NOVEMBER 2025

WHITE PAPER

Knowledge Transfer for Machine Operators

From Paper to Digital Intelligence

PMMI Business Intelligence

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ABOUT THE REPORT

PMMI is the leading global trade association for the packaging and processing industries. Our core purpose is to unite the packaging and processing industries across the supply chain, helping our members to exchange knowledge and ideas so that they can continue to succeed in a rapidly evolving global market. We represent over 1,000 companies from across the value chain, and we work with them every day to ensure they can keep on developing innovative manufacturing solutions.

ABOUT VISION 2030

PMMI's Vision 2030 focuses on the discovery, discussion and solutions to the industry's most significant challenges for OEMs and CPGs. It is a critical component of PMMI's suite of continuous improvement forums for its members and the consumer packaged goods (CPG) companies they serve.

Publication Date: November 2025

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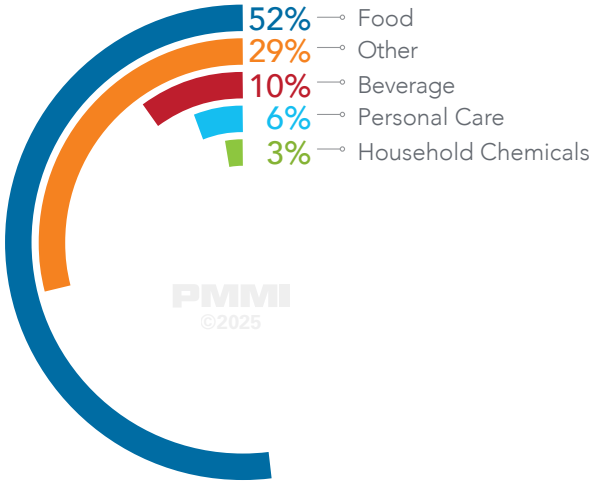
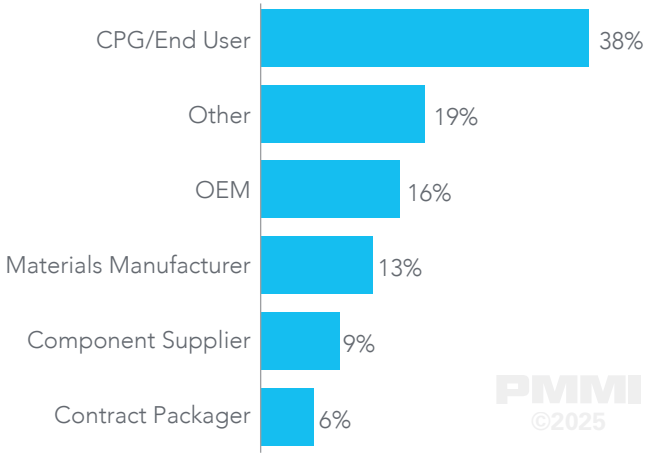
This white paper presents a summary of the Vision 2030 session entitled ***Knowledge Transfer for Machine Operators: From Paper to Digital Knowledge*** which took place at PACK EXPO Las Vegas 2025. Drawing on feedback from a pre-event survey, the session featured a Q&A with expert panelists, followed by roundtable discussions with mixed tables of participants from various industries and sectors. The session focused on the extent to which knowledge transfer is an issue for companies, the most important types of operational knowledge for machine operators, how this knowledge should be collected, and how it can be accessed.

More than half (52%) of the participants in the Vision 2030 knowledge transfer discussion session were from the food industry, with others coming from beverage, personal care, household chemicals, and other end users or consumer packaged goods (CPG) companies. In addition to end users, there were also representatives in the session from OEMs, materials manufacturers, components suppliers and contract packagers.

Which best describes your industry?



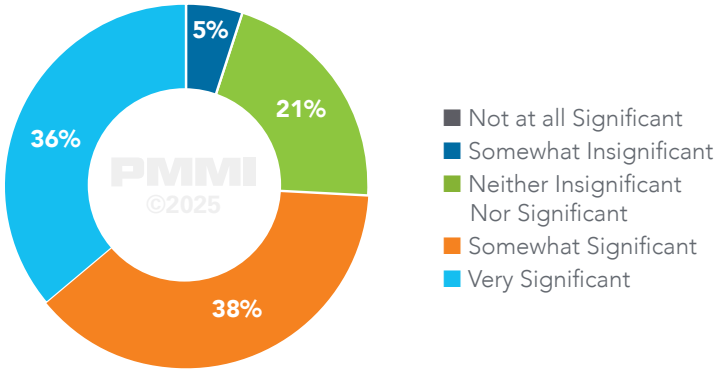
Which of these best describes your company?



How significant Is the knowledge transfer problem?

When asked this question in the pre-event survey, 74% of respondents said it was either extremely significant, or very significant, as seen in the pie chart below.

In your opinion, how significant is the Knowledge Transfer problem among machine operators within your company? (1=Not Significant, 5=Extremely Significant)



Almost three-quarters of respondents (74%) view knowledge transfer as a significant problem.

One participant emphasized the importance of 'tribal knowledge' gathered through practical, real-world experience with machines and manufacturing processes, stating:

> We have a lot of different herbs going into our machines, so all of the operators know the little tweaks. It's a big challenge and it's really just time on the machine that gives them that knowledge. We don't have any documentation or anything to teach them ahead of time how to get the best out of the machines.

Tribal knowledge plays an essential role in the smooth operation of machinery

The term 'tribal knowledge' refers to unwritten or undocumented information or expertise held by individuals or groups of people within an organization. Typically, in the packaging and processing industry, this knowledge is held by those who are at the frontline of operations, in particular machine operators.

There are two issues arising around the transmission of knowledge. Firstly, there is the day-to-day challenge of providing information to the people who really need to know it and duplicate it from shift to shift. For example, knowing the optimal dial settings on a machine, so if they get out of calibration and the machine starts churning out poor product, they can be reset. The second issue seems to be a growing challenge: knowledge loss. This problem arises when individuals leave and take their knowledge with them. It's especially the case when the documentation of knowledge is fragmented, incomplete, inaccurate or, in some cases, non-existent.

> We're getting better at documenting it now, but for so long the operator would come in and [say], "Oh, I like this dial here and I like this dial here." And then the dial gets out of calibration and then it's hard to replicate that again and you're constantly trying to fuss with it. So, it's very important and we are taking steps to try to fix it and to record what the settings are.

Companies with high turnover of staff, or with senior staff approaching retirement, are particularly vulnerable to knowledge loss. Participants in the table discussions noted that, since the Covid pandemic, the issue of staff turnover has been exacerbated. While historically, machine operators tended to have a relatively long tenure, that is no longer the case. New recruits can be trained to operate machines, developing intimate knowledge of how to get the best performance through spending time running them, then within months they might move on, and the machines are underperforming again in the hands of new and inexperienced operators. One panelist described it as:

> One of the biggest contributors to downtime and decreased efficiency.

The other issue around knowledge transfer hinges on the reliability of knowledge. It's important to have good data. The comment was made during the discussions that lots of operators have their opinions about the best way to solve problems and fix issues. These ways have not actually been scientifically proven, but through repeated use they have become accepted knowledge. It is a question of unlearning some tribal knowledge and only transmitting verified knowledge.

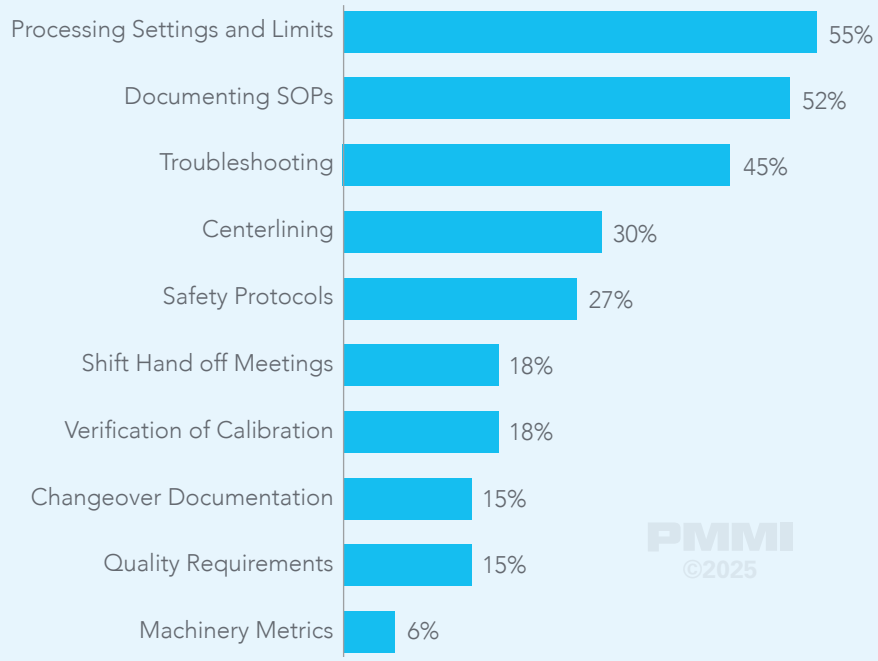
What are the most critical types of operational knowledge that should be captured for machine operators?

Participants suggested that all functional operational knowledge, especially for non-typical operations, is important. The most crucial knowledge to capture includes explicit, repeatable processes and implicit, experience-based insights that prevent issues. It's all about best practices.

The recording of optimal process settings for machines by means of centerlining was identified by many respondents as being key to maintaining efficient production. Process limits were also mentioned; where there is an ideal setting, but it may need to be adjusted based on incoming material. The limits as to how far settings can be adjusted in these scenarios should be recorded for future reference, as should knowing how to verify calibration.

The documentation of standard operating procedures (SOPs) was also a high priority for respondents. Priorities raised during the roundtable discussions were voted on by participants and the results clearly demonstrate these priorities.

What are the most critical types of operational knowledge that should be captured for machine operators?



More than half of participants selected processing settings and limits, and documenting SOPs as key priorities in capturing knowledge

In the roundtable discussions, how to prevent problems and troubleshoot was cited by respondents as key operational knowledge, along with hand-off meetings between shifts, safety protocols, verification of calibration, changeover documentation, quality requirements and machinery metrics. The pre-event survey raised a number of additional issues of importance, such as cleaning and maintenance procedures, and operational information (e.g. resetting faults or fine-tuning setup for particular products).

Experience-based insights to prevent issues with machines include knowledge around the challenges thrown up by unusual problems, during which the usual process steps cannot be followed. Where there is knowledge around different products and feed rates for various materials, or how jams/misfeeds are handled. All this is key to maintaining quality and efficiency. It was also observed that troubleshooting procedures and the results of those procedures should be documented whether they were successful or not.

How should knowledge be captured to ensure accuracy and completeness?

Of critical importance to participants is better communication between engineers and operators. Getting engineers to work and talk meaningfully with the operators is pertinent so they can see how things are really done. It's a case of ensuring that the people who don't operate the machines but who write the SOPs actually get trained on the machines so they are armed with practical experience and accurate information when they are writing the SOPs. After they have been written, the operator can verify them and tweak them as necessary. That way, the operator has a direct role in the authoring of the SOPs. One respondent commented that it is important to find a way to include the potential intricacies of process steps in SOPs. Process steps may be outlined, but experienced operators know that some steps must be adjusted. Those adjustments don't get documented for future workers. AI tools were suggested as a way of overcoming this problem by improving comments and data collection.

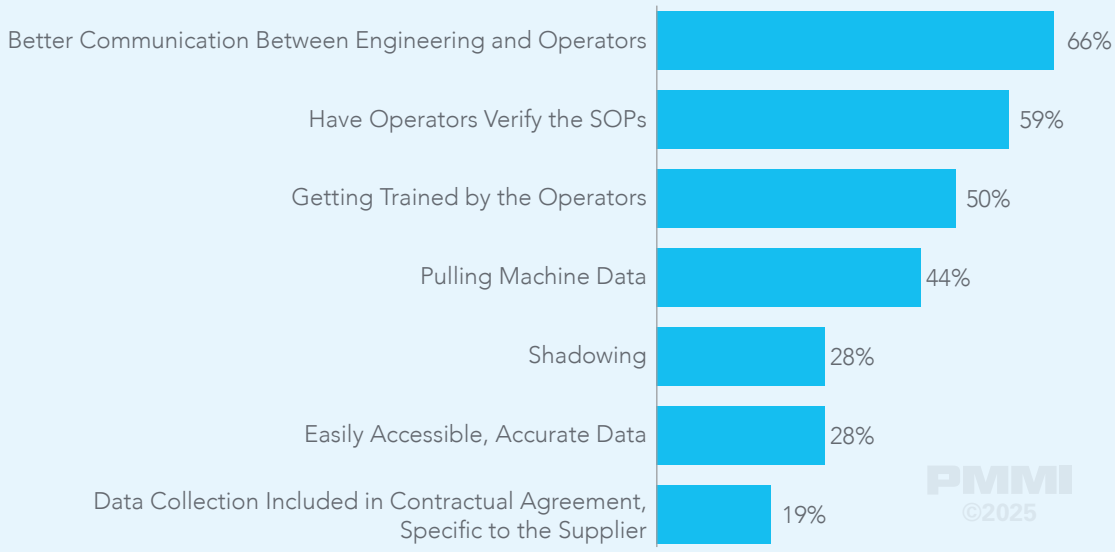
A significant number of respondents mentioned that getting data directly from a machine is a good way of ensuring accuracy, whereas data obtained from an operator may be problematic. QR codes can be scanned using an iPad to provide all the data related to the machine, like settings, work operations or work instructions with a high degree of accuracy. It is, of course, necessary to gather input directly from machine operators. One respondent whose company still uses paper notebooks for shift notes recommended creating easy to use tools, methods, and frameworks for digitally collecting feedback from machine operators about how the machines and materials perform on their shifts.

Safety procedures and shift hand-off information both need to be formally documented. During these hand-offs, one operator can notify the next of any difficulties encountered during their shift. Likewise, when operations run smoothly, feedback should be collected from operators about what contributed to that success.

Training by machine operators is considered an effective way of collecting accurate information, as is shadowing. However, participants emphasized the importance of high quality training and shadowing. For example, if an operator runs a machine and gets optimal results in terms of efficiency and product quality, shadowing will prove effective. However, if an operator has bad operating habits, then those habits could be passed on to a new operator through shadowing or training.

Suggestions made during the roundtable discussions were collected and voted on by participants, with more than two-thirds choosing better communication between engineering and operators as an effective way of collecting data.

How should knowledge be captured to ensure accuracy and completeness? (Select top 3)



The involvement of operators in collecting and transferring knowledge was seen as critical to ensuring data is accurate and complete

How should information be accessed by machine operators?

> The biggest impact would come from replacing outdated, text-heavy manuals with a dynamic, easily accessible knowledge base. The platform should be mobile-first and optimized for shop-floor use by machine operators.

This theme continued in the panel and roundtable discussions, with many participants emphasizing the opportunities offered by digital technology to make training materials more interesting and easier to access.

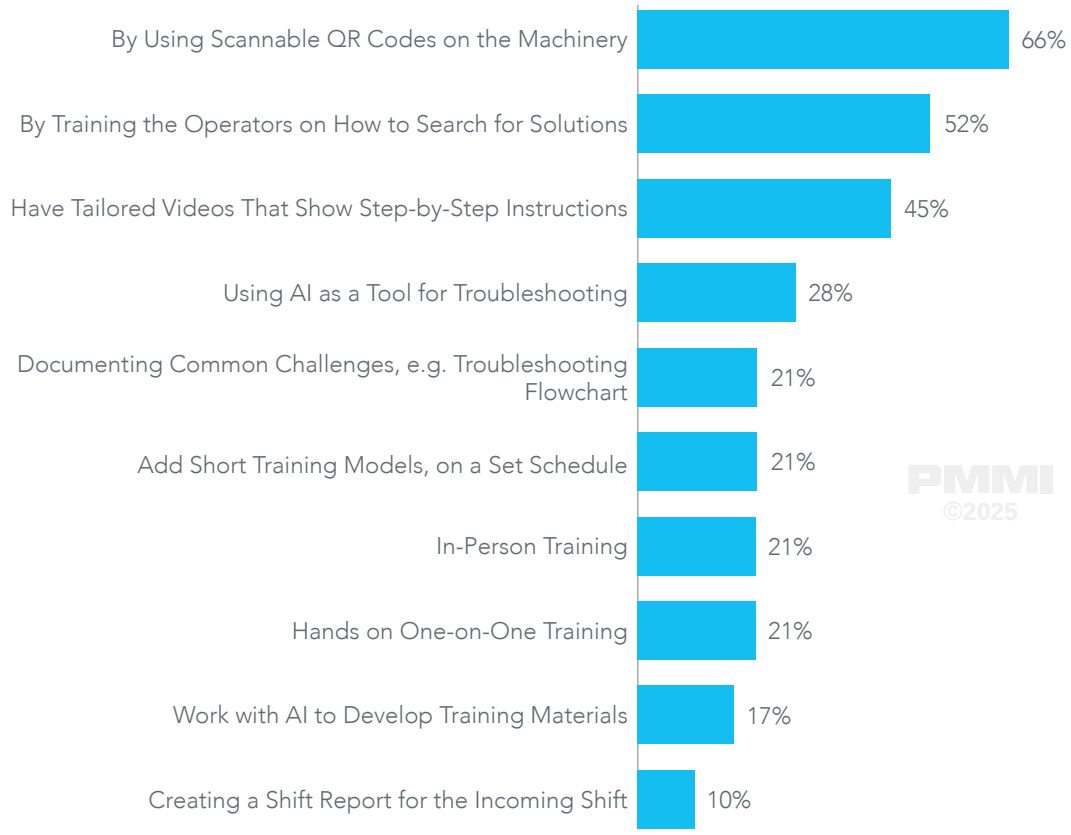
When suggestions from the roundtables were collated, two-thirds of participants favored the use of scannable QR codes on machines to enable operators to access information. Knowledge accessible via QR codes would be in a variety of formats such as documents, systematic checklists, outlines of recovery procedures, user manuals and operational notes made by operators as they work, and short, tailored videos showing step-by-step instructions. Not only can operators quickly obtain a wide range of information and data by scanning the QR code, they could also input new information. For example, operators could upload a video of them troubleshooting a problem, allowing other operators to reference the video if the problem recurs. Operators would refer to these materials when setting up machinery, calibrating it in preparation for a production run, or troubleshooting.

Other suggestions from participants, panelists and in the pre-event survey ranged from using more video training, more images in training materials, body cams for operators, and using AI for troubleshooting, to placing clear, laminated instructions on machines, making material available on mobile devices, and quick help guides or flowcharts for troubleshooting.

The consensus was that there needs to be a central repository of training materials and captured knowledge so that it is easy to access. As one panelist said:

> All three components of collecting, storing, and then disseminating that information are important. We found that we would do good training right at the beginning, but that transfer just wasn't there to new people, to new partners. And we had it all in different areas, so combining that all together into one program that we can use to access all the training data that's available is one thing that we felt that we could do to improve.

How should this information be accessed by machine operators to maximize usability and adoption? (Select top 3)



The involvement of operators in collecting and transferring knowledge was seen as critical to ensuring data is accurate and complete

The respondents emphasized how important it is that QR codes offer the advantage of being able to present information in different languages. To access information via QR codes on machines, operators would need a mobile device and know how to use it. They would need to be trained on how to search for solutions and data. Participants also anticipated significant growth in the use of AI as a tool used by operators to find what they are looking for in a knowledge bank, and to create flow charts and training videos.

Knowledge transfer through a variety of training models was considered key by participants. This training could take the form of in-person training, hands-on one-to-one training, and short training models, for example daily 5-minute sessions on a specific issue at the start of a shift. As well as training, shift overlap meetings or mid-shift huddles promoting cross-shift knowledge sharing and leveraging of best practices were also considered to be an important means of accessing information.

One table also made the point that, while it is important to have information readily available to machine operators, it is also important to "make sure that your operators are trained on how to properly search for that information" so that they can access knowledge easily and readily when it is needed.

Conclusion

The pre-event survey and the discussion session on knowledge transfer both explored practical strategies and tools to enhance operator competence, reduce downtime, and support consistent production performance. They highlighted that tribal knowledge is a major challenge in maintaining equipment efficiency. Participants emphasized that high turnover of machine operators and lack of consistent documentation can lead to inefficiencies, downtime, and lost expertise.

Attendees suggested several ways to address these challenges, including promoting veteran operators into training roles, improving documentation of machine settings, and digitizing manuals into centralized, searchable repositories. Knowledge transfer isn't just about recording information but ensuring accuracy, accessibility, and engagement across departments.

Key themes included the digitization of knowledge and training materials, the importance of SOPs, recording various parameters and centerlining to capture machine settings accurately, and effective communication between engineers and operators. Roundtable discussions covered practical and digital solutions for ensuring knowledge retention and usability.

Participants agreed that, while technology can enhance training, culture change and collaboration (such as effective shift handovers) are also important. Operators should be trained not only to use but also to contribute to knowledge transfer and digital systems, making learning adaptive, cumulative, and accessible.

For a deeper, data-driven view of the the workforce pressures driving today's knowledge-transfer challenges, and the technology solutions and support tools CPGs and OEMs are adopting and planning for, see PMMI's white paper **Inside the Workforce Gap.**

PMMI Business Intelligence

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