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Office of Research

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To Whom It May Concern:

Drexel University is pleased to submit a response to the request for input on a National Bioeconomy Blueprint. This response suggests a novel bioeconomy thrust, in quite brief form, primarily because the idea is quite unconventional. We believe its merit will be to stimulate thought in this or a related direction, rather than to provide the type detailed blueprint that would be useful for more conventional approaches.

Our proposal is to develop the ability to grow biological structures for engineering applications. We propose merging the developments of modern biology with needs of classical engineering of structures to develop a means to *grow* structures rather than simply building them. Nature is adept in this domain, growing the requisite mechanical structures for flora and fauna alike. Such materials can be easily competitive with man made products in terms of salient physical properties. For example, Young's modulus for polypropylene is comparable to that for microtubules, which spontaneous assemble in living cells. Young's modulus for tooth enamel is greater than that of aluminum.

Current bioengineering efforts have been focused on highly functional elements, such as regeneration of kidneys, nerves, etc., and these deal with important problems of disease. However, we would contend that similar efforts could yield structural elements, as well as the functional ones presently sought. Indeed, nano-scale structures that can self-assemble have been a recent topic of intense study. The thrust we are proposing differs from such nanotechnology in the use of biological machinery to generate the ingredients, and biological "standards" to control the interaction. We contend therefore that our current array of bio and nano tools can be improved upon and directed toward such tasks. This could occur at many scales. For example, replacement of simple plastic panels with bio-material at "consumer scale" could occur. One could also imagine larger "industrial scale" construction.

Certain significant technical hurdles are evident, such as the genetic programming that is necessary. Yet a concerted national effort would be likely to be highly productive. Moreover, because the materials to be constructed do not involve human subjects, the protection mechanisms for research in that domain are not required, simplifying the process. Advances in this direction would necessitate deeper understanding of the biomechanics of the structural elements that would be produced in this fashion. A modern engineer knows the properties of the materials used, but if these are assembled from biological material, there must be a priori ability to understand how strong a given "grown structure" would be. The enterprise needed to develop this technology would generate significant spinoffs.

Retraining certain parts our educational system and workforce would be necessary. Working with this grand challenge will require engineers becoming adept at molecular biology without loss of their engineering competence. This therefore mandates a rethinking and reconfiguration of engineering training.

Were such a program to become productive and viable, it would clearly spawn new types of biotech industries, where biomaterials replace man-made materials. Such an industry would likely be quite “green”, using biomaterials for its resources. We thus believe that, because of the various merits described above, such bio-structural engineering could become a viable element in the bioeconomy of the future.

Sincerely,

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