

WHAT IS YOUR AI STRATEGY?

By Andrew Halonen

Artificial intelligence (AI) is the buzzword that is consuming the airwaves at home and at work. Is it real? Is it useful for me and my work? All fair questions. “What is your AI strategy?” asks your teenage child or your organization board. The answer is typically one that is buying time, “we are evaluating our options, looking for value.” The good news is that there is a growing list of options, some of which are very easy to use with minimal training and investment. The applications reach across the corporation from alloy development and manufacturing to technical marketing, customer service, collaboration, and new employee training. The benefits of AI tools for a corporation are efficiency and productivity, saving time and money. For associations, there are opportunities to improve search and discovery of the membership library, an improvement that will be welcomed by members and the industry.

Machine Learning

To Amatrium, artificial intelligence comes to manufacturing in two different sets of tools. One is machine learning, and the other is generative AI. Machine learning is a subset of AI, and it is a tool that compliments intuition and experience. It is a tool that can draw insights from large datasets that contain many variables. YouTube and other social media use machine learning to quickly align related content to match your search topic, making their platforms enjoyable, useful, and convenient. In manufacturing, machine learning is often explored for cost reduction, scrap reduction, productivity improvements and solving intermittent problems.

In forgings, machine learning tools can be used across the entire process, from alloy to finished product, or in a smaller subset of data. Alloys are made up of a number of elements, and each element can vary within a specified range. As we build the spreadsheet (Figure 1), the columns following elements are process conditions from preheat, to forging, through heat treat. Next come the output metrics which are defined by the customer and may include internal measures that have been deemed meaningful. Customer requirements include mechanical properties, aesthetics, and NDT results.

| Chemistry | | | | | | | | | | | | | | Process | | | | | Property, Customer Metric | | | | | | |
|-----------|-------|-------|-------|-------|-------|-------|----|-------|-------|-------|-------|----|----|---------|------------------|----------------------|----------------|-------------------|---------------------------|--------|------------------|----------------------|-----------|----------------|--------------|
| Si | Fe | Cu | Mn | Mg | Cr | Zn | Pb | Ti | Bi | Ni | Zr | Sn | Cd | V | Casting Temp (F) | Homogenized Temp (F) | Press Temp (F) | Press speed (m/s) | Quenching rate (F/s) | Temper | Drack Size (in.) | Yield strength (ksi) | UTS (ksi) | Elongation (%) | QC Pass/Fail |
| 7.218 | 0.092 | 0.113 | 0.026 | 0.366 | 0.016 | 0.068 | 0 | 0.019 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1305 | 932 | 887 | 0.15 | 2.4 T6 | 0.79 | 14.7 | 27.2 | 10.5 | Fail | |
| 7.478 | 0.115 | 0.054 | 0.047 | 0.260 | 0.027 | 0.13 | 0 | 0.02 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 930 | 889 | 0.14 | 2.5 T6 | 0.78 | 13.4 | 27.3 | 11.7 | Fail | |
| 7.252 | 0.14 | 0.071 | 0.031 | 0.423 | 0.001 | 0.138 | 0 | 0.014 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.012 | 1306 | 931 | 890 | 0.17 | 3.8 T3 | 0.05 | 15 | 27.6 | 10.3 | Pass | |
| 6.671 | 0.009 | 0.19 | 0.047 | 0.190 | 0.021 | 0.078 | 0 | 0.014 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.012 | 1303 | 932 | 889 | 0.1 | 3.5 T5 | 0.81 | 14.9 | 26.3 | 11.2 | Fail | |
| 7.469 | 0.131 | 0.09 | 0.019 | 0.314 | 0.016 | 0.168 | 0 | 0.017 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.012 | 1304 | 932 | 889 | 0.11 | 2.3 T5 | 0.82 | 13.9 | 26.8 | 11.7 | Fail | |
| 7.15 | 0.051 | 0.031 | 0.088 | 0.274 | 0.048 | 0.141 | 0 | 0.013 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.012 | 1304 | 930 | 887 | 0.1 | 2.5 T5 | 0.71 | 14.1 | 28.5 | 11 | Pass | |
| 6.754 | 0.17 | 0.134 | 0.022 | 0.438 | 0.023 | 0.058 | 0 | 0.013 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1304 | 931 | 887 | 0.17 | 3.3 T5 | 0.64 | 14.8 | 29 | 11.5 | Fail | |
| 7.065 | 0.018 | 0.056 | 0.025 | 0.449 | 0.044 | 0.078 | 0 | 0.019 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1304 | 931 | 889 | 0.19 | 2.4 T5 | 0.71 | 14.4 | 27.2 | 11.8 | Fail | |
| 7.319 | 0.006 | 0.097 | 0.093 | 0.339 | 0.018 | 0.182 | 0 | 0.012 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 932 | 888 | 0.17 | 3 T5 | 0.62 | 14.1 | 27.8 | 10.8 | Fail | |
| 7.001 | 0.13 | 0.083 | 0.054 | 0.28 | 0.044 | 0.121 | 0 | 0.012 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 931 | 889 | 0.18 | 2.4 T5 | 1 | 14.1 | 28.9 | 10.5 | Fail | |
| 7.251 | 0.109 | 0.035 | 0.048 | 0.368 | 0.04 | 0.154 | 0 | 0.012 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1301 | 931 | 888 | 0.11 | 2.6 T5 | 0.99 | 13.8 | 26.5 | 10.4 | Fail | |
| 6.622 | 0.075 | 0.197 | 0.093 | 0.445 | 0.04 | 0.002 | 0 | 0.012 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1304 | 930 | 888 | 0.18 | 2.1 T5 | 0.84 | 14 | 27.6 | 11.6 | Fail | |
| 6.886 | 0.014 | 0.092 | 0.079 | 0.386 | 0.042 | 0.117 | 0 | 0.02 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 933 | 889 | 0.18 | 2.8 T5 | 0.08 | 14.7 | 26 | 11.6 | Fail | |
| 6.898 | 0.047 | 0.1 | 0.038 | 0.314 | 0.045 | 0.185 | 0 | 0.011 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1302 | 933 | 887 | 0.11 | 2.4 T6 | 0.27 | 14.3 | 26.7 | 11 | Pass | |
| 6.763 | 0.174 | 0.095 | 0.006 | 0.404 | 0.043 | 0.058 | 0 | 0.019 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 931 | 888 | 0.15 | 3.5 T5 | 0.18 | 14.2 | 28.2 | 10.6 | Fail | |
| 7.003 | 0.078 | 0.021 | 0.032 | 0.392 | 0.031 | 0.101 | 0 | 0.012 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 932 | 890 | 0.16 | 2.0 T5 | 0.59 | 13.2 | 27.8 | 10.7 | Fail | |
| 6.829 | 0.14 | 0.031 | 0.092 | 0.433 | 0.024 | 0.04 | 0 | 0.011 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1304 | 933 | 889 | 0.12 | 2.8 T6 | 0.26 | 13.8 | 26.7 | 11.4 | Pass | |
| 6.575 | 0.096 | 0.069 | 0.005 | 0.271 | 0.04 | 0.109 | 0 | 0.011 | 0.003 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1302 | 931 | 889 | 0.108 | 2.4 T5 | 0.6 | 14 | 27.1 | 10.4 | Fail | |
| 6.963 | 0.177 | 0.1 | 0.017 | 0.449 | 0.017 | 0.068 | 0 | 0.013 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1304 | 933 | 889 | 0.12 | 3.5 T5 | 0.89 | 13.1 | 27.1 | 11.6 | Fail | |
| 6.95 | 0.155 | 0.185 | 0.023 | 0.328 | 0.025 | 0.191 | 0 | 0.025 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 930 | 887 | 0.16 | 3.3 T5 | 0.42 | 13 | 26.1 | 11.1 | Pass | |
| 6.84 | 0.086 | 0.103 | 0.046 | 0.441 | 0.008 | 0.046 | 0 | 0.013 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 931 | 887 | 0.15 | 3.1 T5 | 0.81 | 14.5 | 26.6 | 10.3 | Fail | |
| 6.846 | 0.004 | 0.159 | 0.053 | 0.383 | 0.042 | 0.179 | 0 | 0.011 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1304 | 933 | 890 | 0.19 | 3.0 T5 | 0.81 | 14.4 | 27.8 | 10.1 | Fail | |
| 7.341 | 0.137 | 0.035 | 0.087 | 0.311 | 0.09 | 0.184 | 0 | 0.011 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1304 | 932 | 887 | 0.19 | 2.7 T5 | 0.01 | 13.7 | 27.4 | 10.1 | Pass | |
| 6.67 | 0.166 | 0.099 | 0.05 | 0.362 | 0.012 | 0.056 | 0 | 0.011 | 0 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1301 | 931 | 889 | 0.19 | 2.5 T5 | 0.37 | 13.3 | 27.9 | 10.4 | Pass | |
| 6.853 | 0.122 | 0.101 | 0.097 | 0.369 | 0.01 | 0.191 | 0 | 0.011 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 930 | 888 | 0.15 | 3.5 T5 | 0.1 | 14.9 | 26 | 11.9 | Pass | |
| 6.956 | 0.165 | 0.151 | 0.043 | 0.291 | 0.024 | 0.043 | 0 | 0.015 | 0.001 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1302 | 932 | 887 | 0.19 | 2.8 T5 | 0.15 | 13.6 | 27 | 11.8 | Pass | |
| 6.624 | 0.07 | 0.116 | 0.01 | 0.292 | 0.016 | 0.017 | 0 | 0.019 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.009 | 1300 | 933 | 889 | 0.1 | 2.9 T6 | 0.64 | 13.4 | 26.7 | 10.1 | Fail | |
| 7.327 | 0.179 | 0.005 | 0.04 | 0.26 | 0.04 | 0.03 | 0 | 0.019 | 0.003 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1304 | 932 | 890 | 0.17 | 3.7 T6 | 0.03 | 14.6 | 26.8 | 10.4 | Pass | |
| 7.413 | 0.128 | 0.117 | 0.087 | 0.265 | 0.038 | 0.112 | 0 | 0.019 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 932 | 890 | 0.12 | 3.8 T6 | 0.12 | 13.7 | 27.6 | 11.4 | Pass | |
| 7.219 | 0.019 | 0.061 | 0.097 | 0.258 | 0.02 | 0.015 | 0 | 0.016 | 0.003 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1302 | 932 | 889 | 0.15 | 3.9 T6 | 0.72 | 13.2 | 27.5 | 10.1 | Fail | |
| 6.794 | 0.188 | 0.164 | 0.054 | 0.447 | 0.025 | 0.18 | 0 | 0.021 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 931 | 888 | 0.1 | 3.9 T6 | 0.4 | 14 | 28.9 | 10.7 | Pass | |
| 7.1 | 0.198 | 0.095 | 0.038 | 0.257 | 0.002 | 0.077 | 0 | 0.017 | 0.003 | 0.005 | 0.001 | 0 | 0 | 0.009 | 1304 | 930 | 888 | 0.1 | 3.1 T6 | 0.47 | 13.3 | 28.7 | 10.3 | Pass | |
| 7.117 | 0.165 | 0.088 | 0.002 | 0.359 | 0.013 | 0.03 | 0 | 0.02 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1301 | 930 | 888 | 0.17 | 3.8 T6 | 0.45 | 14.1 | 28 | 11.4 | Pass | |
| 6.677 | 0.009 | 0.031 | 0.09 | 0.382 | 0.023 | 0.131 | 0 | 0.011 | 0.003 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1303 | 932 | 888 | 0.16 | 4 T5 | 0.82 | 14.2 | 27.9 | 11.5 | Fail | |
| 6.815 | 0.011 | 0.055 | 0.049 | 0.339 | 0.033 | 0.137 | 0 | 0.014 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1302 | 931 | 889 | 0.15 | 3.4 T5 | 0.34 | 14.3 | 27.1 | 11.3 | Pass | |
| 6.611 | 0.191 | 0.129 | 0.026 | 0.402 | 0.032 | 0.163 | 0 | 0.016 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.009 | 1302 | 931 | 889 | 0.1 | 2.9 T6 | 0.27 | 14.3 | 28 | 11.7 | Pass | |
| 6.762 | 0.017 | 0.065 | 0.051 | 0.268 | 0.002 | 0.115 | 0 | 0.016 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.009 | 1303 | 930 | 889 | 0.18 | 2.8 T5 | 0.27 | 13.7 | 28.4 | 10.9 | Pass | |
| 7.448 | 0.011 | 0.156 | 0.003 | 0.297 | 0.023 | 0.123 | 0 | 0.02 | 0 | 0.005 | 0.001 | 0 | 0 | 0.011 | 1302 | 931 | 889 | 0.12 | 3.4 T6 | 0.49 | 14.2 | 28.4 | 11.7 | Pass | |
| 7.25 | 0.038 | 0.073 | 0.017 | 0.442 | 0.018 | 0.048 | 0 | 0.015 | 0.002 | 0.005 | 0.001 | 0 | 0 | 0.009 | 1304 | 932 | 890 | 0.19 | 3.3 T6 | 0.09 | 14.5 | 28.2 | 10.5 | Pass | |

Figure 1: Sample Data Set

A recent article by the author in *Light Metal Age* magazine describes the process of building the model and tailoring algorithms to the dataset¹.

In one study, the desired output was a finite number, the machining time for a product that required over 150 process steps. For another, it was a graph to show the relationship between chemistry and a process condition that was identified by the model as a significant contribution to the outcome. A third output from machine learning may be a permutation of importance chart (Figure 2) is one that provides a horizontal bar for each variable in order of influence on the desired outcome.

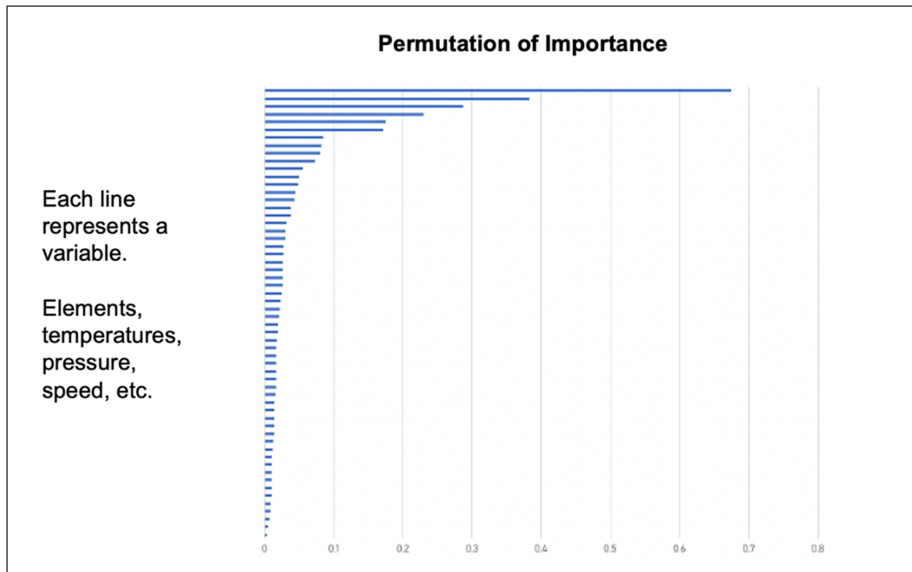


Figure 2: Permutation of Importance

Above, it was mentioned that machine learning can be used for a smaller set of data, and a good example of this is in alloy prediction. There are a growing number of success stories, including the prediction of properties in the addition of cerium in aluminum for metal casting².

Data is King

Success in AI requires sufficient and high-quality data. The collection of data is also the #1 barrier to success in AI tools. In machine learning on the manufacturing floor, there are many challenges to data collection. Data collection must be done consistently today, a month from now, and a year from now such that the AI algorithms can predict process conditions to drive new outcomes, and so success can be measured.

Generative AI

The other AI tool is referred to as generative AI, and within it are the large language models (LLM). When OpenAI released ChatGPT on November 22, 2022, many realized that writing will never be the same. The LLMs are genius writers, and there is no doubt that they have a place in our toolbox in forging operations. A comprehensive description of ChatGPT is in the recent FIA Magazine³. The article speaks to the public versions, one of which is free, the other requires a small monthly payment. When security is added to ChatGPT, organizations can take advantage of their vast engineering library for broader use cases. The product is called AmatriumGPT⁴ and is hosted on the Microsoft Azure server. The data and answer stay in-house, only the question goes to ChatGPT-4o to generate the answer.

Two Applications of a Secure GPT:

1. Technical Marketing:

Data: Modelling [sic] of the Forging Process for a Magnesium Alloy Automotive Control Arm⁵

Request: press release, 100 words, targeting design engineers

Answer, which was generated in 8 seconds:

Title: Innovating Automotive Forging: Advanced Modeling of Magnesium Alloy Control Arms Press Release:

We are thrilled to announce the breakthrough Master's thesis by Talal Paracha at the University of Waterloo, which meticulously models the forging process for magnesium alloy automotive control arms using DEFORM 3D. This research highlights the superior strength-to-weight ratio of magnesium alloys AZ80 and ZK60, providing design engineers crucial insights into optimizing preform shapes, reducing forging loads, and ensuring die fill. With a focus on innovative design and precision engineering, this work opens new avenues for lightweight, durable automotive components. Join us in revolutionizing automotive design with cutting-edge material science.

Do not expect the result to be perfect, yet it was written in just 8 seconds. With proof-reading and perhaps a few modifications, it's ready for publication. Time is money. How many hours did this tool save from the typical iterative process of reading, writing, and collaboration between Engineering and Marketing?

2. Customer Service: An equipment producer receives a call from a customer with technical questions. The customer service representative has the secure GPT ready and already equipped with technical data-sheets, manuals and related publications, the answer can quickly be generated without the typical interruptions to engineering.

Data: COHO controls by REL, Inc⁶. Three files; a manual, a brochure, and the transcript from a YouTube video.

Request: What safety controls are built-in?

Answer in 37 seconds:

The answer was a list of 11 items, each listing function and action, with this summary at the end:

Summary: The COHO control system is equipped with comprehensive safety controls, including:

- Safety proximity sensors
- Emergency stops (E-Stops)
- Safety light curtains
- Diagnostic modes
- User authentication and access levels
- Alarm systems
- Safety interlocks
- Redundant safety checks
- Integration with various safety devices
- System state memory

Customer service receives a high-quality answer quickly that is easy to share via email, along with the reference materials.

Association Library

Trade associations are formed to sustain and grow an industry. Many associations have a technical library only accessible by the members who pay for access and participation. Improvements to the library are critical to keep members engaged, and to maintain the position as the primary resource for the industry. Most libraries today require keyword search, and in return, the library provides a list of references. Compared to the function of AmatriumGPT that produces both a paragraph answer, and the supporting citations! Game-changer.

Example question: What steels are common for gears, and why is forging a superior technology? 100 words.

Answer on Figure 3 produced in about 30 seconds, well-scripted, complete with citations. The first citation lists multiple pages referenced in the answer. The user has options to download or print the citation for further reference.

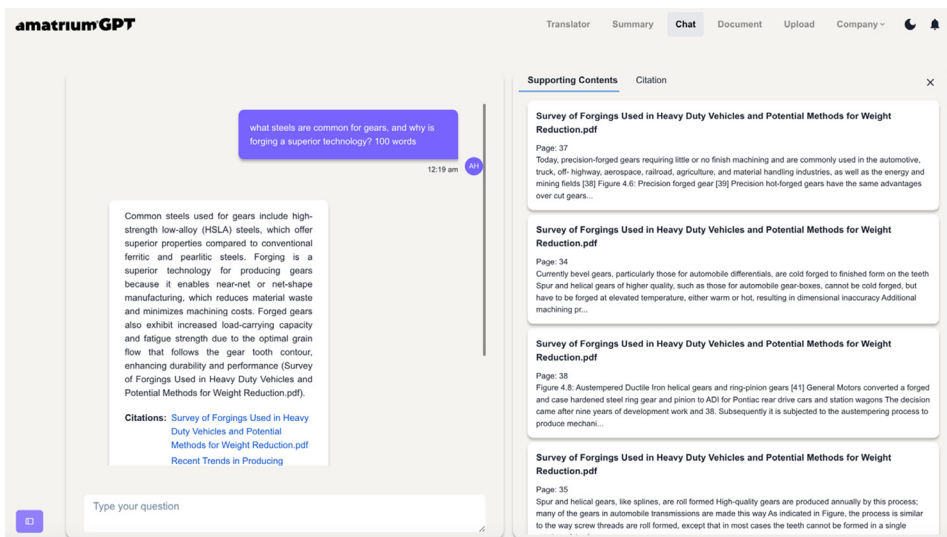


Figure 3: Example of Query Result with Citations from the User Library

Conclusion

The AI tools deliver high value and efficiency provided there is good data. Machine learning is much more intense while the GenAI tools are readily available and offer significant time

savings. Hours or days of work, now done in less than a minute. Organizations have limited human resources and are dealing with job-hopping. Integrating these systems in the operation will improve collaboration and will be critical to retain company knowledge as key employees retire or move on. Maximize the value of resources across the organization. Your competitive advantage depends on it.

References:

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