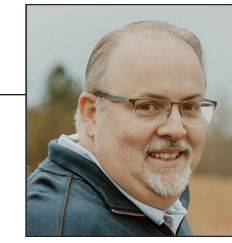
Editorial





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The emergence of AI in additives development

The continuing evolution of artificial intelligence (AI) and its penetration into the core of the world of papermaking were undeniable at TAPPICon 2024 and especially within the content presented and sponsored by TAPPI's Papermaking Additives Committee. On one side of the spectrum, there were traditional methods of chemical development and application grounded in natural intelligence, while on the other, there was the emerging presence of algorithmic decision-making and machine learning within the development cycle. The latter technology is brimming with the kind of promise that could reshape how additives are conceived, developed, and applied, turning what was once a matter of trial and error into something far more precise and previously out of reach.

Machine learning holds immense potential to sift through enormous datasets in the hope of uncovering insights buried deep within. But what is all too easy to overlook in all the enthusiasm is that these tools are not magic. They do not work well with just any dataset. These new tools work best with large, high-quality, cleaned, and well-organized data pools. This reality can create a dilemma: in the early stages of developing genuinely innovative solutions to the complex problems our industry faces, such datasets are often unavailable — and without them, we must rely on traditional investigator-driven research.

Special issue highlights traditional and emerging methods

This special issue organized Guest Editor Anthony Petty II and Scott Rosencrance of the *TAPPI Journal* Editorial Board features specially curated content derived from the TAPPICon 2024 Papermaking Additives Track. All of these papers underwent additional peer review for publication here. These selections run the spectrum from traditional chemical development methods to emerging methods that incorporate AI and machine learning.

On the end of the spectrum based in natural intelligence, the development of additives through investigator-driven research is clearly illustrated in the work of Biegler et al. (p. 131) and Soidinsalo et al. (p. 142). Their papers illustrate the process of deriving insights, iterating on those insights, and making progress with limited and often imperfect data. From this, they establish structure-function relationships that can emerge from rigorous bench chemistry and through an investigator's experience and ingenuity.

In contrast to the papers of Biegler and Soidinsalo is the work of Haverinen-Nielsen et al. (p. 166), whose paper describes an integration of machine learning with chemistry and physics models to create an "advisory module" that fine-tunes additive use. Similarly, Arjunan et al. (p. 173) demonstrates the benefits of a cleaned and curated dataset to power a self-learning model that delivers value to the user. Both of these papers acknowledge the necessary role of human expertise in final decision-making and in the development of the models themselves, but they underscore the potential for these

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algorithmic approaches to rapidly analyze vast amounts of data, diagnose inefficiencies, and suggest solutions — offering a glimpse into a future where AI is a partner in machine operation and optimization.

The work of Blazey et al. (p. 152) underscores that human-driven problem solving remains essential, providing the imagination and context needed to solve what might otherwise seem like an intractable machine problem. The structure of the process, however, is still inherently algorithmic, as it involves generating a dataset through specific techniques and then refining it to find a solution; thus, it is the expertise and creativity of the investigator that drives the process forward.

Bridging the divide between natural and artificial intelligence isn't just a technical hurdle — it's the true challenge that lies at the core of where we are headed. It is hoped that the papers in this special issue demonstrate progress on both ends of this intelligence spectrum while outlining and suggesting how these two approaches can coexist and complement one another. Successfully integrating these two approaches to problem-solving — one grounded in human ingenuity, the other in boundless computational power — will help to propel our industry toward its most ambitious goals. **TJ**

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