As computer vision (CV) adoption increases within manufacturing organizations, there is a need to focus on more than just CV model development, validation, and deployment. Organizations working with vendors to successfully accomplish this goal will be able to implement CV faster while realizing greater business value.

Looking Beyond the AI Model to Improve the Value of Computer Vision in Manufacturing Operations

December 2022

Written by: Matt Arcaro, Research Director, Computer Vision AI Tools and Technologies

AT A GLANCE

KEY STATS

- 42.6% of manufacturing decision makers said they expect CV to have a significant impact on their organization's overall market competitiveness over the next three years.
- 31.1% of manufacturing respondents indicated that building end-to-end process workflows and applications is a critical, top 3 technical challenge in CV solution development.
- Manufacturing respondents identified manufacturing, facilities and operations, R&D, and supply chain as the business areas that could benefit the most from CV.

Introduction

Artificial intelligence (AI), particularly computer vision (CV), which focuses on utilizing AI to derive inference insights from images, videos, and sensor data, has experienced strong growth among customer organizations in the past few years. Major drivers for the increased experimentation and use of CV include advancements in machine learning and deep learning research and investments in ecosystem commercialization, which have improved the efficacy and ease of developing and deploying high-quality CV models for a wide range of use cases. In fact, in IDC's 2022 *North American Computer Vision AI Adoption and Usage Survey*, fielded in October 2022, 42.6% of manufacturing decision makers indicated that they expect CV to have a significant impact on their organization's overall market competitiveness over the next three years. This reinforces the considerable hope and faith organizations have that CV will deliver improved visibility, efficiency, capabilities, and speed despite the technology's limited market presence.

It's not surprising that manufacturing organizations are positioning CV as a way to improve or reinvent many of the manual, physical processes that they rely on as part of their operations. IDC's research reinforces that the operational technology (OT) domain represents a strong ROI case and low-hanging fruit for the use of CV due to its ability to complement or reduce the need for workers across a wide range of use cases. These include visual and quality inspection, asset predictive maintenance, worker safety and compliance, physical security and facilities management, and inventory control and management.

Yet as organizations increasingly look to CV to move the needle for their businesses, IDC stresses that they must focus on more than just CV model development, validation, and deployment for any given use case. IDC's research shows that organizations that have failed to successfully deploy CV use cases have often underappreciated or failed to consider the importance of non-model-specific aspects of their solution, including:

- Baselining the technology maturity for a given CV use case
- Defining and calculating a reasonable ROI for prioritized use cases

- Aligning and agreeing to stakeholder, business, and technology requirements
- Validating commercial and open source tools and software
- Identifying available existing capture, compute, and storage hardware
- Developing and validating a sustainable solution deployment architecture
- Allocating resources to design, deploy, and support solution life-cycle processes
- Understanding and building sufficient end-to-end process workflows and applications

This last aspect is an area of considerable importance for manufacturers. For example, in the previously mentioned survey, 31.1% of respondents cited building end-to-end process workflows and applications as a top 3 technical challenge in developing and deploying CV.

In this Spotlight, IDC examines how manufacturers can maximize the effectiveness of CV by focusing on end-to-end process workflows.

Industry and Domain Definitions

- **AI inferencing:** The process by which a computer-generated model makes a prediction based on a given input or set of inputs
- **Composite models:** The combination of multiple CV models and/or algorithmic workflow logic to build complex AI-based recipes
- **Computer vision (CV):** The field of study that enables and improves the way computers can interpret and understand images, videos, and sensor data (e.g., radar, lidar) by leveraging AI and machine learning (ML)
- **Computer vision model:** A purposely trained AI-based recipe designed to take visual or visualized data (e.g., images, videos, lidar) as inputs
- **Digital twins:** A digital representation of a real-world component, process, device, and/or system leveraging a combination of real-time and historical data inputs (e.g., Internet of Things [IoT] sensor data)
- **Edge/on-device computing:** Running software or compute workflows near or on the device of interest, including potentially on the capture device (e.g., camera)

End-to-End Computer Vision Process and Strategy Considerations

It is daunting to realize that the breadth and depth of CV customer use cases can almost mimic the range of tasks accomplished by the human visual system. IDC believes it is this use case diversity, along with the novelty and hype of AI, that often overwhelms organizations into elevating CV to the status of a purpose-built tool, one with its own ecosystem and domain experts. We believe that organizations must think beyond the CV model and focus on the end-to-end process and strategy. A comprehensive strategy will help organizations not only improve the effectiveness of known CV use cases but also understand whether CV is the most appropriate tool for a given use case. Benefits of such an approach include:

- **Hardware availability and compatibility.** CV use cases need a visual input source to feed into the AI models. Before considering the purchase of all-new hardware, organizations should think through their existing capture infrastructure, whether a standalone security camera, a mobile device (like a smartphone), or even a sophisticated multicamera array. A thorough audit of available infrastructure, including capture devices/cameras, compute infrastructure (i.e., on-premises servers and GPUs), and video management software (VMS) systems will help organizations drive down costs, improve time to deployment, and increase solution resiliency.

» **Use case identification and prioritization.** Organizations need to develop a process and approach to determine how and when to apply CV. The establishment of a diverse team of technology, business, and domain specialists can contribute a broad and complete perspective on the evaluation of CV use cases. These teams are responsible for developing and aligning on use case guardrails for ROI calculation methods, technology fit (i.e., whether the use case is well established or still experimental), as well as the end-to-end business and technology requirements.

» **Computational architecture considerations and resiliency.** Organizations need to think through the optimal balance for compute, storage, and availability requirements for a given CV use case. For example, CV models can be designed to support inferencing in the public cloud, private cloud, or on premises. Such models can even be optimized for edge or on-device deployments. It's important to outline how and where a solution's inferencing must occur to achieve the optimal balance of technical and business requirements. IDC notes that more organizations are leveraging a hybrid architecture approach, where a distributed compute and storage structure is utilized to maximize the business impact and efficiency for a given use case. A manufacturer deploying a physical security CV use case may run an initial screening model at the edge to determine if a high-level event has occurred (e.g., motion detected). When such an event occurs, the system will batch that footage and distribute it to a higher-level computing device (e.g., an onsite cluster or public cloud instance) to run additional complex CV models and processing tasks.

» **APIs and integration availability.** When looking at the end-to-end process flow of a CV-enabled or -enhanced use case, organizations will realize that the application of models and inferencing isn't the lion's share of the solution. Instead, some will leverage the output of single or multiple CV models as an input to measure or trigger a downstream response. It is this information exchange that is so critical. Whether through the development of information exchanges such as APIs or native integrations, organizations need clarity on the format, timing, and systems required to take a CV inference insight and deliver business value. Examples of the systems integral to aligning CV inference outputs with a use case's business value include enterprise resource planning (ERP) systems for quality management (QM) as well as workforce management (WM); video management (VM) systems; and customer relationship management (CRM) systems. Organizations typically start their CV journey with the direct alignment of a CV inference output and a specific system, but with time and experience, organizations capitalize on the cascading impacts by integrating additional AI capabilities (beyond CV) and non-AI-derived data sources into complex processes (e.g., digital twins).

» **Solution life-cycle management (LCM).** Organizations often think that once a CV solution makes it to production, the hard work is over. Unfortunately, this couldn't be further from the truth. Instead, organizations must build in sufficient technology, process, and resource headspace to support a solution today while allowing it to evolve (and potentially scale) for tomorrow. Of course, LCM will differ greatly depending on solution design, use case complexity, and long-term ambitions, but organizations need to think through several key aspects, such as:

- **Device management** to ensure that solution hardware and software are monitored, maintained, and updated throughout a device's life cycle
- **Machine learning operations (MLOps)** to ensure that the CV models operate as expected and that sufficient feedback can be provided to deliver improvement updates and tunable model thresholds

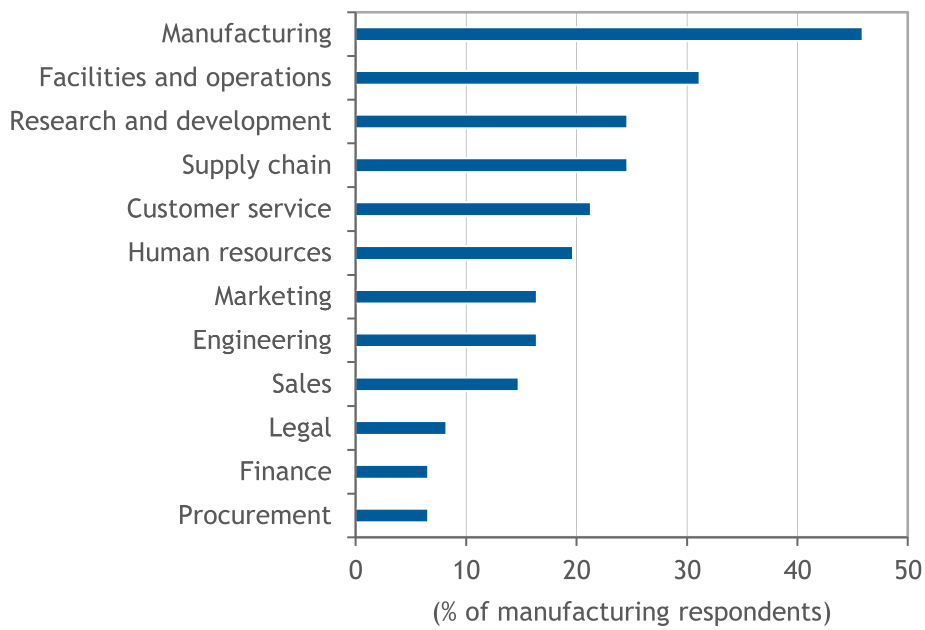
- **Dispatch and onsite resources** to help troubleshoot device and infrastructure issues that may occur postproduction
- **Physical security and cybersecurity** to ensure a sufficient level of protection for the hardware, software, and data included as part of a solution
- **Scalability and rollout support** to align organizational and third-party resources to successfully extend and adapt a CV use case to reach additional cameras and sites/locations or address adjacent use cases

Understanding Manufacturing CV Opportunities and Business Value

As shown in Figure 1, manufacturing organizations view CV as a technology enabler suited for multiple, distinct areas of their business. In particular, they identified manufacturing, facilities and operations, research and development (R&D), and supply chain as the four prime domain areas for CV use case experimentation and production deployment.

FIGURE 1: ***Where Do Manufacturing Decision Makers See the Most Promise for CV?***

Q. *Select up to three areas of your business that you believe could most benefit from computer vision.*



n = 61

Source: IDC's North American Computer Vision AI Adoption and Usage Survey, October 2022

IDC's discussions with customers and vendors reinforce CV's potential to deliver business value to manufacturers (more generally) as well as to the manufacturing subdomains of facilities and operations. Manufacturers tend to have complex, dynamic physical environments that are often outfitted with a combination of (predominantly) manual processes and (to a lesser extent) automated processes. CV is thus a great candidate to help shift the needle further toward automation, especially because often the first step along this process of augmentation is the inclusion of a human in the loop to provide analysis and verification. Further, these use cases (e.g., visual inspection, asset predictive maintenance, physical security, worker safety monitoring) have a known, quantifiable cost that can be used to aid a manufacturer in understanding both the priority for development and the overall ROI.

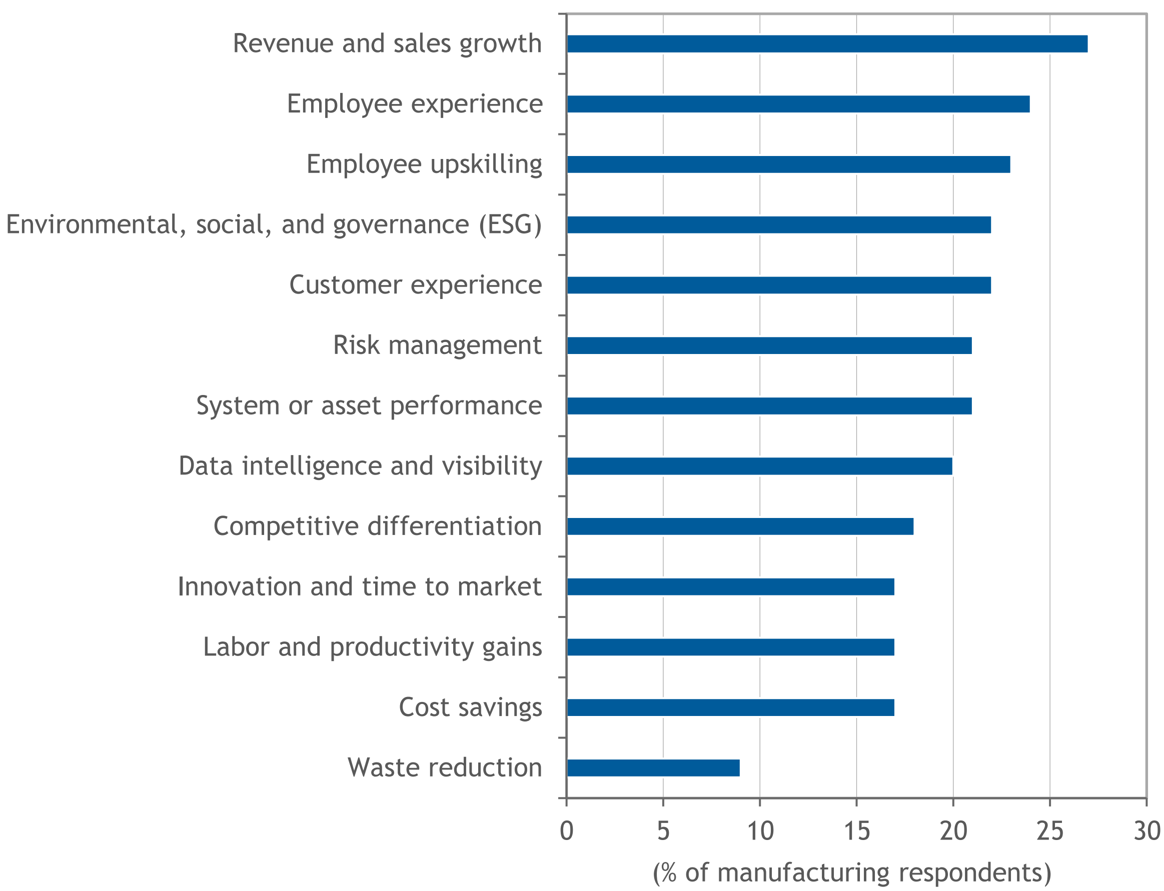
R&D represents another strong area for CV business value. One potential area where we see a linkage between R&D and CV is the embedding of CV capabilities to help deliver robust feature enhancements in a manufacturing organization's products and services. In this way, manufacturers can utilize CV to extend the value they can deliver to customers, either in an adjacent, value-add manner or by potentially capturing additional revenue in a new area.

Supply chain use cases also align with where CV can deliver business value to manufacturing organizations. For example, CV can be used to provide data transparency and verification in multiple ways to support an organization as well as its network of upstream and downstream suppliers. Whether verifying inventory, providing chain of custody on shipping/transportation, or automating the movement of goods, CV is an essential technology ingredient to a manufacturing organization's digital transformation.

As shown in Figure 2, manufacturing organizations are utilizing a variety of metrics to measure and quantify the success of their CV initiatives.

FIGURE 2: ***How Do Manufacturing Decision Makers Measure and Quantify CV Success?***

Q. *Which of the following business metrics do you use to measure and quantify CV success?*



n = 61

Source: IDC's North American Computer Vision AI Adoption and Usage Survey, October 2022

Manufacturing organizations aren't alone in justifying CV based on a multitude of factors. IDC therefore recommends that organizations convene with a diverse group of technology, business, and domain specialists to discuss, prioritize, and align on specific use case metrics as well as the methods for calculating these metrics. Once a project is underway or a solution is implemented, there will likely be changes, but having this initial alignment up front will pay dividends in terms of coming to a consensus for any modifications or course corrections.

Considering SAS

SAS delivers a comprehensive portfolio of tools, software, and resources to develop and deploy CV solutions. This portfolio has been integrated into the greater SAS Viya platform, which enables it to deliver and carefully orchestrate an end-to-end solution for customers, including support for CV model development and training, analytic pipeline development, and operationalization.

To help with CV model development, SAS works with its customers to understand if a specific, customized CV model is needed or if an off-the-shelf, open source model (e.g., worker/object detection) would suffice. Should a customizable model be needed, the company's resources and tooling can help customers with all steps in the CV model pipeline, from image annotation and preprocessing to model training, validation, and deployment.

The SAS team understands that implementing CV successfully requires a robust toolset of capabilities for the creation (and updating) of use case–specific analytic pipelines. These pipelines, which are akin to process flow diagrams, allow additional constraints and business logic to be incorporated to align the CV portion of the solution with the realization of business value (i.e., solving the original business problem). For example, an analytic pipeline could consist of a variety of image preprocessing and postprocessing steps, integration of third-party data sources, incorporation of advanced analytic components, and even multiple, composite CV models.

In terms of operationalizing CV models, SAS leverages its Event Stream Processing (ESP) analytics engine. ESP enables customers to perform real-time analysis of video at the edge. This ability to support inferencing at the edge ensures ultra-low latency for mission-critical tasks. It also helps customers manage the data distribution, transmission, compute, and storage challenges that often occur when deploying CV at scale. ESP has been designed to maximize impact while minimizing the level of effort by supporting Kubernetes for optimized scaling; utilizing prebuilt integrations and connectors to interface with a broad range of data sources; providing native support with SAS data analytics solutions and open source technologies (e.g., Python, ONNX); embedding monitoring, visualization, and dashboard capabilities; and broadening access for multiple user personas through a low-code user/graphical interface.

The SAS Viya platform and its included capabilities help deliver CV solutions that are resilient and flexible to assist customers in performing a range of activities, from experimentation to building proof of concept to scaling across a near-infinite number of devices and locations. From cloud to core to the edge, SAS can help customers design, develop, and deploy CV use cases that meet or exceed their business requirements.

Challenges

The CV ecosystem represents an area of tremendous growth, opportunity, and business value. One way to help establish and better align CV opportunities with business value is through providing a portfolio of domain- or use case–specific pretrained CV models. At present, SAS does not provide a portfolio or library of such specific pretrained models beyond the ability to import available open source models.

Like other analytics vendors, SAS will continue to be challenged to attract new customers to its platform. This marketwide phenomenon is due to a combination of hype, aggressive messaging, and the market fragmentation of the overall machine learning and analytics ecosystem. CV, however, represents a strong opportunity to help vendors such as SAS cut through this noise and deliver transformative business value for customers. Further, positive engagements will open the door for vendors such as SAS to build customer trust, which will lead to increased CV use and adoption.

Conclusion

Manufacturing organizations understand that CV will have a significant impact on their business over the next three years. Whether the goal is to deliver internal operational efficiencies or to delight customers with new experiences, manufacturing organizations need to align themselves with a vendor that can help them consider the complete, end-to-end process of developing and deploying CV. IDC's research shows that this is the key to not only maximizing the value of CV for a given use case but also being able to develop, deploy, and maintain a scalable, repeatable approach to CV across a variety of business areas and domains.

About the Analyst

Matt Arcaro, *Research Director, Computer Vision AI Tools and Technologies*

Matt Arcaro, Research Director, is responsible for IDC's worldwide computer vision (CV) and AI technologies and tools research. Mr. Arcaro works within IDC's software market research and advisory practice and directly reports to IDC's greater AI- and ML-focused team.

MESSAGE FROM THE SPONSOR

Computer Vision (CV) use cases in Manufacturing are poised to take off. Several factors such as governance and scaling must be taken into consideration, but the value of CV use cases could ultimately power automation and localized feedback loops that offer significant safety and productivity gains.

SAS believes that 5 factors are needed for successful CV implementations:

1. Business sponsorship – Define desired value and expected ROI.
2. Flexibility – Solve multiple use cases, not just one.
3. Integration – Interface with existing systems.
4. Costs – Understand costs and possibility of repurposing resources (hardware, software, personnel) to ensure the right business justification.
5. Execute and scale – Most CV efforts start with a PoC, then try to expand. Scalability is not a given.

All these factors must be considered to meet both the current business challenge and future challenges that a manufacturing organization will face.

Watch this on-demand presentation to learn more.

IDC Custom Solutions

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IDC Research, Inc.
140 Kendrick Street
Building B
Needham, MA 02494, USA
T 508.872.8200
F 508.935.4015
Twitter @IDC
IDC-insights-community.com
www.idc.com