Bringing a literary train to life with a 3-D printer

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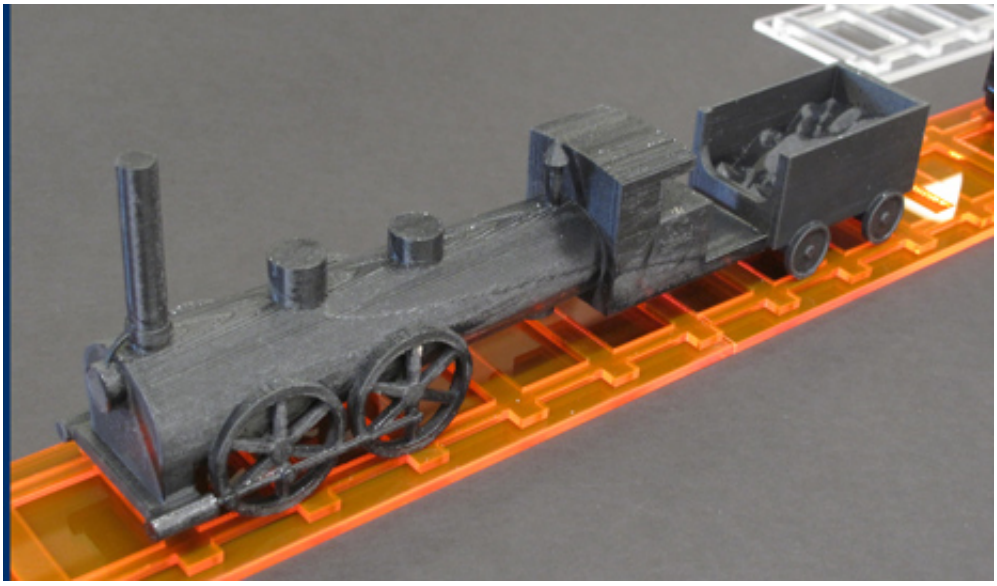

Because Zola only described the train engine as having two wheels, the CEID team left the back wheels off of their model as well.

When readers describe the experience of a great novel, they might say the story "leaps off the page." But for assistant professor of French Morgane Cadieu, that phrase took on new meaning last fall when she and three of her students set out to create a 3D-printed train based entirely on descriptions from Emile Zola's 1890 novel "La Bête humaine" ("The Beast Within").

"As part of the movement known as 'naturalism,' Zola's novel is

recognized for its thick technical description. In fact, readers often complain that it's too detailed, that it's a book made for engineers," said Cadieu, whose student research team consisted of Sienna Jun '16, John Sununu '15, and Alexandro Gonzalez-Calvillo '16. "So one of my aims was to see if an engineer could in fact build a real object—an actual train with all the features Zola describes—relying only on these so-called naturalist descriptions."

To accomplish her project, Cadieu turned to Yale's Center for Engineering Innovation & Design (CEID), a cutting-edge makerspace that fosters collaborations across the entire campus community.

"Centrally located on the Yale campus, the CEID is the place to be for everything from developing novel medical devices to creating one-of-a-kind musical instruments," said Vince Wilczynski, deputy dean of the School of Engineering & Applied Science (SEAS) and the James S. Tyler Director of the CEID. "Professor Cadieu's project is the latest example of the CEID's unique position as a central hub for interdisciplinary ingenuity."

Once connected with CEID staff—including research support specialist Glen Weston-Murphy and CEID design fellow Ngoc Doan '14—Cadieu found that creating a literary train would require both tools and translation. A blueprint of the model could be efficiently drawn up using the CEID's computer-aided design software, at which point it could be rapidly produced on the CEID's 3D printers. The translation, however, would require some effort.

"The second goal of the project was to teach students the importance of close reading, of paying attention to nuance and context," said Cadieu. "But in order to take the literature at its word, we first had to translate the original French descriptions into literary English, then translate the literary words into more technical, precise terms of engineering. Finally,

we translated those terms into an object, into computer code."

As a result of this process, Cadieu and her students discovered that Zola, despite having consciously "translated" into fiction copious minutiae of the trains he saw as a child, had not communicated enough details to make a train that was realistic—or even one that was functional. For example, the train engine is only ever described as having two front wheels, with no words spent on back wheels. In adhering to the letter of the text, Cadieu and her students chose to leave the back wheels off their model as well, and the CEID staff instead created a nearly-invisible hitch near the back of the engine.

"Zola describes how big the wheels are in relation to the train body," said Doan, "but there's no acknowledgment of how the wheels keep the train from toppling over. That became the real engineering task."

But what Zola's text lacks in fine points of structure is certainly made up in metaphorical breadth, and reading the text closely required the team to therefore adhere not only to the letter but also to the spirit of the text. The text gives exaggerated importance to the chimney of Zola's train, for example, just in how often it's described; in response, the team chose to design a very prominent, very tall chimney at the front of the engine. Similarly, characters' visceral reactions to the train whistle far exceeded an actual whistle's diminutive size.

Morgane Cadieu, assistant professor of French, and Yale senior John Sununu with the 3D model.

"Zola's characters feel the presence of the train coming toward them, and so the whistle sound evokes anxiety," said Jun, a junior majoring in both art history and French. "The sound is very much a part of the physicality of the train, and we tried to convey that menace just in the whistle's appearance."

Despite such exaggerations, the final product turned out more realistic than Cadieu anticipated. "What we didn't expect is that if you look closely at trains from the end of the 19th century, they really look similar—the chimneys are this high," said Cadieu. "And yet Zola's intense focus on small parts of the train—the fog, the sound, the light—could easily be interpreted another way, producing a lot of different trains. For that reason, we decided to connect this 3D train body only through the 2D 'fog' of literary descriptions in between the cars and also above it."

In that sense, the model train took on one more symbolic meaning: as the connecting force between literature and science.

"I came to Yale determined to nurture my science background even as I plunged myself into studying French," said Sununu, a senior majoring in French and economics. "Enabled by the technology of the CEID, this is the first project I know of that's taken the heart and soul of literature and brought it to life physically."

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