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The Impact of the Humanities in Science and Technology Research: A Multidisciplinary Approach to the Ethical, Social, and Legal Impacts of Science and Innovation

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Grubbs rightfully suggests that basic science researchers can gain invaluable multidisciplinary insight from increased interactions with the humanities (Grubbs 2016). We generally agree; although often unappreciated, the humanities, and even popular culture (Greenbaum 2008), can have a substantial impact on the direction of academic science research. However, while frequently this impact is positive, in some instances this impact can be damaging, even hindering the advancement of science and innovation. For example, many advancements in applied science are arguably a direct result of the influences of science fiction—to wit, recently, the U.S. government even assembled a group of engineers and science fiction writers in an effort to inspire further innovation (Liptak 2016). Conversely, perhaps one of the most destructive influences on science innovation has been a classic work of fiction, *Frankenstein*. Notably, the *Frankenstein* myth is celebrating its 200th anniversary since its inception during the Mount Tambora volcanic winter of 1816 (De Boer and Sanders 2002). Arguably, no other work of fiction can similarly claim to have such a lasting impact in articulating the public's visceral fears of scientific and technological innovation. Witness the extensive damage the pejorative prefix “Franken-” can do when it is simply associated to areas of innovation that have outpaced society's comfort zone (Turney 1998), most prominently in the area of genetically

modified (GM) foods—a.k.a. Frankenfoods (Glass-O'Shea 2011). This groundswell of anti-GM conventional wisdom has likely substantially impeded research in the area of genetic engineering (Lieberman and Gray 2007).

In general, at the intersection between humanities and the sciences there are helpful metaphors and what can be only charitably termed unhelpful metaphors. Helpful metaphors include the aforementioned pop cultural touchstones that readily convey complicated science and/or social aspects of the relevant science or technology, often (but not necessarily; Gisin et al. 2003) to a lay audience. In contrast, unhelpful metaphors, like the *Frankenstein* monster, easily allow the uninitiated to justify their latching onto an enduring and often misguided idea. Unfortunately, all too often, in light of the visceral reaction elicited by the metaphor, the ill-informed individual can become intractably convinced of their position, eventually unable to distinguish scientific fact from the fiction associated with the metaphor. When attached to an uncomfortable scientific or technological innovation, the ideas conjured up by *Frankenstein's* monster help entrench a negative association within the general population, even in light of substantial scientific evidence to the contrary. The *Frankenstein* script, as currently employed, also impedes even a rational debate on GM products as it allows for only a

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binary appreciation of the science: good or bad, without any gray areas in between (Hellsten 2003).

Perhaps even more insidious, the framing of the Frankenstein story affords for not only a knee-jerk assessment of a particular technology—for example, the monster or GM crop, but even worse, a de facto demonization of the entire scientific endeavor that created the monster. Under this understanding of the story, there can never be a positive outcome to this type of research—all of Dr. Frankenstein's scientific efforts are now suspect. Applying this to the GM debate, if GM food is the monster, the entire GM endeavor is *verboten*, and there can never any redeemable outcome via the use of this technology. Unfortunately, it's not only GM that is affected by the application of the Frankenstein story; many scientific endeavors can be and have been shoehorned into this myth, including stem cells, human genetic and biomechanical enhancement, cloning, and artificial intelligence.

Not that there aren't valid concerns with GM: The proven safety of many GM foods notwithstanding, there are a number of ethical, legal, and social concerns associated with genetic modification, on top of the scientific concerns. These include, among others, intellectual property issues related to the ownership of GM seeds and the use of sometimes onerous licenses to enforce those property rights, compelled labeling of GM products and/or their derivatives, and the environmental impact of GM foods and emerging resulting agronomic practices, particularly the feared effect of invasive GM varieties into wild-type non-GM populations of flora and fauna. In addition, many are concerned with the reported increased use of pesticides and herbicides, potentially poor yields, cross-contamination, and reduced genetic diversity.

All these concerns notwithstanding, the impulsive reaction, fed in part by the Frankenstein metaphor, remains unjustified in light of all the potential benefits associated with GM.

But even Frankenstein is redeemable. While the monster metaphor has noticeably held back innovation, perhaps science and society can learn from another, albeit underappreciated, but more nuanced literary parallel from the book and its film adaptations: the enraged mob of terrified townspeople acting impulsively against something even as they lack any firsthand knowledge of the problem.

With emotions often highly charged in GM debates, and with fearmongering capitalizing on hard-to-articulate concerns, high levels of dread, and general repugnance,

anti-GM efforts often look more like the incensed mob impulsively rejecting science, rather than the misguided scientist. If those in the GM and other innovation technologies debates can step back and appreciate this metaphor, perhaps the ethical, legal, and social impacts of these technologies can be rationally debated and good science, when available, can be put into practice. ■

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