearly 10 million manufacturing jobs will be needed in the next decade, millions of these jobs will go unfilled. Exacerbating this problem is the fact that new workers will not have the level of expertise of those retiring from the workforce. This will leave the manufacturing and industrial sector with a less productive workforce.

What is needed are methods for training the new workforce that instill the subject matter expertise and behavioral skills repertoire of the expert. This requires the development of tools that effectively curate, package and deliver that expertise to new workers in a time-effective, cost-effective and scalable manner that speeds the time to productivity, all while reducing training costs.

To build such a tool one needs to understand (a) the nature of expertise so that it can be captured and curated, and (b) how the brain learns so that the curated content can be packaged and delivered in the optimal manner.

THE NATURE OF EXPERTISE

Experts have a vast store of subject matter expertise and a behavioral skills repertoire that they draw from when on-the-job. Experts know the steps needed to complete a task, the order in which those steps must be completed, and the challenges associated with mastering each step. What is needed is a tool for capturing and curating this vast knowledge by allowing the expert to convey the step-by-step directions needed to complete a task quickly and efficiently. What results are a set of Standard Operating Procedures (SOP) that must then be packaged and delivered to workers in a way that speeds the time to productivity and enhances subject matter and behavioral skills expertise.

THE BRAIN SCIENCE OF LEARNING

The traditional approach to packaging and delivering information is to construct a training manual or training video that captures the steps needed to complete some task. This could be delivered during the onboarding process and also made available to the workers on the plant floor.

From a learning science perspective—the marriage of psychology and brain science--this approach is suboptimal for a number of reasons.

First, the load on the cognitive processing systems in the brain, in particular the prefrontal cortex, is high. Working memory and attention must be recruited to memorize the steps needed to complete the task, but working memory and attention are limited resources, and they are easily taxed leading to slow and inefficient learning.

Second, the learning takes place in a vacuum separated in both time and location from the task to be learned. The temporal separation places additional load on the cognitive system to store the information in long-term memory for later retrieval when on-the-job. The spatial separation means that experiential and behavioral skills learning systems in the brain that would be recruited should the learning take place while performing the task, will not be

recruited. This means that the strong behavioral skills repertoire of the expert will not be trained.

Taken together, this reduces the overall effectiveness of training and weakens learning and retention. In short, tasks that are most quickly and accurately learned through *physical repetition* are learned slowly and inaccurately through *mental repetition*.

PTC'S VUFORIA EXPERT CAPTURE™ IN CONTEXT

The learning science offers a roadmap for addressing the workforce skills gap. First, one must capture and curate content from experts to build the standard operating procedures. Second, that curated content must be presented to workers in a way that minimize the load on cognitive processes, such as working memory and attention, by presenting information when and where workers need it. Third, that curated content must be presented while the worker is performing the task so that experiential and behavioral skills learning systems in the brain are also being recruited. This will simultaneously train the subject matter expertise in the worker, but will also build the critical behavioral skills repertoire needed to be effective.

PTC's Vuforia Expert Capture™ uses augmented reality technology to meet these needs. Vuforia Expert Capture™ allows subject matter experts to record the step-by-step directions needed to perform critical manufacturing and industrial tasks quickly and accurately. Using augmented reality tools (e.g., the Microsoft Hololens) this step-by-step, expert content is presented to workers when and where they need it, meaning in real-time and in the flow of work while *physically* performing the task. Presenting expert content in the flow of work *when* the worker needs it minimizes the need to retrieve previously studied

information from long term memory or, if that information has been forgotten, minimizes the need to revisit the manual. This significantly reduces the working memory and attention load on the worker, and allows the worker to reserve these precious cognitive resources for other tasks at hand (Figure 1).

Figure 1: Evolution of Temporal Distance
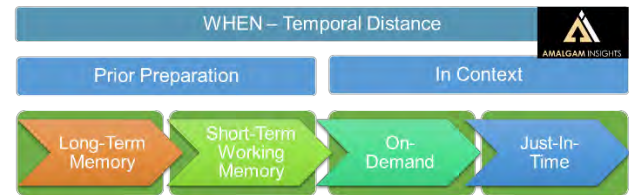
Presenting information *where* the worker needs it means that the instructions are presented as text or graphics (e.g., arrows) within the worker's field of view while they are performing the task. There is no need to walk across the plant floor to revisit the manual, or to shift visual attention away from the task at hand and to a manual. Rather, the task and instructions are all presented within the worker's field of view. This significantly reduces the working memory and attention load on the worker, and allows the worker to reserve these precious cognitive resources for other tasks at hand.

Figure 2: Evolution of Spatial Distance
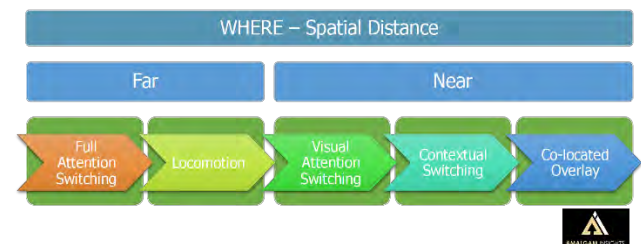
By offering step-by-step guidance to the worker while they are performing the task, PTC's Vuforia Expert Capture™ engages cognitive learning systems in the

brain, but more importantly simultaneously engages experiential and behavioral skills learning systems in the brain. This "learning by doing" approach builds the strong subject matter expertise in workers but does this while simultaneously training the strong behavioral skills repertoire needed in industrial and manufacturing settings. Taken together, this speeds the time to productivity, trains subject matter and behavioral skills expertise, all while reducing training costs.

CONCLUSIONS AND RECOMMENDATIONS

If you are involved in the manufacturing and industrial sector and the current workforce skills gap is threatening your organization, you should **consider augmenting your current training solutions with solutions that are optimized for the way that the brain learns**. The brain learns most effectively when knowledge is presented in the flow of work and broadly engages multiple learning and memory systems in the brain. Augmented reality training tools can achieve these aims by capturing and curating the extensive knowledge of your subject matter experts,

and packaging and delivering that content to workers in a way that speeds the time to productivity, trains subject matter and behavioral skills expertise, all while reducing training costs.

PTC's Vuforia Expert Capture™ is recommended for companies seeking to record step-by-step directions from manufacturing and industrial subject matter experts because these directions can be recorded quickly and accurately in a format that is easy to understand.

PTC's Vuforia Expert Capture™ is also recommended because it **delivers this expert content in a way that trains both the subject matter expertise and the behavioral skills repertoire** needed to address the challenges that they will face in a complex and variable work environment. It does this by delivering the expert content in a way that reduces the load on cognitive processing systems in the brain while engaging experiential and behavioral skills learning systems in the brain *in synchrony*.

Finally, we recommend PTC's Vuforia Expert Capture™ because **its "learning by doing" approach speeds the time to expertise**. Training workers while they perform the task builds subject matter expertise, a behavioral skills repertoire, and accelerates the worker's time to reach expertise. With so many subject matter experts retiring, speeding the development of expertise in new workers is critical in industrial and manufacturing settings.

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ABOUT AMALGAM INSIGHTS

AMALGAM INSIGHTS

Is a leading research and advisory firm focused the financial, programmatic, and cognitive tools that multiply the value of enterprise technology including the following research practices: Technology Expense and IT Subscription Management, Accounting and Business Planning Technologies, Data Science and Machine Learning, DevOps and Open Source Development, Talent Management, Learning & Development, and Extended Reality.

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Todd is a Learning Scientist/Research Fellow at Amalgam Insights. He focuses on the Talent Management and Learning & Development sectors and the challenge of leveraging talent and learning science—the marriage of psychology and brain science—to provide customers with optimized talent management and learning and development solutions.

Prior to Amalgam Insights, Todd:

- Established leader in the field of human learning, memory, and performance in a 25-year career as an academic and researcher.

- Awarded over $10 million in federal research funds for his own human learning and performance laboratory.

- Published over 200 peer-reviewed research reports and cited over 10,000 times by fellow researchers.

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