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Chemistry in the Global Economy

Engineering, manufacturing, and electronic design play a massive role in the global economy. A host of essays could be written just about engineering alone given all of the subsections of the broad engineering category. Virtually every product available today has been influenced in some way by engineering, from the computer that I am writing this paper on, to the chair on which I currently sit. It is just a bit too much, so I will focus on a particular field of interest for me: chemical engineering. That is, I will focus on the role of chemical engineering, chemical manufacturing, and the role of electronics plus chemistry in the global economy.

Stanford University defines the role of chemical engineers as follows: “In broad terms, chemical engineers conceive and design processes to produce, transform and transport materials — beginning with experimentation in the laboratory followed by implementation of the technology in full-scale production.” Creating materials and the processes to effectively make them is what makes chemical engineering so versatile – its tendrils reach just about everywhere. For example, some chemical engineers are heavily involved with meeting environmental regulations, something that is not going to go away in the foreseeable future. In all likelihood, chemical engineers in energy, environmental issues, biotechnology, and other fields will have an excellent outlook due to continuing needs for energy, a functional environment, and new pharmaceutical products.

The importance of the role of chemical manufacturing is difficult to understate. Every polymer, metal, and processed fluid (like gasoline or lubricant) is directly related to chemistry in manufacturing. After all, gasoline can’t be pumped out of the ground and into an engine – it has to be refined first. To show the prevalence of chemistry in manufacturing the 50 largest chemical companies worldwide grossed 851 billion dollars in sales in 2017 according to Chemical and Engineering News. An industry of that size and global reach is and will continue to be indispensable. However, I do see a shift in the chemical industry in the future, and it requires a social change as well – altering the lifecycle of plastic. Plastic is everywhere as it is light, versatile, and inexpensive but it has an issue: most of it ends up as pollution. Per a July 1st article in *The Chemical Engineer* only 9% of the plastic produced since the 1950s has been recycled, with 12% being incinerated and the remainder ending up in a landfill or as pollution. That works out to about 7.1 billion tons of plastic in your local dump or body of water. It is a serious issue potentially causing health problems, hindering tourism, and damaging fishing industries, among others. Unfortunately, the answer isn't as simple as tossing all plastic products into a recycling bin – plastic is a pain to recycle. Looking at "7 Things You Didn't Know About Plastic (and Recycling)", an April 4th article by Lilly Sedaghat for *National Geographic,* I learned that the seven recycling codes found on plastics are rather misleading. There are thousands of different kinds of plastics and they can't be mixed together to make a quality product. Plastics also have a tendency to weaken the more often they are recycled, so fresh plastic is often mixed in to help keep the quality up to snuff. Recycling plastic is a good thing, but it is not a viable long-term answer.

There are several potential solutions to the question of what to do with plastic in the future. First, any plastic that weakens with repeated recycling could be phased out and replaced with a next generation of plastic, metal, or glass (metal and glass can be recycled indefinitely). Another option, although not a great one, is to incinerate plastic that has reached the end of its lifespan. Finally, and this is probably the least attractive option, is to just ignore all of the plastic that ends up as waste. Happily, it turns out that there are some new plastics that are designed with usefulness and recyclability in mind. As described in “A Synthetic Polymer System with Repeatable Chemical Recyclability” (an article published in the April 27th edition of *Science*) scientists at Colorado State University were able to create a plastic that can be used, taken to a recycling plant, broken down to its base components, and reused without degradation of the plastic. This is great long-term news for both the environment and chemical manufacturers. Environmental plastic could be drastically reduced while continuing to use plastic as the omni-material that it is today.

The third member of the chemistry triumvirate is electronics; electronics and chemistry have a long history together. Aspects of automation, primarily monitoring equipment, were prevalent in the chemical manufacturing industry by the 1930s, with the use of electronics and automation only increasing since that time (per Dr. Han Schuler in his article “Automation in Chemical Industry” published in *Anwendungen* or *Applications,* August 2006). Given that and current trends toward automation in other industries, it seems extremely likely that electronics, focusing especially on automation, will continue to be highly important to the chemical industry in the future. Chemistry has a critical role in the manufacture of electronic devises as well. As an example, the silicon chip which runs computers around the world, has several chemistry heavy manufacturing steps. The refining of silicon dioxide to pure silicon, bombarding the silicon to change its conductive properties, and electroplating the chip are all good examples (sourced from “How a Computer Chip is Created – from Sand to CPU” by Jamie McKane published April 15, 2017).

It would be difficult to imagine life without some of the innovations that have been produced as a product of chemistry, both in the home and on a broad economic scale. The industrial production of fertilizers, electronics, plastics, fuels, and medicines have radically altered human society in the past 150 years or so. With that in mind, chemical manufacturing, chemical engineering, and electronics plus chemistry could combine to form something truly innovative and far-reaching: a Martian habitat. Any material used in a structure for a Martian outpost would need to withstand extreme cold, dust storms, and massive levels of radiation all while being light-weight for transport – a marvel of chemical engineering. It would need to meet the most stringent levels of chemical manufacturing; a single defect could be deadly. Finally, it would need top-tier electronics to run diagnostics, maintain homeostasis for the astronauts, and be durable enough to survive the Martian environment and to get to Mars intact.