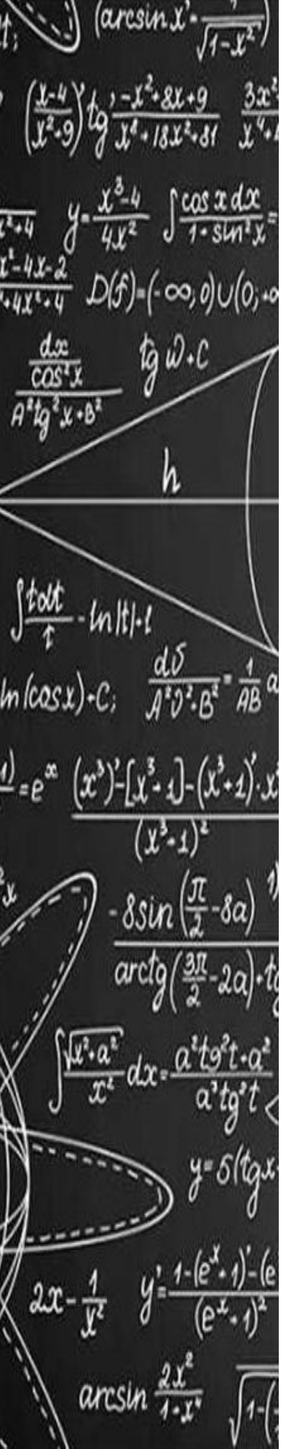
What is the future of Manufacturing?



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think this is an exciting time to work in manufacturing; possibilities are becoming unlimited, the 3D printing, desktop water-jet cutter, small CNC machines, availability of materials, and many other opportunities.

for example do you think there will be smaller scale factories, possibility of making things at home, maybe new technologies (what is your dream of a new emerging technology or a new machine), what about limitation of resources/materials (does that mean there will be less or more production), new materials, personalized product, more automation, what would be the next big thing?, CPS (Cyber-Physical Systems), Virtual and Augmented reality in use for industry 4.0, or what about the future of manufacturing education,….

In a few sentences describe your version of the future of manufacturing.

THE FUTURE OF MANUFACTURING IS RECYCLED MATERIALS!

The future of manufacturing will involve more and more recycled materials. With the massive amounts of single use plastics and discarded textiles accumulating and polluting the world there is a need to repurpose this waste into new products. Manufacturing for these materials will involve 2 steps. First, automating machines to sort, clean and process waste materials into a useable form. Secondly, once these waste materials have been turned into a useful medium there will have to be new manufacturing processes created to effectively use these materials to create new products that are still at a comparable quality to their non-recycled counterparts.

Source: from the Saola shoes

ORBITAL MANUFACTURING

In the far future (1 or 2 centuries maybe), I think orbital manufacturing infrastructure will play an important role in colonizing the solar system.

Asteroids and comets offer a very rich source of metals and water. Once our space industry develops much further, there's going to be a large incentive to mine asteroids. It's possible that most of our heavy mining equipment will be built on orbital platforms in orbit after raw materials are processed (in orbit as well). The cost of brining material back down to earth for refining and launching them back out of our gravity well is extremely costly in terms of both time and energy use. It may be more economical to steer an asteroid into orbit and simply perform all the processing and manufacturing there. Using orbital manufacturing may also be the only way to construct huge structures/vehicles in space such as 100m telescopes, generational ships, and O'Neill cylinders (rotating habitats).

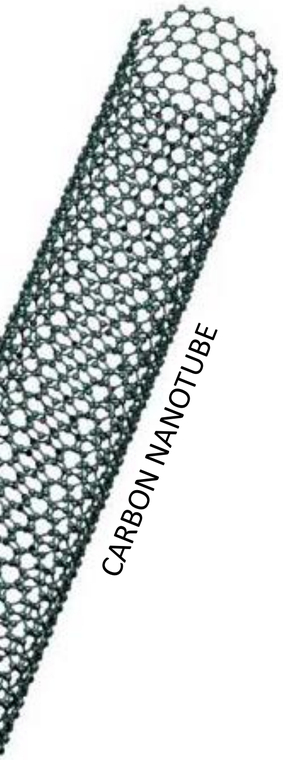
Some manufacturing techniques use perfect vacuums, and they're painful and expensive to get right on earth. This could be easier to implement in space. One example of this is solar panel manufacture. Many crystals form best in micro-g/zero-g environments too, and this has applications in industries such as medicine, optics, and electronics.

Source: Isaac Arthur from the video below

https://www.youtube.com/watch?v=HkU85zKxK-s

His channel makes excellent content. Highly, highly recommended.

CARBON NANOTUBE PRINTING



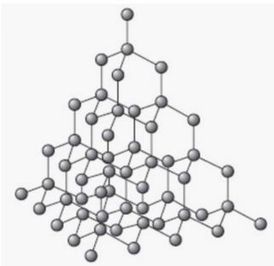
Carbon Nanotube (CNT), like diamond and graphite, is a molecule made from carbon atoms

It has a big potential in structural engineering

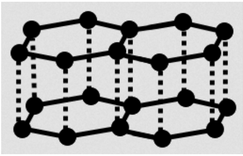
	Structural Steel	Carbon Nanotubes
Tensile Strength (GPa)	0.40	11 ~ 63
Density (g/cm^3)	7.8	1.3 ~ 1.4

→ It is both light and stronger than current building materials

Currently, there is no method to produce CNT reliably and in large quantities



DIAMOND



GRAPHITE

However, under the right conditions, carbon atoms form CNT on their own

This process is called self-assembly

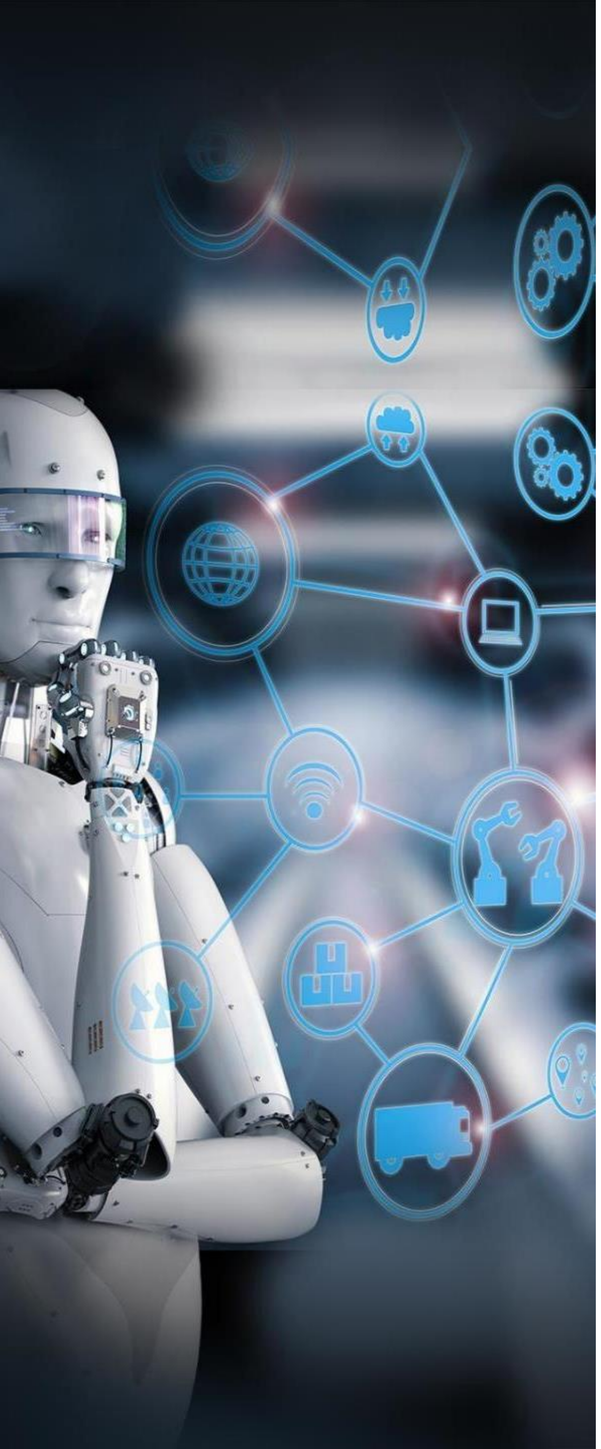
Self-Assembly

Therefore, CNT can potentially be “3D printed” from an atomic scale

In the future, robots like on the right might “print” structures as a building is being constructed

3D PRINTED HOUSES

- I think that in todays economy with houses being more expensive than ever before (especially in Vancouver) 3D printed houses will be the future of manufacturing
- It’s already being used in some places and the results are incredible https://www.youtube.com/watch?v=GUdnrtnjT5Q
- These houses cost as little as 10k$ and can take roughly 24h to make
- This technology can also help us colonise mars if need be as colonies can be 3D printed and all we’d need to send to Mars is the printer and enough material



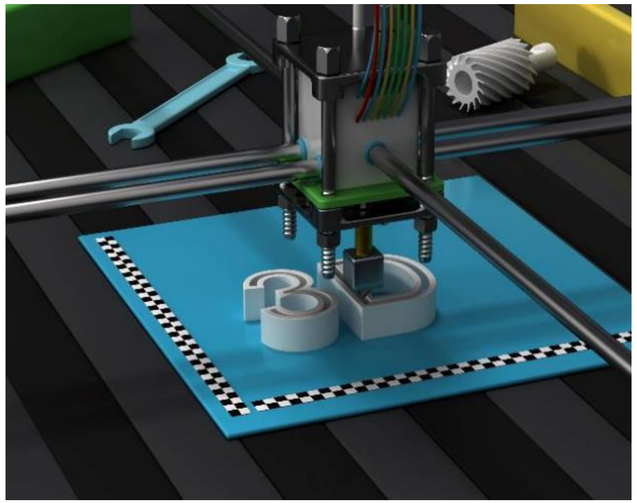
WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

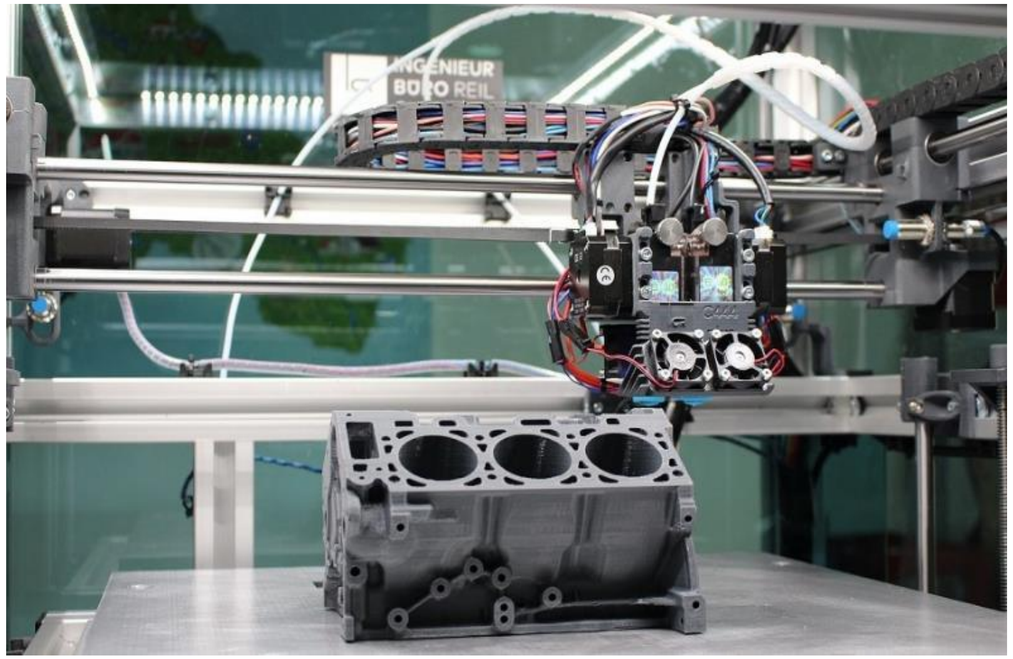
COGNITIVE MANUFACTURING (AI) COULD GREATLY IMPROVE MANUFACTURING PROCESS

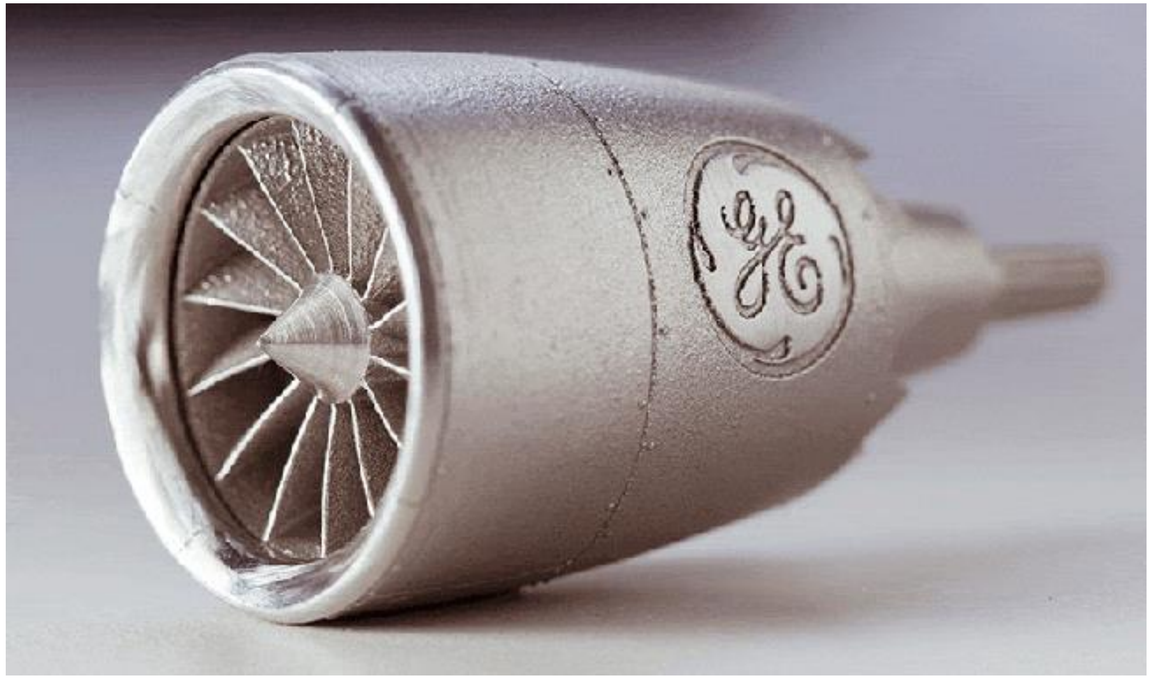
- Cognitive manufacturing could start another chapter of Industrial Revolution
- AI can improve quality, cost and fulfillment of manufacturing system such as processes and training (e.g. virtual training)
- It will increase production rate, reduce manufacturing time
- E.g. BP company integrated quality control using AI which achieves 95% accuracy within few hours while typically a technician take weeks with 80% accuracy in quality inspection. https://www.ibm.com/blogs/internet-of-things/iot-watson-and-manufacturing/
- Limitations: work delay due to power outages, material resources, experts with highly specialized knowledge

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think the future of manufacturing will be increasingly important and beneficial for small scale start ups and entrepreneurs. By that I mean more manufacturing technology will become available without the need for large scale investment. Therefore, individuals could purchase machines capable of creating large and complex dimensions at a fraction of the present cost. It would be my dream to own an additive manufacturing process (polymer, or metal based) from which I could create anything I needed. For example, household supplies, automotive parts, etc. The opportunities would be endless!







FOCUS ON SUSTAINABILITY

The future holds a shift in manufacturing materials and processes to focus on sustainability

- Factories will be transformed into green facilities by reducing waste, recycling energy and water, and capturing carbon emissions
- Lower waste technologies like powder metallurgy will become more common
- Plastics will be replaced with biodegradable substitutes
- Clothing, shoes and plastic-based textiles will be replaced with natural or recycled materials

Pela Case's biodegradable plastic phone cases, made of biopolymers and flax

https://thedieline.com/blog/2018/8/20/pela-case-develops-a-compostable-plastic-alternative-to-protect-your-phone

Allbirds' organic shoes (left) and Adidas' recycled plastic shoes (right)

https://www.wellandgood.com/good-looks/allbirds-tree-topper/
https://vt.co/news/world/adidas-launch-first-ever-100-recyclable-sneakers-made-from-plastic-waste/

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I imagine future manufacturing technology to be more accessible, merging into our lives and to be built into our homes. Similarly to our paper printers, laptops and smartphones, I believe this technology will be available in smaller scale as a home appliance. To manufacture parts, people would buy a g-code or printing script from online store and program their own personal CNC machines / 3D printers.

I think 3D printing will have a significant contribution to the future manufacturing in larger scales as well. Multiple hoses could be used to print complex designs. Larger scale printers could be moved around and calibrated at the new location.

FUTURE OF MANUFACTURING: RAPID PROTOTYPING WITHOUT HUMAN INPUT

3D printing has made manufacturing accessible to many people who would not otherwise use manufacturing in their daily lives. As the process of 3D printing becomes more streamlined, **I think in the future there will be 3D printing services that do not require human input to operate**.

This means setting up the printer, extracting the finished part, doing post-processing work, and packaging the part will all be done by robots. This will require advances in robotic control technology, system fault detection and correction, and a streamlined packaging and delivery procedure.

I think it would be beneficial if manufacturers of cars, consumer electronics, and other equipment open-source their 3D models so that people can print them from this 3rd party on demand. Currently, there is no financial incentive for companies to do this but maybe some legislation in the future can support this idea.

Source: https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&ved=2ahUKEwibk-fq6eLlAhWBMH0KHdHaD60QjRx6BAgBEAQ&url=https%3A%2F%2Fairwolf3d.com%2F2018%2F03%2F07%2F3d-printed-center-console-dodge-hellcat%2F&psig=AOvVaw3lqId7PdP5ez1cdA2wvcl0&ust=1573584663936700

Source: https://i.all3dp.com/cdn-cgi/image/fit=cover,w=1284,h=722,gravity=0.5x0.5,format=auto/wp-content/uploads/2019/08/05072856/ultimakers-3d-printer-farm-ultimaker-190727.jpg

NANOTECHNOLOGY

In its broadest definition, nanotechnology, refers to the study and application of technology on a nanoscale, typically between 1 to 100 nanometers. As other manufacturing technologies improve in other aspects, particularly precision, we should see according developments in nanotechnology. Although not a new concept, the potential for its future uses are limitless. Some possibilities are [1]:

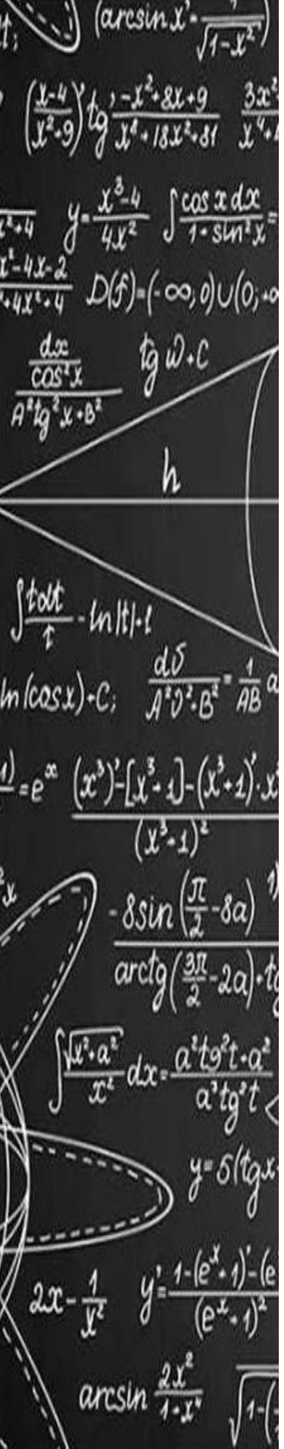
- Faster computer processing
- Nanorobots to deliver drugs to specific tissues and organs
- More durable clothing

Nanotechnology has a promising future but is dependent on the future of other manufacturing technologies.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I envision the potential of manufacturing to be limitless; especially 3D printing. As printers get optimized and parts become cheaper and more affordable to own, I believe everyone will have a 3D printer at their home. Everyday items will be manufactured in one's home. With the emergence of open sourced databases, there will be gcodes and stl files of any item. For example, if you are missing a square piece from a keyboard, you should be able to search it up and print off a duplicate piece. In the future, anyone will be able to manufacture their own basic eating utensils, bobby pins, cups. Etc. The list goes on.

In the next 20 years, I believe manufacturing will explode in usage and everyone will have an advanced 3D printer in their homes.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

Manufacturing may become fully digitalized.

People may be able to use Virtual and Augmented reality to built virtual models and 3D print them at home. Virtual and augmented reality can also be used for custom fitting of clothes or visualizing how an object looks like without obtaining the physical product. Such technology allows for easy personalization, and the widening variety of designs would benefit the art scene.

People will no longer need to step out of their houses to get what they want.

With the ability to physically create things at home, consumer goods can be sent through the cloud (internet) and brought to life by on-demand manufacturing.

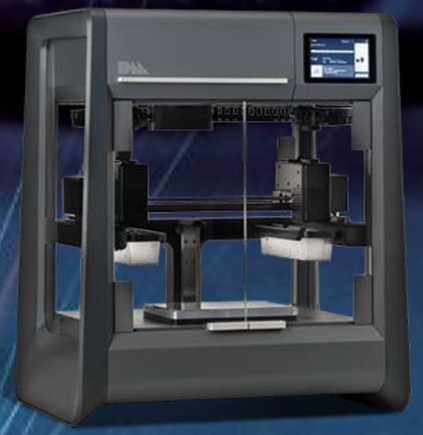
The economics will change as supply is now matched with demand. There will be less material waste, reduced carbon footprint, smaller inventory carry costs and more effort can be spent on improving customer service.

At the manufacturing side, data analysis and automation helps make manufacturing of consumer goods less supervised and more efficient. Manufacturers can then direct their efforts towards researching new technologies, machines or materials.

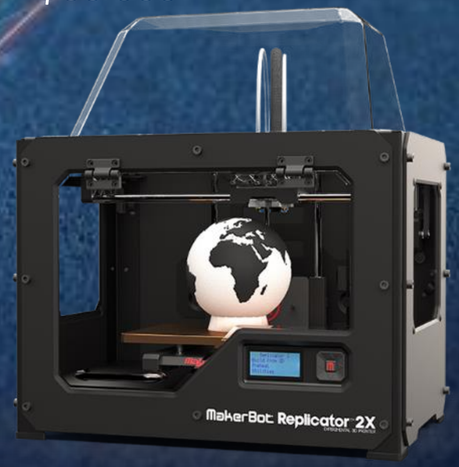
AFFORDABLE HOME-SIZED METAL 3D PRINTERS

Metal 3D printing is much more durable and therefore can be used for more ‘real’ applications unlike plastic 3D printing. Regular 3D printers are affordable and in many households already but metal 3D printers are still prohibitively expensive. A compact and affordable one would allow people to create objects with better material properties and real world use.

In the future it would be ideal to have multi-material printers that could do plastic, metal, ceramic, or other materials. Similar to today’s multi-function printers that can do 3d printing + laser engraving + laser cutting.



Desktop metal 3d printer
~$60 000

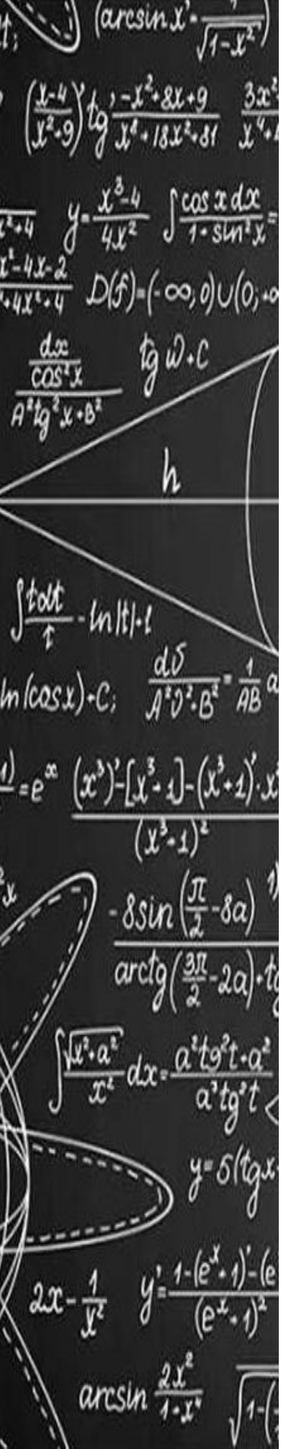


Home 3D printer
~$200 - $2000+

The Future of Manufacturing

I imagine that the future holds a lot of great things for the world of manufacturing, especially in terms of robotics. Considering how climate change has been such a big issue in the 21st century, I can only imagine change will take place within all sectors of engineering to address this issue. The way manufacturing processes will become “green” is through robotics. Automation is vital aspect of the industry’s future. Some manufacturing processes are already automated as this enables a level of accuracy and productivity beyond human capability including environments that would be considered for unsafe for human work. Although automation removes tedious manufacturing jobs, it opens the doors to new jobs in robotic operation.

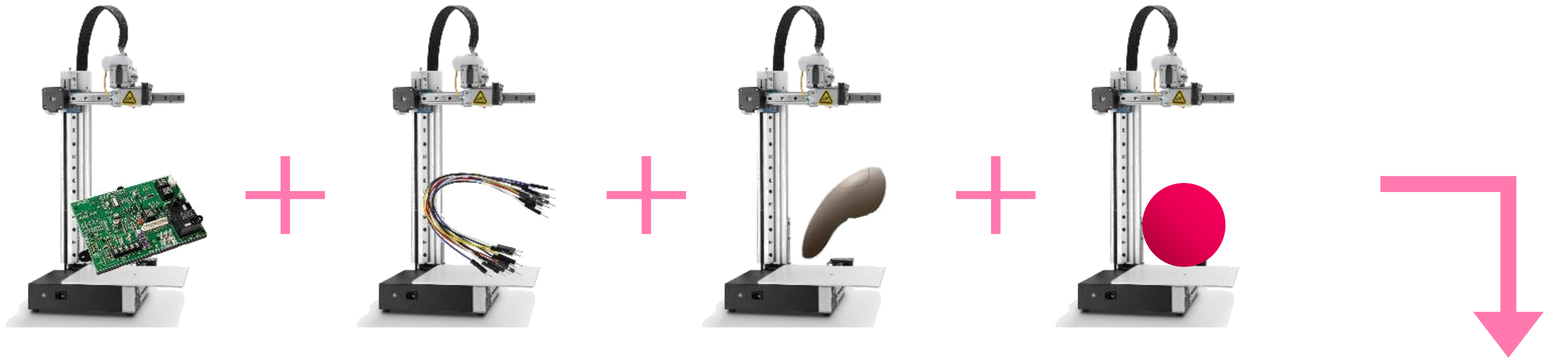
As the population and therefore the demand of products increases, we will require higher production while leaving the smallest impacts to the environment. I believe that the implementation of robotic technology can be implemented in every possible manufacturing processes somewhere to further improve the productivity of the processes while making the processes as environmentally friendly as possible.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

With all of the research being conducted on new manufacturing methods, I believe it is an exciting time. More specifically, I am excited about the possibility of 3D printing organs for transplants. There is a constant shortage of organs available for people who need it. The research going into 3D printing parts such as hearts and lungs could drastically change the world of medicine. As this technology gets developed and more popular, it will be interesting to see how material availability will affect the growth rate and adoption of the technology. I imagine a future 3D printing method where organs can be custom printed for each patient. This customizability will decrease the wait time for organ transplants and hopefully save lives. Having enough 3D printers and life cells available for use could be a limitation, however, it will be interesting to see how many doctors will adopt this new technology.

3D PRINTING WITH MULTIPLE MATERIALS WILL BE MORE ACCESSIBLE



I think that **3D printing** from the comfort of your own home with **different types of material** in the same print would be so much fun! You could make your own **robots**, cameras, water bottles, phone cases, etc.

This would allow for more people to create things that they otherwise might not have been able to make. People could **start their own businesses** by making products at home, or make **personalized gifts** for people instead of buying something.

Source: https://static.independent.co.uk/s3fs-public/thumbnails/image/2017/11/01/14/sony-aibo-robot-dog.jpg

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think that future of manufacturing will be a **merger between Conventional manufacturing processes and Additive Manufacturing that uses** metals, composites and ceramics.

For example:

In the future, a 3D printer may be used to print a mold made from ceramics. Other conventional methods (such as casting, thermoforming etc.) would then be used to make the actual part using the 3d printed ceramic mold. This way, the flexibility of creating a different geometry increases since the mold can be easily replaced.

3D printing of a concrete structure

Source: https://www.weforum.org/agenda/2017/06/what-s-going-on-with-manufacturing-b013f435-1746-4bce-ac75-05c642652d42/

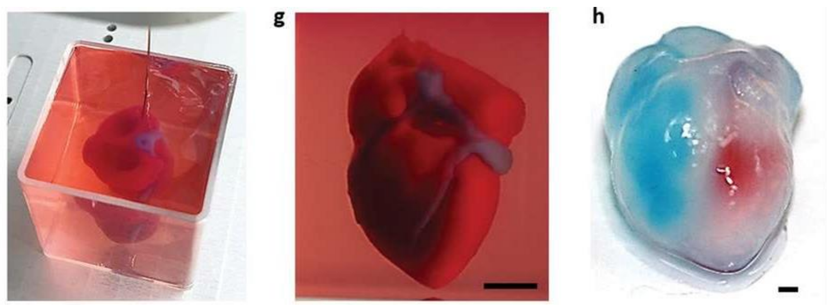
WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

- The future of manufacturing probably rests in personalized manufacturing. With 3D printers and software operated machines making personalized parts is becoming easier and easier. These personalized parts yield higher satisfaction and function better. By improving 3D printer technologies and making them more reliable, inexpensive and faster the technology could revolutionize how we make things. One day the goal is to be able to print at the atomic scale and be able to create almost anything, made of multiple materials and very complex geometries. By being able to increase resolution and include multiple materials, 3D printing will bring forward a manufacturing revolution. Imagine losing something and being able to wirelessly setup a print to find the new printed object when you get home.

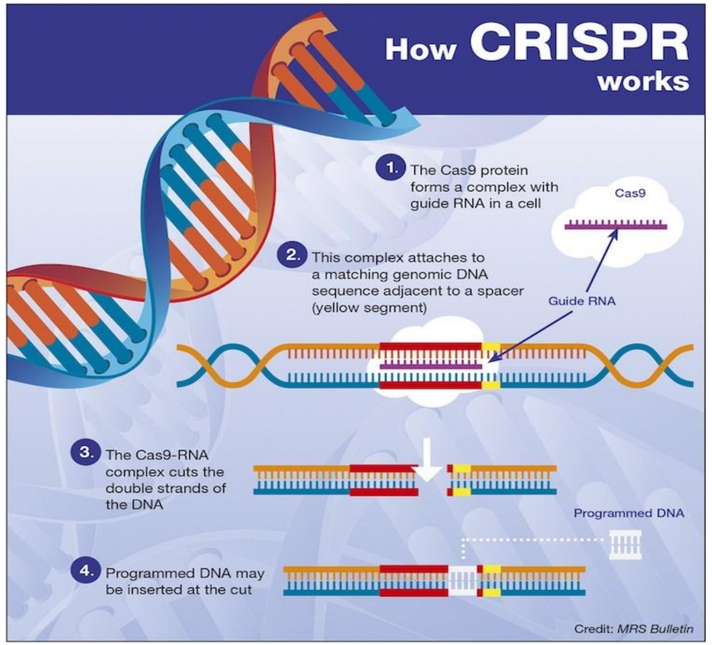
FUTURE OF MANUFACTURING: BIOMEDICAL APPLICATIONS

Personalized Healthcare in the Form of Personalized Organs

- drastic decrease in waiting times for organ transplants with the popularization of 3D printed organs
- continued research through CRISPR (gene editing) technology may allow editing of entire gene networks, therefore stem cells can be created from other types of cells
- with stem cell creating (vs. stem cell harvesting), accessibility of 3D printed organs increases as biomaterial supply increases
- results in a growing biomedical industry where engineers, doctors, scientists, social workers, etc. need to work together to properly diagnose a patient, choose the most appropriate method of treatment, and successfully treat the patient using cutting edge technology in interdisciplinary teams



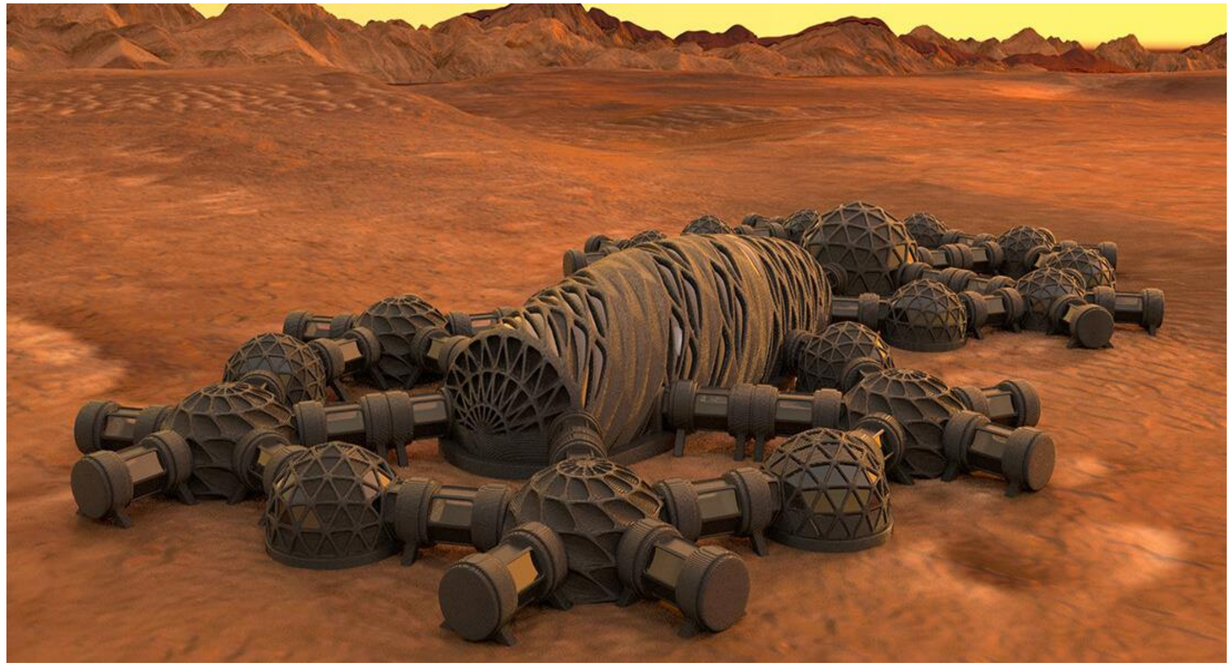
Existing 3D Printed Prototype Heart



CRISPR Gene Editing Overview

3D PRINTING IN SPACE

We are on the way to conquering the solar system, starting with building a settlement on the Moon. Because of the cost associated with cargo, it is critical that we optimize the materials we bring to the Moon. In the future, we will be able to 3D print using lunar regolith, a local resource covering the Moon's surface. With this technology, we could create entire lunar bases using solar 3D printers, meaning that astronauts will only need to bring the printer as cargo.



DECENTRALIZED FACTORIES

Smaller factories closer to the general population will leverage additive manufacturing and ai systems to produce tools and products on demand. Items will not have to be shipped by trucks, trains, planes, or boats but instead will be “shipped” over the internet to the small factories to be made.

THE FUTURE OF MANUFACTURING

I believe that the future of manufacturing will involve an even greater focus on 3D printing and robotics. The range of materials available for 3D printing will vastly increase in the coming years, growing to include different metals, ceramics, and biomaterials that were not previously possible to use. With these new materials, many parts that could have only been manufactured through processes such as casting, or machining will be possible to 3D print. As 3D printing becomes more ubiquitous and less expensive, more and more parts will be produced this way. Advanced robotics will also have a strong influence on the future of manufacturing. More and more companies are investing in machine learning assisted manufacturing. Machine learning is becoming more and more advanced, leading to higher part production quality and increasingly streamlined processes that traditional manufacturing methods. I think that this will continue in the coming years until many large-scale manufacturing processes will be almost completely without human involvement.

AUTOMATED MANUFACTURING

I believe the future of manufacturing is fully automated manufacturing

An example would be a customer ordering a customized house on some online platform, the customized house becomes coded instruction to a team of robots, the robots gather the material needed, tools needed, machines needed and they go to the site where the house must be built and they start working away

A more realistic example would be in an assembly line of a car factory where the entire car is made by robots instead of people. There would only need to be a few people to inspect the cars, and maintain the robots

This vision of manufacturing would dramatically decrease the need for physical labour and increase productivity as the labourers could be tasked with something more higher level such as QA, robot maintenance, algorithm development

THE FUTURE OF MANUFACTURING WILL INVOLVE

- Increased use Internet of Things capabilities to:
  - Track parts on the production line to inform the laborer's or robots at each production stage of any custom/unique production needs for each part in real time
  - Track part defects
  - Predict maintenance issues on the production line so that issues can be resolved more quickly (saves time, money)
- The rise of micro-factories:
  - Small-scale factories to produce prototypes and new products
  - Test success of new products before reconfiguring large-scale production facilities
    - If the product fails in the end, then lots of money and time is saved since large-scale production facilities were not changed yet
  - Micro-factories have greater capabilities due to advances in additive manufacturing, which are expected to continue progressing quickly

The First Build Micro factory. First Build helps companies, students and members of the public bring their ideas to life quickly and inexpensively

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think this is an exciting time to work in manufacturing; possibilities are becoming unlimited, the 3D printing, desktop water-jet cutter, small CNC machines, availability of materials, and many other opportunities. In a few sentences describe your version of the future of manufacturing.

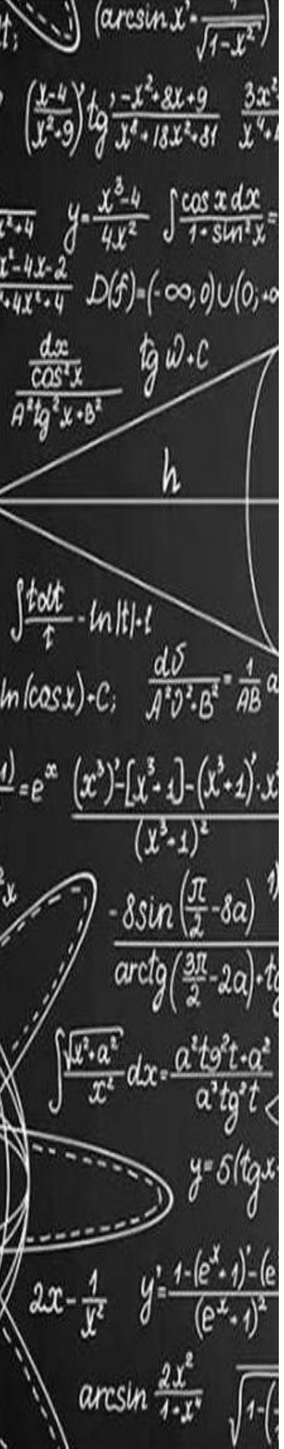
https://www.forbes.com/sites/bernardmarr/2018/08/22/7-amazing-real-world-examples-of-3d-printing-in-2018/#5351346b6585

Fast Production Additive Manufacturing

The main reason additive manufacturing isn't used for high production products is the time required to do so. Other than how long it takes to print; they have fantastic flexibility and the quality of parts produced gets better everyday. The reason for the high cost is mostly attributed to the investment cost in the machine and how long they take to operate. If additive manufacturing could become a high production manufacturing process, it would dominate manufacturing as an industry.

CLOTHING AUTOMATION

A technology I'm excited to see in the future are ones that feel very close to happening. The one I'm hoping to be a part of is in clothing automation as it will be a big game changer in the textile industry. Clothing still heavily relies on manual labor and is the reason for the exploitation of labor in developing countries. With the development of automation for the stitching and pattern builds in clothing, we could eliminate that exploitation as well as make more tailored fits for the individual than to make generic standards of sizes that not everyone properly fits. We would be able to re-introduce quality in clothing and bring back the industry to become Canadian made.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think manufacturing will continue its current trajectory becoming more automated and less reliant on human interaction to create products. First world countries will stop exporting their manufacturing to countries with cheaper labor capitalist economies will continue to thrive. With additive manufacturing, it could be possible to create products without the need for long-lead time, costly multi-step processes requiring a great deal of infrastructure and large labor force. With the manufacturing process becoming easier and more efficient, I think that will create big problems with sustainability and sourcing of materials. This could charge a revolution in material recycling technologies and force the industry to source materials that are more naturally abundant.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think the future of manufacturing lies in large scale additive manufacturing. Imagine a world where we could customize our own house like in a game, then export it into a CAD model which could then be 3D printed within a short time frame, rather than building a house like we do now that would take months, if not years to complete.

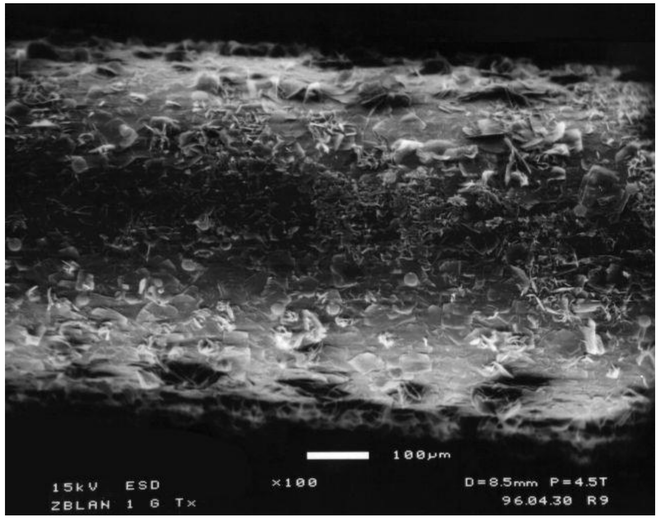
Imagine if 3D bio-printing could be done on a large scale – if we could print organs to meet the demand for transplants everywhere.

Imagine if we could do away with waiting for delivery and simply print a product on demand. All you would need is the right combination of feed material, and you could have a new phone cover, or water bottle, or even a piece of custom-made furniture in a few hours!

OFF-EARTH MANUFACTURING

The future could see a widespread use of products that were manufactured in space. Space manufacturing is the production of manufactured goods in an environment outside a planetary atmosphere. Typically this includes conditions of microgravity and hard vacuum which lend themselves well to the production of certain products that would normally suffer from a loss of quality because of gravity. Some notable applications include:

- Creating materials for miniaturized devices and computers where even defects at the atomic- and molecular-level matter. Building in microgravity can reduce those defects and thus lead to better performing products.
- The development of homogenous alloys and metallic glasses that would normally be difficult or even impossible to make on Earth due to convection that sinks heavier material down through a solution



ZBLAN (A special type of fibre optic cable) fibers processed on the ground have a tree-bark-like structure on the outside which results in signal losses, whereas ZBLAN made in space doesn't show crystallization.
(Image credit: NASA)

ADDITIVE MANUFACTURING OF METALS – THE FUTURE OF MANUFACTURING

I believe that the future of manufacturing lies in the additive manufacturing of metals. Processes such as direct laser metal sintering (DSLM, shown on the right) will greatly improve the ability of manufacturers to form metals. Building parts layer by layer will give manufacturers the ability to make parts that are more complex than parts that are made by casting or machining. The parts will also be of higher quality. Additionally, methods like DSLM have the flexibility of technologies such as 3D printing and CNC machining, since only the G-code needs to be changed to edit a part. The main issues with this technology currently are the cost and the time associated with making a part. However, as technologies improve and become cheaper, I believe that additive manufacturing methods such as DSLM will totally reshape how parts are made in industry.

Source: https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwivg6fmzO_lAhUCOn0KHX6BCkUQjRx6BAgBEAQ&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DyiUUZxp7bLQ&psig=AOvVaw0tXwluPUNgcydEDtOxXH4p&ust=1574023520286776

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think think that developments in manufacturing will be focused on two over-arching goals: (1) replacing human workers that perform intricate and currently hard-to-automate) tasks, and (2) increasing production efficiency in terms of material consumed.

1. I believe that a lot the novel work done by manufacturing engineers will be making breakthroughs in applying new technology to automate tasks that were previously believed to be un-automatable. For example, as computers have grown more powerful and machine vision systems have become cheaper, humans performing QC and detailed visual tasks can be replaced.

2. I believe that given the increased focus on efficient manufacturing, waste and emissions reduction, and overall environmental production, manufacturing engineers will be increasingly focused on finding ways to make existing processes more efficient and environmentally-friendly. Many processes are too embedded in the supply chain to be replaced completely, so the focus will be on mitigating impact.

Ten years ago, machine vision systems cost $40,000 to $60,000, while today they run in the $5,000 to $20,000 range. - George Fabel, Ph.D. (1997)

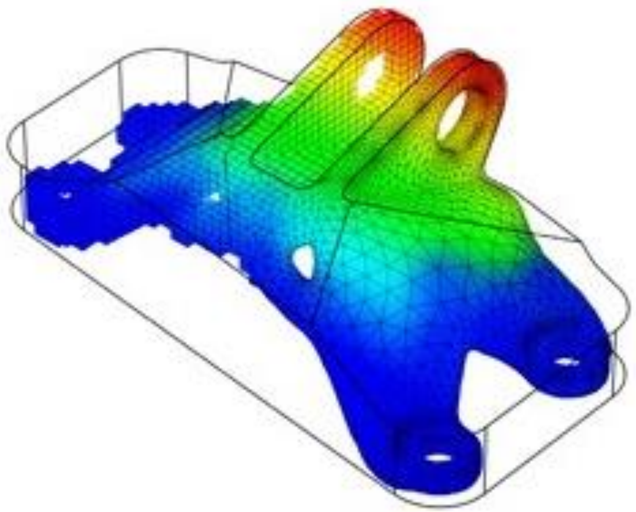
TODAY: <CAD$100 for camera AND built-in image processing on µController

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

There are many advancements in manufacturing over the last few years. One of these has been 3D printing. With costs of metal printing decreasing by the day, the possibilities of implementing this commercially become more and more enticing. Eventually, like any manufacturing process, the amount of material used will be reduced to the bare minimum, maximizing profits and minimizing environmental concerns.

One barrier to utilizing 3D printing is the user's knowledge. Knowing how to optimize geometry so that the absolute minimum amount of material is required is quite difficult. A recently developed design tool called topology optimization will solve this problem and allow 3D printing to fulfill its potential.

This software iteratively designs geometry while simultaneously conducting FEA to optimize the amount of material used.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think that is an exciting time to learn how to manufacture. With so many emerging technologies, the limitations to what you can build are decreasing and the possibilities are expanding.

I believe that the future of manufacturing will stem from additive manufacturing. With the flexibility and increasing availability of usable materials, additive manufacturing can be used for many applications.

Currently, additive manufacturing has a few of drawbacks when compared to other manufacturing processes. This includes that it is very slow if trying to do mass production, and that it is expensive.

If the manufacturing industry sees a future in additive manufacturing, then further developments can be made to make this process cheaper, faster, and easier for everybody to use.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think more and more manufacturing processes will become automated in the future. This is extremely exciting for a few reasons! Firstly, parts can be more precise due to automation, and secondly, the processes will likely be safer once automated. No many how many safety precautions taken, there will always be injuries when it comes to certain manufacturing processes. Automation also means that parts can be produced at a faster rate. There will no longer be the limitation of not having enough labor force to manufacture parts.

The amount of materials available, and socially acceptable for use is going to be a big limitation. Climate change is caused using a lot of non-renewable materials. There will likely have to be more research in the future regarding which types of materials are recyclable and renewable, and how to manufacture these types of materials. In addition, new processes will have to come through to reduce the amount of material used for a part as much as possible. All the research that still has to be done is very exciting.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

The future of manufacturing will be fully automated assembly lines with advanced capabilities such as being able to self-detect inefficiencies and automatically adjust input parameters to optimize manufacturing with no human intervention needed. Also, additive manufacturing and rapid prototyping methods will become accessible to everyone in their homes and people will be able to quickly manufacture any custom parts with any materials they need. Easy, quick, and accessible modeling software will also be developed to facilitate custom manufacturing in people's homes and will likely be a physical mold like clay that can be manipulated by people and then converted to a computer model with 3D scanning, so no difficult CAD modeling is needed.

FUTURE OF MANUFACTURING

I believe the future of manufacturing will be shaped by the accessibility of technology and knowledge. For example, as 3D printing became highly accessible to general public due to decreasing cost, people (at home) are becoming more and more involved in the “technological advancement” that only happened in “labs” in the past. In the next 10 years, I imagine that more and more people will be making their own personalized goods at home and improving upon mass-production goods to fit their need. From this, the quality and the rate of education will increase exponentially.

I remember seeing food, clothes, etc. being teleported to home by just calling a number on TV in sci-fi comics when I was young. Maybe, in the next few decades that may be possible with 3D printing. 3D printer that can print anything sitting in your home with companies sending codes instead of actual goods.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I believe that the future of manufacturing can be found in the additive manufacturing business. As resource management becomes more important with time, I believe that businesses will fall into one of two options to remedy this issue. One, adopt methods of manufacturing that minimizes or eliminates waste. Two, allow for higher levels of customization from the consumers, thereby reducing the need for some bulk production. In both cases, additive manufacturing presents a viable option for the future.

Furthermore, as businesses adopt these systems, they will also be able to advance them. Faster 3D printing systems can resolve issues with its viability in bulk production, while a more versatile system in terms of material choice can remove current limitations on the parts these systems can develop. Even now, we are beginning to see 3D printing systems make realistic but nonfunctioning human organs, food, and use a growing number of different materials. With time, these systems can prove to be a practical solution for the future.

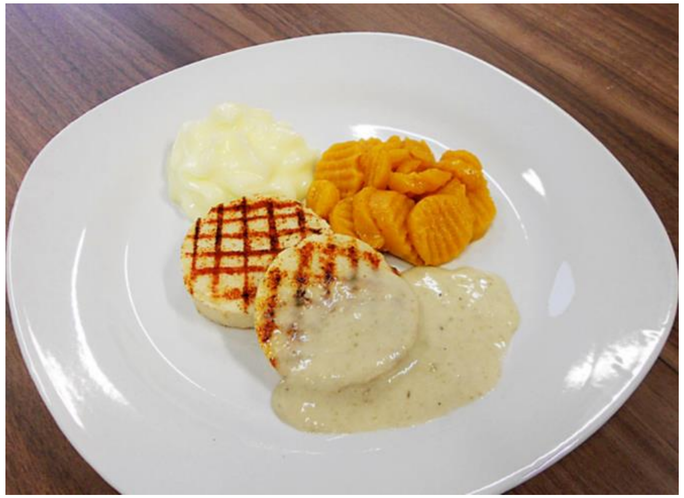


Image 1: 3D Printed Food

Source: https://3dprintingindustry.com/news/australian-rippa-future-3d-printing-food-99819/

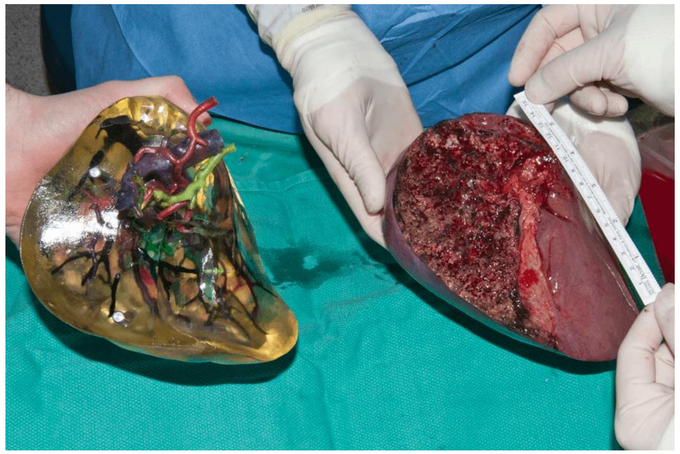


Image 2: 3D Printed Liver (left) next to a Real Liver

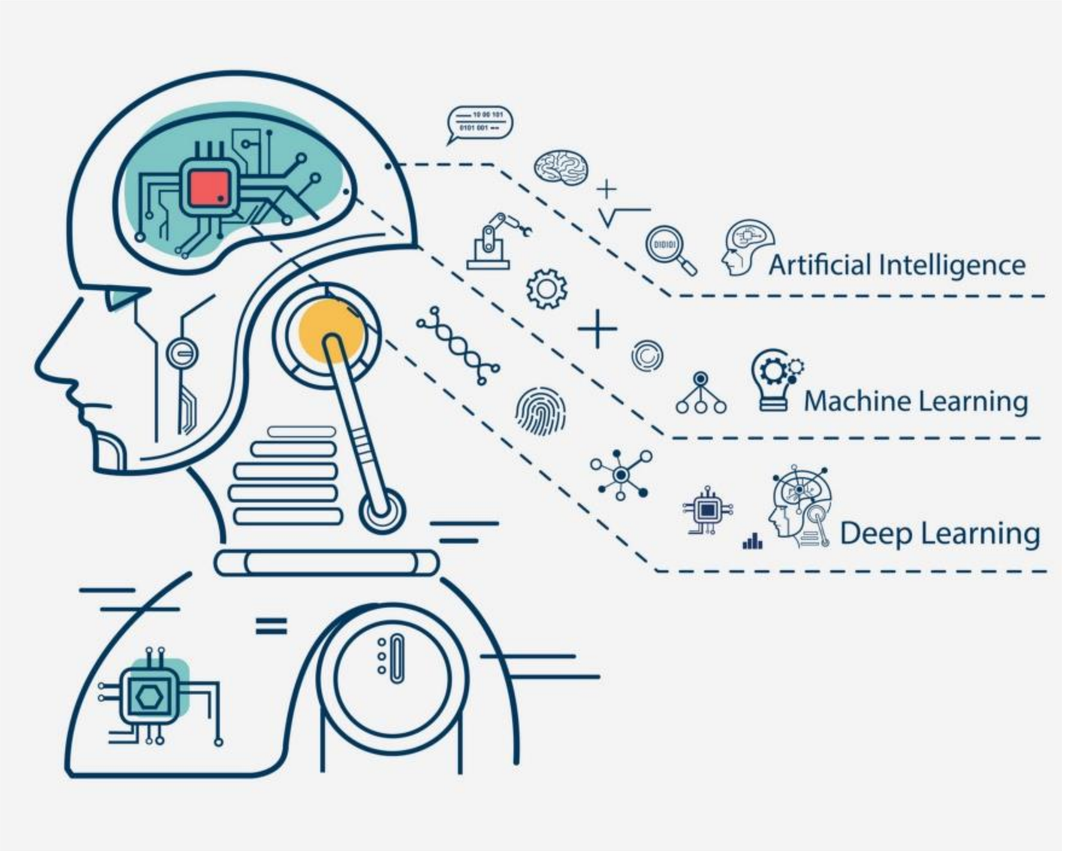
Source: https://www.the-scientist.com/news-opinion/how-3-d-printing-could-help-shape-surgery-66070

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think the future of manufacturing will use machine learning to predict mechanical failures and the remaining useful life of manufacturing systems or components.

I envision a mostly automated manufacturing environment where the robot has an internal clock that tells the engineer that a certain component is about to wear out based on its operating conditions. Even better, the robot is high functioning and learns to replace the component itself.

Using machine learning to predict when preventative measures are necessary reduce cost, increase productivity and product quality.



Source: https://www.istockphoto.com/de/en/vector/machine-learning-3-step-infographic-artificial-intelligence-machine-learning-and-gm962219860-262788671

FUTURE OF MANUFACTURING

The limited availability of resources will have a major impact on manufacturing. New materials will be developed focusing on disposal and reuse and process will be developed focusing minimizing the materials and inputs.

For example, the use of recycled wood or bamboo for construction projects shows the emphasis on environmentally friendly innovation regarding manufacturing and construction.

FUTURE OF MANUFACTURING

- I believe the future of manufacturing is sustainable manufacturing. In the present day, most of the large-scale manufacturing is done in factories that emit greenhouse gases and harmful substances that damage the ozone layer. In order to reduce emissions to the global target value, the future of manufacturing should focus on implementing sustainable manufacturing practices, especially in large manufacturing factories.
- One example of sustainable manufacturing may be using byproducts from one factory such as steam as an energy source in another factory. When a group of factories form a cycle that reuses the byproducts at each factory, the net waste may be minimized. When designing manufacturing plants or machines, features that allow for sustainable processes should always be taken into consideration.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think the future of manufacturing largely encompasses automated processes through the integration of artificial intelligence. Robots will be able to make decisions when problems arise, and human labor will eventually be phased out.

Source: Forbes

Additive manufacturing will become even more readily available at lower costs and with a wider variety of materials. I also think that a breakthrough software will be able to convert a description, a picture, or a sketch of an object into a 3D model for printing. This will allow custom products to be easily printed at home by anyone.

I foresee restrictions being put into place regarding the types of materials that can be used in production processes as well as new biodegradable and environmentally friendly materials being invented as a replacement for current, potentially harmful materials.

Source: Byflow

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

In my vision of the future of manufacturing processes, additive manufacturing techniques will be able to include organic materials. Presently, trees are being chopped down at a high rate, and growing food has become more difficult as the earth's atmosphere slowly becomes more and more saturated with carbon dioxide and greenhouse gases.

If there exists a machine that can grow plants, trees or food, at a high rate, many problems could be solved. The way this machine may work is by taking in organic material, such as food compost, or other organic waste, and converting it to a printing medium that can be used to manufacture plants or trees, in the same manner a 3D printer takes in filament to create complex objects.

I believe if a machine like this were to exist, world hunger can be reduced and less land would be needed for agriculture, as this machine would just print out food without the need to grow and cultivate it, and less resources would be required.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

- More “green” materials implemented, i.e. environmentally friendly materials used in manufacturing
- Some examples:
  - Recyclable plastics for 3D printing
  - Manufacturing process using **any** scrap material from household
- Manufacturing process that utilize renewable sources, e.g. bamboo, wood, soil, sand, …
  - E.g. thermoforming using bamboo sheets
  - Casting/injection molding using mud/soil/clay (like pottery but more automated and systematic)

FUTURE OF HOME 3D PRINTING

Existing technology: SLA (Stereolithography) printers, unlike FDM printers (Monoprice, used in project 2 in 1180) use resin that is cured via UV light instead of filament that cures via cooling.

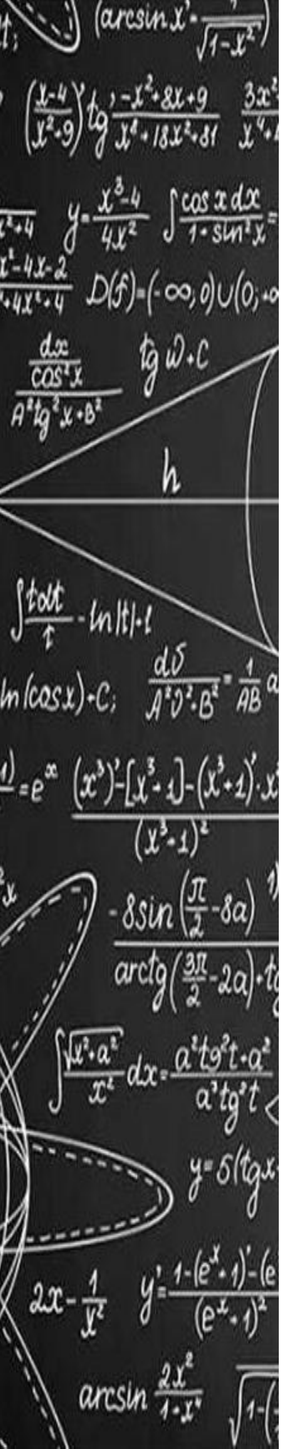
Current Issues: Existing FDM printers are much more convenient as they are more set-and-forget, instead of requiring:

- Care against exposure of resin bath to sunlight

- Handling of liquid resin as well as regular filtration procedures to prevent murky resin from blocking UV laser

- Separate washing station filled with isopropyl alcohol to remove leftover resin from parts

Promising aspects: Detail is no longer restrained by the physical nozzle size, instead being limited by the accuracy of the laser galvos. SLA is capable of extreme detail, severe overhangs and end-user-ready finishes. Potential fixes for current issues: Automated part cleaning and curing? Automatic dispensing of smaller amounts of resin to prevent amount of liquid that laser must travel through? Resin that only cures via specific wavelengths that sun and artificial indoor lighting would not trigger? Resin that is solid/jelly-like until heated for printing so easier to handle? Water-based resin that can evaporate without requiring washing?



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think that soon, manufacturing processes will become increasingly integrated with machine learning technology. This might make it easier to produce customized parts with traditionally low-flexibility processes. For example, if someone wants to make an injection molded part, a computer might be used to calculate the optimal mold shape, injection temperature/pressure, material selection, etc. to maximize quality and speed while minimizing cost. I believe factories will be able to produce more customized parts, faster.

Also, I foresee machine learning being used increasingly for quality control. Novel methods could be developed to reliably identify out-of-specification parts, and perhaps determine how these parts can be best salvaged/recycled. Computers might also suggest improvements to the process that help reduce the number of failed parts and waste material, thus contributing to sustainable manufacturing.

In conclusion, I think that people will be able to simply define what product they would like manufactured, and computers will automatically design the optimal manufacturing processes.

THE FUTURE OF MANUFACTURING INVOLVES CENTRALIZATION AND PERSONALIZATION

In the future, manufacturing will become more centralized around larger factories. Smaller factories will fail to succeed, since they cannot afford the machines that larger factories use. Almost all items available in stores will be produced by a few manufacturing conglomerates (around 5-10 companies in the world!).

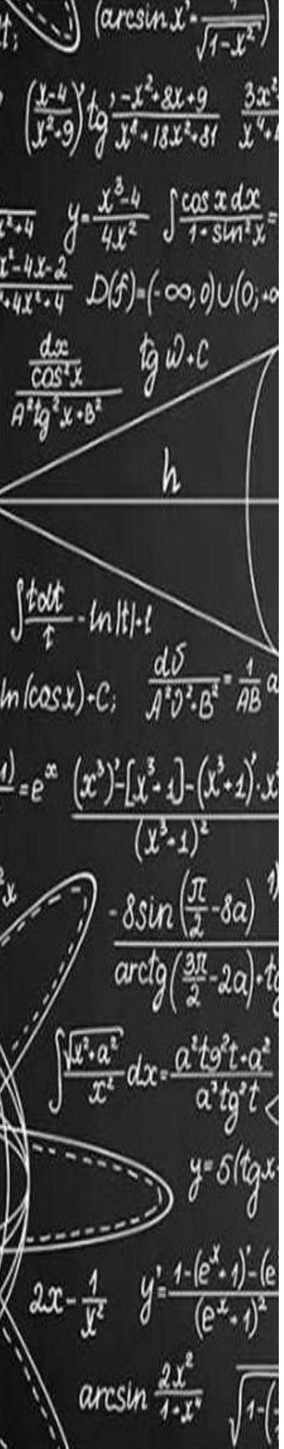
Alongside, 3D printing technology will advance to be able to 3D print any type of material. Thus, consumers will be able to personalize their items a lot more. Right now, if a consumer wants to buy a cabinet, then he or she will have a few choices of cabinets from a store like Ikea. In the future, consumers can go into Ikea, tell the employee exactly how they want their cabinet, and the personalized cabinet can be produced for a very low cost at a factory in less than a day.

I envision a new “dream” machine in which a worker can use AR to design a CAD model of any item very quickly. Then, the machine will “print” this item with a speed hundreds of times quicker than the faster current 3D printer.

Alongside, I don’t believe there will be limitation in materials since new chemical processes can produce artificial versions of raw materials like steel from other atoms. Alongside, machines for making things at home will become obsolete since production is much faster and can already be customized at large factories. Furthermore, various artwork will also be manufactured in these factories. Thus, sculpting and painting will become obsolete as well.

Source: www.stockx.com

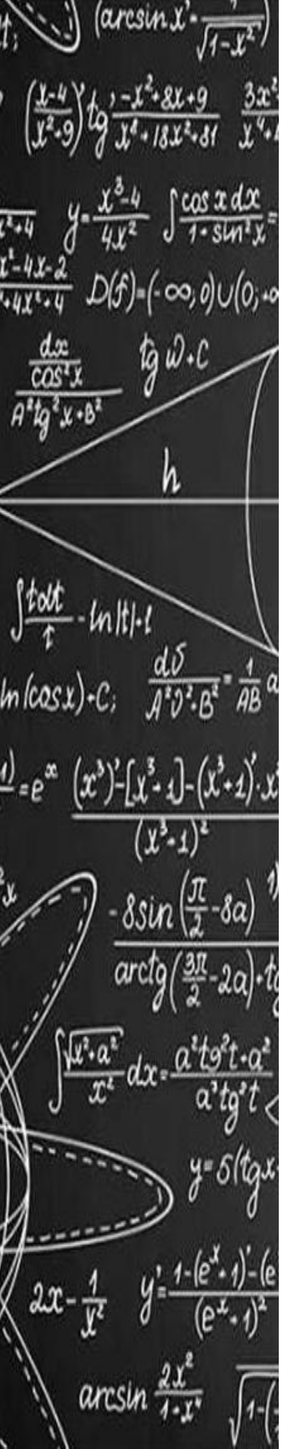
These are newly released Nike “Fear of God” shoes. Currently, designer shoes require at least a little human interaction (like stitching) to make. However, future manufacturing machines will automatically stitch shoes and workers can easily create designs using AR.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think that in the next 15 years, we may not see the widespread implementation of new manufacturing methods altogether, but we will see an added focus on optimization of current methods using modern data collection and processing techniques. This could involve the implementation of feedback systems within production lines where process input parameters for operations are adjusted on the fly by the measurements taken from previous outputs (i.e. machine learning). This type of system may also make it possible to input a target specification to the production line and have the machine itself dial in the input parameters required to meet the target specification.

I think that we will continue to see improvements in additive manufacturing processes in terms of quality, cycle time, and accessibility. I believe it will become nearly an all-in-one prototyping tool.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

The future of manufacturing is going to be highly integrated and the quality / repeatability of parts is going to increase. In addition:

- AI and virtual reality will be a common tool in the workplace (as CAD is now!)
- Processes will be fully automated and more efficient due to the use of Artificial Intelligence and Big Data Analysis
- Education of manufacturing can become more interactive, either through augmented reality or smaller scale manufacturing equipment
- I believe a critical component in the future of manufacturing is to start integrating recycled materials into processes
- Collaboration of robots, drones and humans in the workplace

3D PRINTERS FOR EVERYONE

- As technology improves, 3D printers are becoming cheaper and more reliable. Right now, you have to be dedicated to the hobby, and you have to tinker a bit use 3D printers, but in the near future, there will be affordable and reliable 3D printers out there so simple that even grandma can use them!

- Just like how most homes right now have a paper printer, more homes in the future would have their own 3D printer! They can be used to print replacement parts for appliances, car accessories, toys, etc.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

Heavy use of complex robotic tools (e.g. Robotic arms) that can manufacture complex parts that would currently be done by hand. These robots would also be capable of reading and sensing large amounts of haptic or optic feedback to better manufacture each specific product. Improvements in robotic motors and gearboxes will allow smaller and cheaper robotic arms to be produced.

Complex robotic machines are already developed for processes as complicated as composite material layups(e.g. Automated Fibre Placement, Figure 1).

New developments such as automated hand layup machines are well on their way(Figure 2)

Figure 1: AFP technology
Source: Automated Dynamics

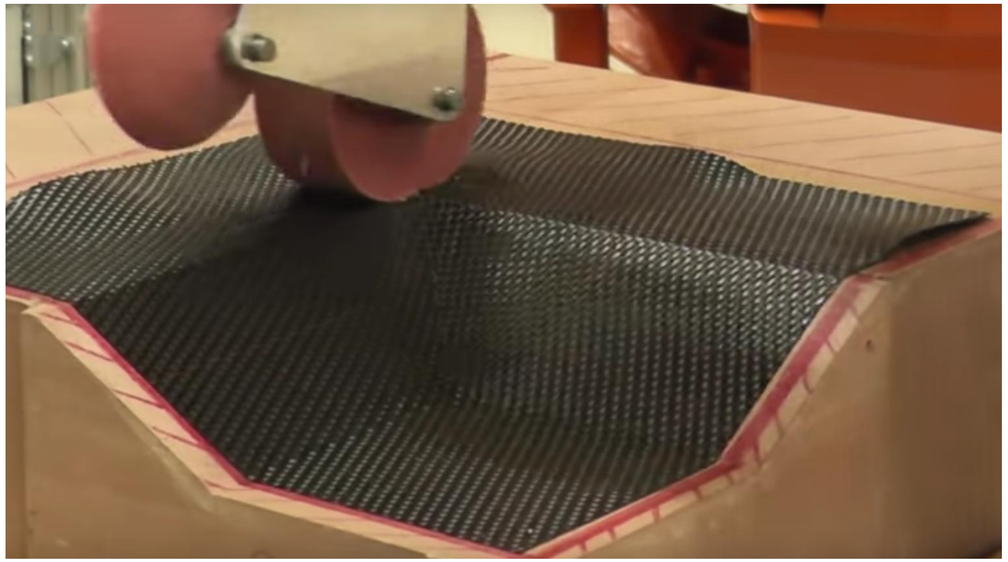


Figure 2: Automated prepreg layup technology.
Source: Bristol University, UK

COLOUR CONTROLLED
3D Printing

FUN

ENDLESS POSSIBILITIES

AT WORK

NEW MACHINE

AT HOME

NEW CAD TECHNOLOGIES

SMALL SCALE

LARGE SCALE

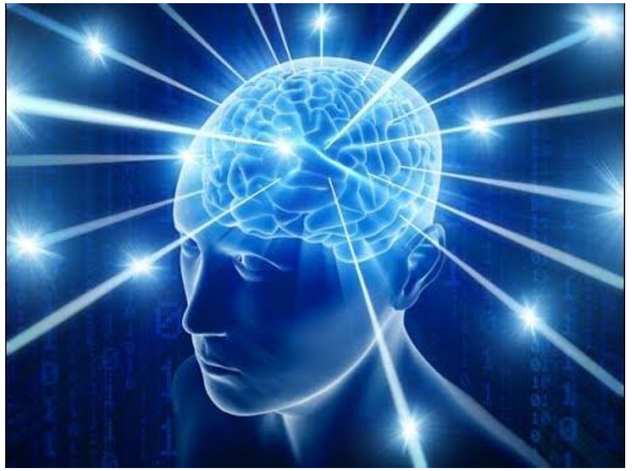
THE FUTURE OF MANUFACTURING

- The first topic that I would discuss would be using Graphene (single layer of carbon atoms) for high strength material in columns of buildings.
- The second thing I would imagine would be further improvements to 3D printing human tissue/organs to replace faulty/damaged/cancerous organs in humans.
- The final topic I would discuss is incorporating machine learning into manufacturing so that all computerized machine is essentially on autopilot. Currently there are some equipment that is fully automated but I believe the amount of automation will increase even further.

WHAT DO I THINK THE FUTURE OF MANUFACTURING WILL LOOK LIKE?

I think the future of manufacturing will be all about innovation to existing technologies. As manufacturing technologies become more accessible to larger markets, there will be more breakthroughs in the manufacturing field. An example of increasing accessibility are technologies such as metal or SLA 3-d printing becoming more affordable. As manufacturing gains more exposure, more engineers and inventors can tinker with existing technology.

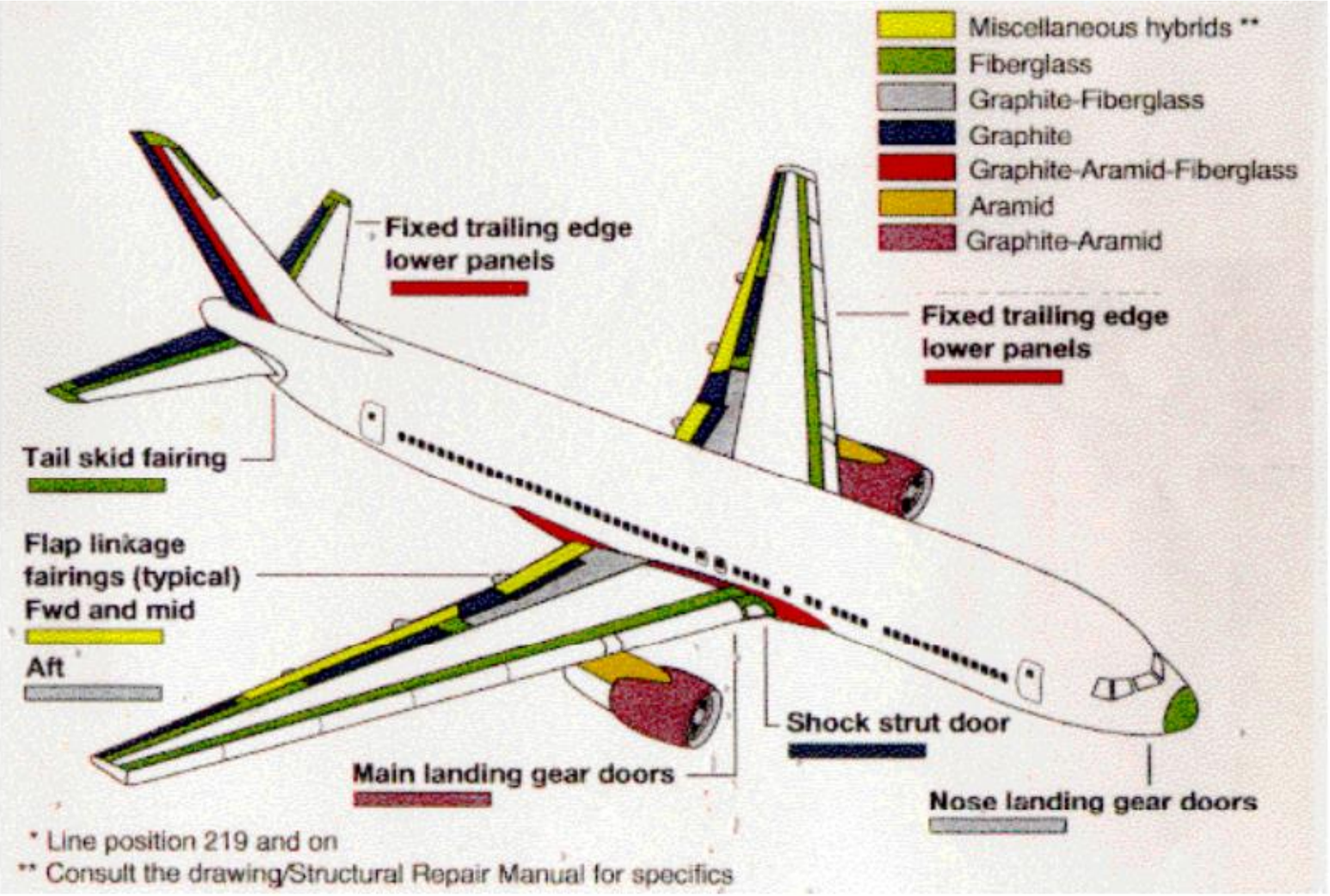
An innovation in consumer manufacturing technologies that I foresee would be a 3-d printer that doesn't take in a solid file to print, but instead uses simpler inputs. With the advancement in AI and machine learning, I believe it will be possible to have 3-d printers that use photos to create a 3-d model. This would make it extremely easy for an everyday person to grab an image of some object and immediately print out a carbon copy of it at home. The future of manufacturing is accessibility into a larger market, where manufacturing technology can then mix with different fields such as AI and machine learning. Another breakthrough could be accessible 3d clothing printers. Really, the sky is the limit if the technology can become more accessible, which I think is happening.

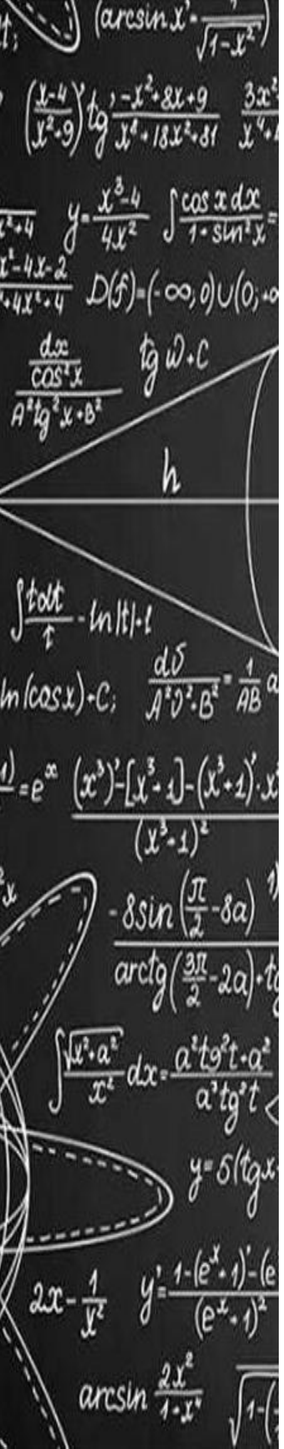


Galaxy Brain

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

- The future of manufacturing will involve composite materials. Composite materials have high strength to weight ratio
- There have previously been issues with machining composite in terms of cost and structural integrity, but with advance in techniques, composite such as CFRP will become the new conventional material
- The aerospace industry will benefit from incorporating composite materials due to their weight savings.





AI TECHNOLOGY, VR/AR TRAINING AND ENVIRONMENTAL-AWARENESS

I think the future of manufacturing is a largely automated one (more so than now), with AI technology taking over the roles of human workers in both production itself as well as the management of production, possibly using machine learning. Systems could be predictive and self-adjusting without need for human interference, including using IoT to communicate between different sectors.

Alternatively, perhaps humans' workers would not be replaced, but just experience a role change. Human jobs could shift to overseeing the operation and maintenance of such automated tools.

Maybe training for human workers could be improved with VR or AR technology, making tasks faster and easier to learn, and improving results.

I also think we will move to more biodegradable materials and sustainable manufacturing processes, due to the concern for the environment expressed by recent generations.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think that the future of manufacturing is one depending more and more on automation. Large manufacturers have consistently moved towards automation to build and assemble products to increase time, consistency and precision, and decrease human error and associated costs and problems with employing humans. As the robots used in manufacturing becoming “smarter” and the coupled technologies become more advanced the benefits of using robot with rise. For instance as vision capabilities are integrated with the robots, the need for precise programming of robot path and time out conditions diminishes the precision required in programing the robots, and the time and labor associated with loading parts into exact positions and orientations in order for the robots to handle. The many advantages I believe will continue to advance the use of robotics in manufacturing.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think with the invention of new manufacturing processes there will be less demand for skilled laborers to preform the work. By that I mean that instead of having to outsource, for a company to stay viable with high manufacturing costs in the western world, companies will begin making products closer to home. I envision a central manufacturing hub which is likely automated that will manufacture products for a specific city. So a factory which makes say iPhone located outside Vancouver which supplies iPhone to all the stores in the lower mainland. This will reduce shipping times, reduce greenhouse gases, reduce labor requirements, and reduce inventory.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

With the wider availability of technology and the increasingly ease of access to information; the term ‘manufacturer’ may not necessarily apply to a specialized business or company that will solely manufacture for products and consumer goods. Instead it may apply to people like you, the average individual. In the future the demands would sway to more personalized products; things that are tailored to you and therefore manufacturing will be more on an individual basis. As machines and manufacturing tools advanced and become cheaper they can be more affordable for individuals to own and use. With 3D printers already in schools, children at a young age will have the opportunity to learn how to use these tools and even manufacture their own products, so the ease of creating things will become easier and readily accessible to the average person. Maybe in the future we will have the ability to print our own food and organics, have a personalized robot arm that can assemble our own chairs and tables instead of us needing to deal with the headache of IKEA flat packs and have clothes selected online and sewn by our own automated sewing machines, ready by our wardrobe to be worn instantly.

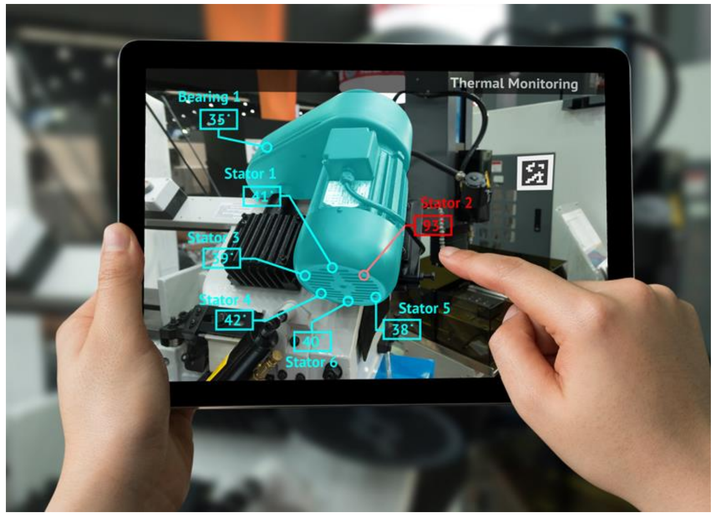
As with increasing personalization and access to manufacturing tools, the future will also see a large focus to sustainability in our own consumer goods and our carbon footprint. There will be a larger emphasis in the materials we use for production and its ability to be recycled or decomposed. Plastics and non biodegradable synthetic materials may no longer be the predominant or viable materials in our products and instead we may see the use of alternative materials that are readily available or are synthetically made but impose minimal impact to the environment.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

Augmented reality is a new technology with many potential use cases, manufacturing included. This technology is quite new, so there aren't many use cases yet, and companies are currently fighting to become the first to own this space. Some sample use cases for streamlining process are:

- Remove need to find faster/more flexible ways to manufacture prototypes, by placing CAD models directly into real space, instead of 3D printing or machining. Ex: Airbus using 3D models to check hydraulics brackets specifications instead of prototyping a physical piece.

- Give visual instruction to front line workers, more intuitive than written instructions. Reduce time needed for supervisor to train people. Tailor help to person based to personal data collected with headset. Manufacturing instructions can be updated easily through software. Ex: Microsoft Guides for front line workers.



Source: https://www.machinedesign.com/industrial-automation/augmented-reality-and-manufacturing

Source: https://regmedia.co.uk/2019/06/10/powerbi-guides.jpg?x=442&y=293&crop=1

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

3D printing will become more common and powerful soon. It will be used extensively in biomedical engineering, making human liver, bone tissue, organs, and possibly even food. 3D printers will likely become a form of factory automation, as well as a ubiquitous household item.

Another possibility for 3D printing is it could be scaled to construction size. 3D printers could fabricate houses in a few days by laying concrete, which would then need to be finished by human workers. From experiments that have been done, the concrete walls from 3D printers are substantially stronger than traditional houses and are built much faster.

In my opinion it is only a matter of time before much of manufacturing is replaced by 3D printing. I also think that in our lifetime 3D printers will become very cheap and will be able to print using almost any material.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

- Additive manufacturing has been growing exponentially in recent years and is taking an exciting path. A great advantage of it is that it allows personalization and customization.

- In the future, everything will be about customization. I dream of a world where everyone can have its own personalized car. There will be no need to buy a specific model. One will go to the car agency, and with the aid of a professional designer, one will build its own car from zero. Then, in a week, the car will be delivered to you with all the specifications you made. The streets will be filled with cars, but no car would look the same as another.

- About the materials, waste will be dramatically minimized. Most of the materials will be easily recycled without contamination. The future will be bright and clean.

FUTURE OF MANUFACTURING?

I believe that current manufacturing processes will survive and continue to be optimized, however, I think there will be a decentralization of the manufacturing process (aided by advancements made in additive manufacturing). I believe several small-scale manufacturing hubs will pop up and people will go to these hubs to purchase whatever they need. While these hubs will carry consumables that are cheaper to create offsite (like convenience stores), many of the items that they sell will be printed onsite and then sold to you.

Companies will focus on designing products and producing codes for them to be run by the machines to create parts. These codes that they will sell will self-destruct after one use, ensuring the world economies can still operate on principles that we use today.

ADDITIVE MANUFACTURING IN CONSTRUCTION: THE FUTURE OF MANUFACTURING?

I believe that the future of manufacturing will involve rapid, automated construction of residential and commercial structures. Currently, additive manufacturing is available for small scale applications (3D printing), it is only a matter of time before it evolves to a larger industrial scale. There are significant advantages such as decreased construction time, reduced cost, increased safety, and increased accuracy of production.

As large construction projects already use extensive 3D modelling software (Revit, AutoCAD, etc.) these blueprints could be transferred to G-Code files similar to those used in CNC machines.

This technology is emerging today and being used primarily to construct small, affordable homes out of concrete. A main challenge that this technology will need to overcome is being able to integrate multiple different construction materials (wood, steel, etc.) without significant changes to the system.

(Image sourced from https://www.3dnatives.com/en/3d-printing-construction-310120184/)

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think that automation will play in increasingly important role in manufacturing moving forward. Technologies such as additive manufacturing will continue to improve and a greater number of parts will be created in this way. This will allow designs, which may not be simple enough to create using more traditional methods to be easily manufactured. Additionally, with increased automation, manufacturing will be more accessible to the public. Parts could be manufactured locally rather than shipped around the world with the increased flexibility of automated techniques.

There could be challenges moving into the future as well. This increased accessibility from automation may put greater strain on resources. Additionally, there is the potential for poorly designed products if parts can be so easily manufactured by anyone.

SMALL SCALE AUTOMATED 3D PRINTERS AND DESKTOP CNCS

With the way technology is developing and the readily available tools at people's disposal, I think we will start to see a lot more small scale manufacturing and development in house. People will turn to manufacturing parts and products themselves instead of out souring jobs to bigger factories/shops like they have in the past.

Two examples of this are small scale CNCs and new 3D printers that can be turned into assembly lines with automated part beds.

There is a company at Entrepreneurship @ UBC doing this exact thing. They develop technology that can help individuals with high production 3d printing. This tech reduces their printing cost without taking up a ton of space.

Additionally desktop CNCs have been very beneficial to me and I haven't had to outsource various projects such as molds to CNC shops. In doing so I've been able to decrease my lead times and lower production costs. With this desktop technology becoming more affordable and hitting higher tolerances, I believe we will start to see a lot more of this.

https://3dque.com/qpod

FUTURE OF MANUFACTURING: ZERO WASTE AND UNSKILLED LABOUR

ZERO WASTE:

In the future of manufacturing I believe that machined components will be made almost exclusively through metal 3D printing. As printing technology gets more rapid and precise, companies will turn to this technology for both prototyping and full scale manufacturing. Additive manufacture has the added benefit of producing close to zero waste when compared to material removal processes, allowing manufacturers to use more expensive materials such as titanium, like the upright shown in the picture on the right.

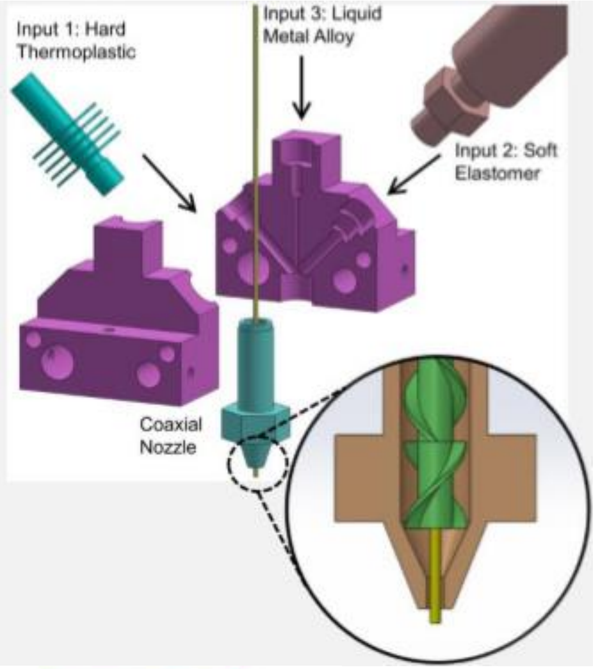
UNSKILLED LABOUR:

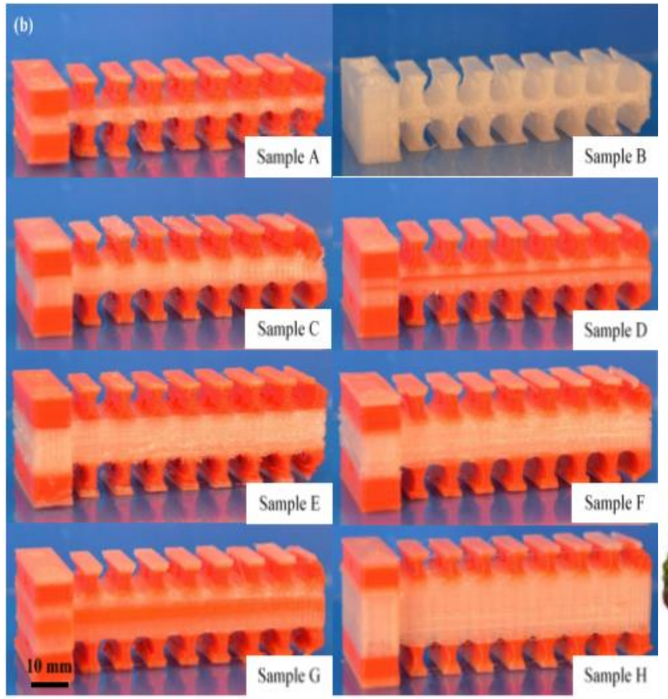
Large scale manufacturing will be done by unskilled workers who can be trained rapidly to complete specific processes using augmented reality technology. Augmented reality will also allow companies to update their processes and procedures without requiring major re-training of their work force.

Source: http://www.speedhunters.com/2017/11/the-future-of-car-modification/

SOFT ROBOTICS MANUFACTURING

- Experimental Research into additive manufacturing
- 3D printing composites
  - PLA-ABS
  - Thermoplastic-Elastomers
  - Flexible Metals
- Can be used to create “soft” robots that have more flexibility than rigid robots
  - Printing Tendon driven robots





(Dan Samento, University of Alberta, 2019)

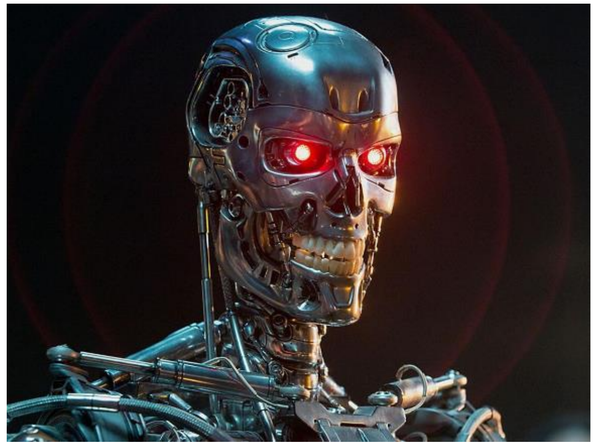
WHAT IS THE FUTURE OF MANUFACTURING?

I hope that the future of manufacturing includes less material and resource waste. Machines can be more efficient so that less material is wasted to achieve the desired design. For example, with milling, turning, and CNC machines, better optimizing their paths so that they cut down on wasted material, and perform functions in less steps. With forging and casting, maybe they could find a way to take access raw materials from each step and re-insert them back into the process.

Maybe the future of machining could include the equivalent of laprascopic and robotic surgery where the surgeon is operating using forms of virtual reality to perform a surgery, but with machining, improving safety and allowing for more opportunities in having machines that operated based on a user's design formed in virtual reality.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think the future of manufacturing will largely be automation. With advancements in AI, even jobs like physical quality control will be taken over by robots. If human presence is required, I robots being controlled through virtual reality to allow the worker to ‘work’ in dangerous locations and/or work from the comfort of their home. Metal 3d printers will eventually become mainstream and desktop size just like plastic one are now. As items such as 3D scanners and CNCs become more affordable to the average person, there will be many legal battles regarding at home manufacturing of patented and trademarked designs.



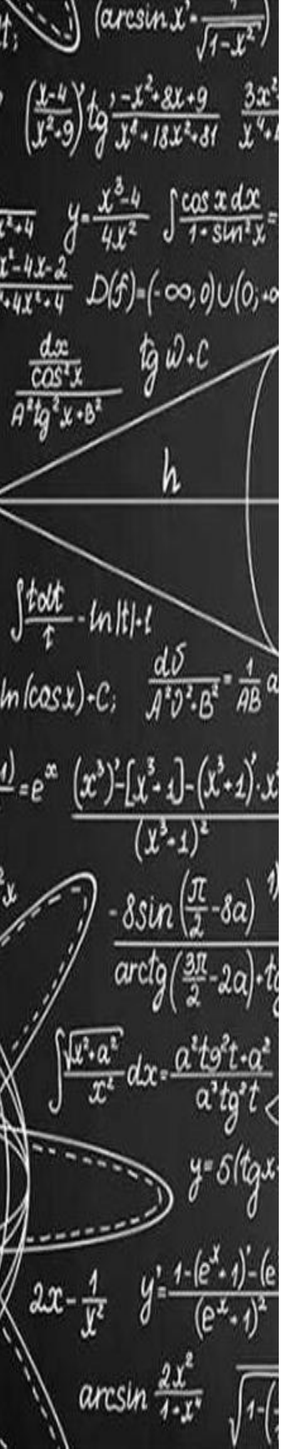
Source: from the movie “Terminator”

I don’t see the outsourcing of manufacturing to other countries stopping anytime soon due to most north American companies bottom line and the capitalistic society we live in.

Sooner or later we will live in a grey dystopia, slaves to the robot overlords we accidently created.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

- I think that there are many avenues for the future of manufacturing. I think that rapid prototyping and 3D printing will certainly be used even more extensively in the future. I also believe that rapid prototyping/ 3D printing will become more advanced, with more materials available, and higher speeds and resolutions available as well.
- Manufacturing will also benefit from new developments in the material space. Carbon nanotubes have been touted as a next-gen miracle material, and we are closer than ever to making them widely available.
- I also believe that manufacturing will be heavily influenced by climate change and sustainability. I think that new processes and materials will be more considerate of the environment, and contribute positively to climate change.

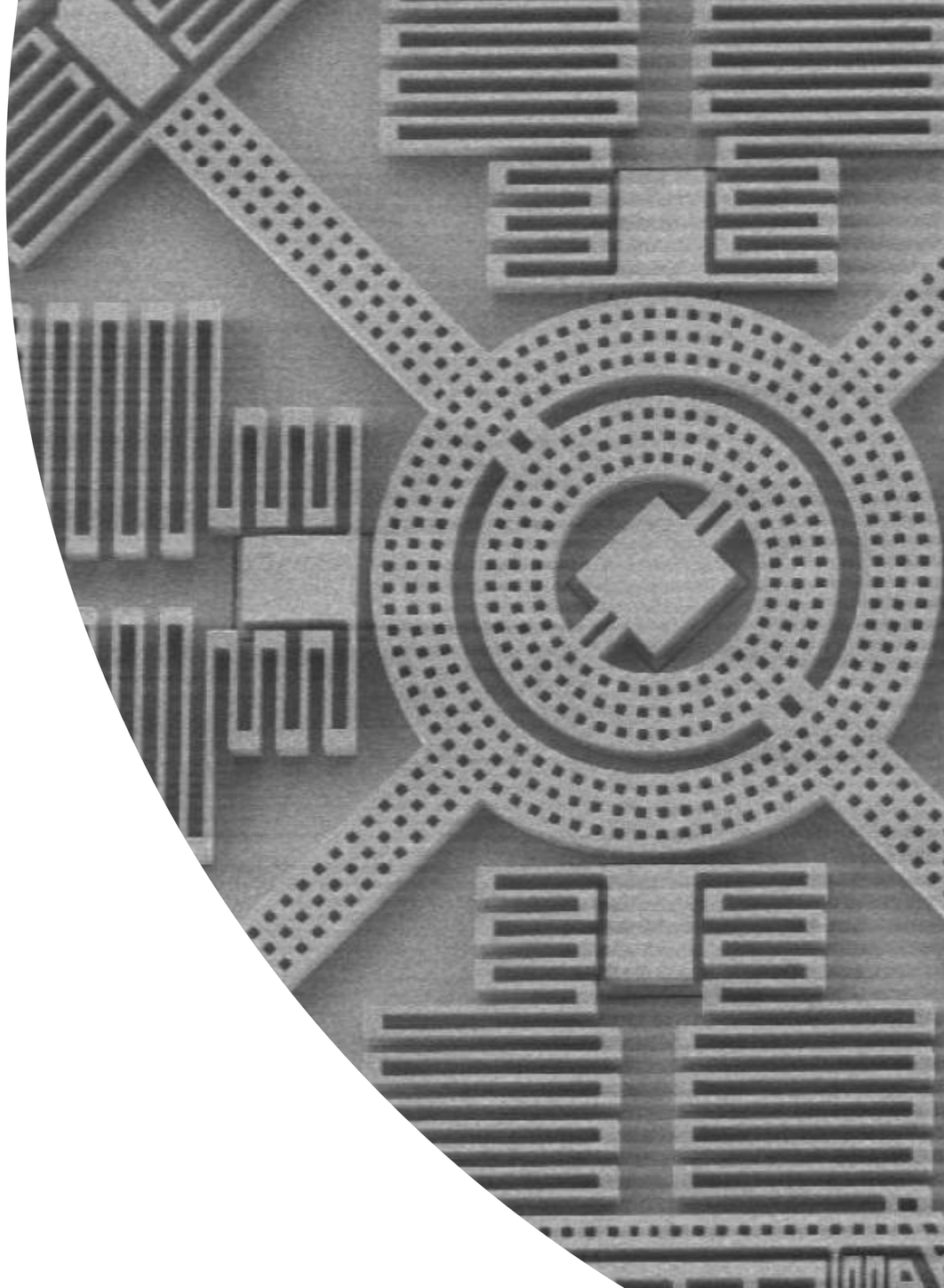


WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

MEMS (micro-electromechanical-systems) are becoming a greater and greater part of our lives. The technology of these devices and the capacity to machine them is improving constantly. Some of the most common applications of these devices are inkjet printers, automotive sensors, inertial measurement units, and optical switches.

Micromachining is the primary method for producing these devices. Bulk micromachining, surface micromachining, and thermal oxidation are used. Additionally, flexible/compliant machine technology is improving, which offers substantial benefits and unlocks opportunities for more mechanisms to be made.

One of the most exciting developments is the arrival of 5G networks. Radio-frequency (RF MEMS) enables improvements in infrastructure and creates new markets for BAW filters. Inertial sensors, one of the other uses for MEMS are being used more and more, especially in personal fitness devices and transportation. Devices like these enable automotive ESC and autonomous driving. In addition, MEMS are the sole successors to medical wearables sensors.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I believe the future of manufacturing will see the rise of the *"smart factory" through the* integration of collaborative robotics, internet of thing (IoT), and digital twins.

By integrating collaborative robots with the general work force, factory employees will increasingly automate mundane tasks freeing them up to focus on bigger, more difficult tasks/projects – This will increase productivity.

Source: "Internet of Business": https://internetofbusiness.com

Furthermore, through the advent of IoT on production floors, factories will become fully integrated. The exchange of data between various operations will allow for process optimization at a level never before seen in manufacturing.

Finally, the use of "digital twins" – a virtual model of a factory's machines, processes, and networks – will allow for the full simulation of factories. Problems will be simulated and predicted before they can occur and processes will be digitally optimized before being rolled out to the actual factory floor. The future of manufacturing will be driven by the advent of the smart factory.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

Atomic-scale manufacturing

(https://www.youtube.com/watch?time_continue=20&v=PdVjzTYTOS4&feature=emb_title)

I was interested in manufacturing at the atomic level when I first heard of a push in the bicycle industry to make frames out of graphene, which is a single sheet of atoms that creates high strength to density ratio. To able to manufacture this more readily new technology for rearranging atoms on an atomic scale is needed.

With the rise in prominence of 3D printing it may be possible to have 3D printers output a filament so fine that it outputs a single atomic layer at a time. This will allow the manufacturer to create microstructures that are able to exhibit anisotropic behaviours.

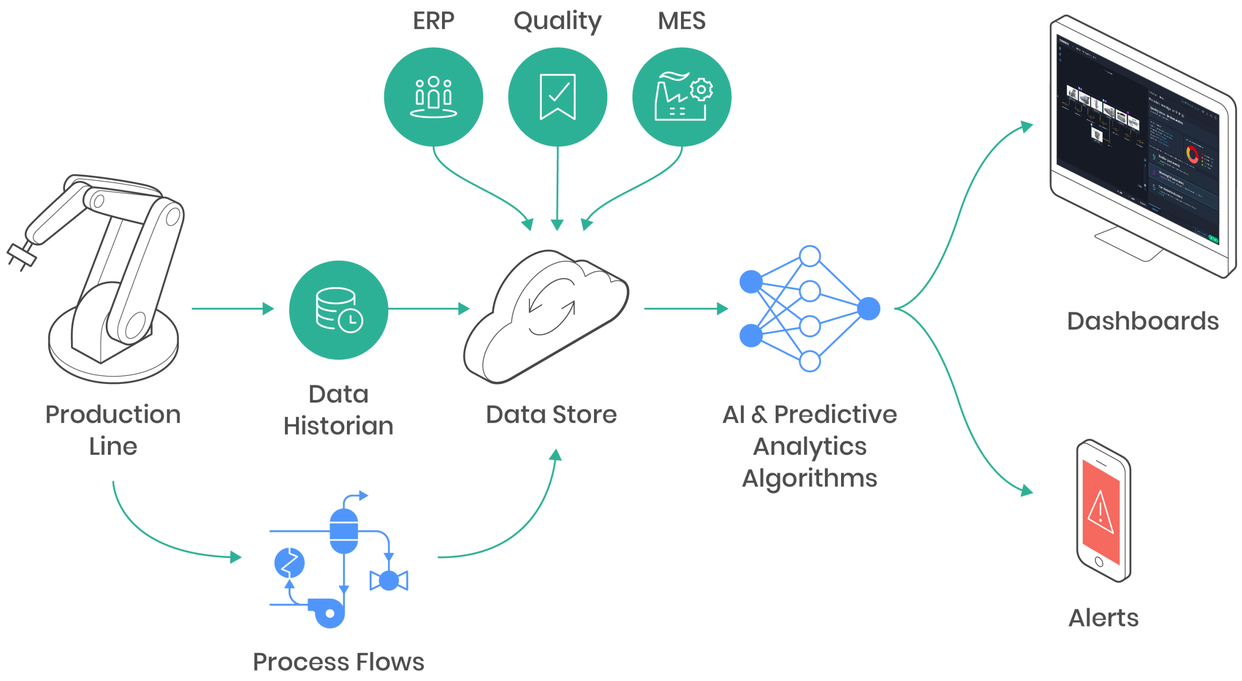
Secondly virtual reality is also a technology that is being well developed at this time. This could also assist in the manufacturing process by allowing the designer to better see the microstructures of the designs. Often designs are evaluated based on what is visible to the naked eye. However, many design features and properties are dependant on the microstructure and can only be evaluated with a closer look. By using magnifying imaging technology to create a view that engineers and designers alike can interact with will allow them to make better suited designs. I am imagining a virtual reality CAD program where the user can physically interact with the structure on a macroscopic and atomic scale.

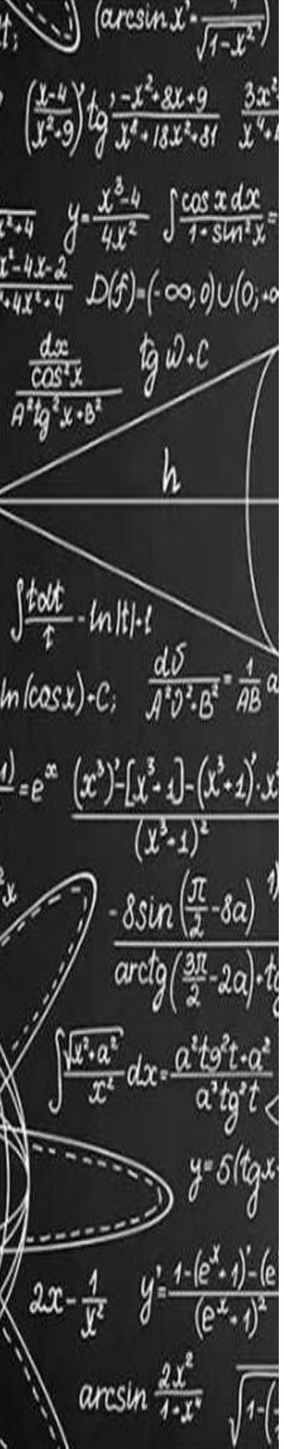
WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

The integration of AI into the manufacturing industry, taking the form of Software as a Service (SaaS) and Predictive Maintenance.

SaaS, being a pillar of cloud computing, will streamline machine learning and AI into industries and reduce heavy implementation costs and a steep learning curve. This will provide a ‘turnkey’ or ‘plug and play’ service for AI implementation via AI software juggernauts.

Predictive maintenance models will use data from the operational and mechanical aspects of the manufacturing process to maximize productivity, reduce costs and downtime, and create new design iterations using manufacturing history.





WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think that the advancements in metal 3D printing are very useful for special use cases, with low production amounts. For example, a student rocketry team in the Netherlands is producing a rocket engine nozzle by 3D printing titanium. This nozzle has cooling fins integrated and reduced the weight by 10%. This would be difficult to achieve with other manufacturing techniques.

The use of 3D printers also makes it useful in making more specialized industries. Industries where the low demand for certain products makes it difficult to make an expensive assembly line, but they still need the precision that comes from those expensive machines in the assembly line.

THE FUTURE OF MANUFACTURING

1. I think that the 3D Printing market will grow exponentially in coming years. Newer technologies will arise that will allow 3D Printing processes to be much faster. There is already research in 3D printing materials such as silicon, and I think in the future, technology will allow for any material to be 3D printed, making this manufacturing process the most convenient due to its versatility.

2. I think that the emergence of Artificial Intelligence (AI) technology will also play a large role in the future of manufacturing. Any manufacturing process with many complex processes has a chance of breakdown at any point, but the use of AI will be able to predict the interactions between each production unit and prevent delays to maximize efficiency.

THE FUTURE OF MANUFACTURING

The main area of advancement in the future of manufacturing, in my opinion, is implementation of artificial intelligence into already existing forms of manufacturing. For instance, having a CNC machine program itself so that a given final part can be made without setting any tool paths or defining details in the design.

Combining artificial intelligence with 3D printing can create significant advancements, but also a high risk. Imagine a robot capable of printing any object it pleases. With 3D printers now working in a variety of different materials, this would give the robot unlimited capabilities.

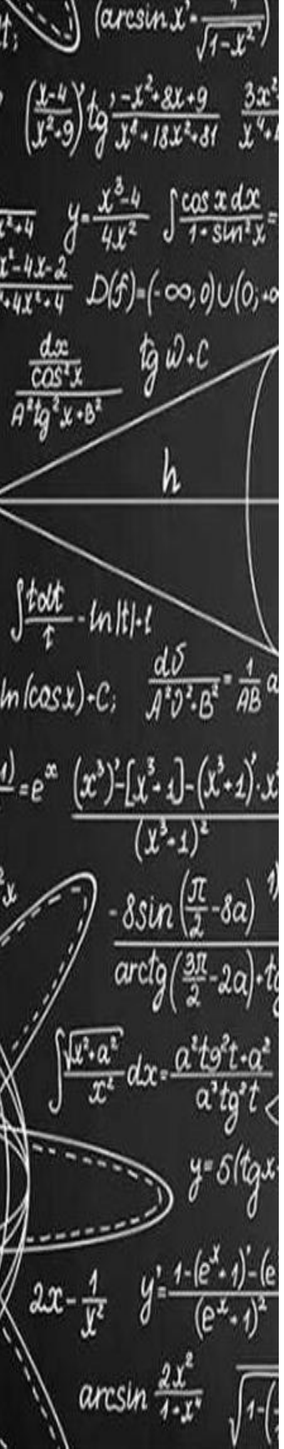
With that in mind, 3D printing and AI in manufacturing can be implemented in many industries whether it be construction or technology. I believe the manufacturing industry is soon to take a huge leap, making it one of the most interesting fields to work in.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

The manufacturing of raw materials into basic parts(e.g. fasteners, gears, metal bar) might be remained almost the same. However, I believe in the future all assembly lines in industry will be automated. There will be basically no human operating in the factory while the accuracy and precision is almost perfect. Tesla's Model 3 has issues with production because their robots are not reliable and workers are not efficient at assembling car components by hand. With the development of AI and machine learning, industrial robots will become more and more reliable.

Another way to speed up manufacturing efficiency is the application of 3D printing to all kinds of materials and sizes. This will also be an automated process and might be more time and cost efficient at building complex feature parts than traditional methods, such as casting and molding.

Source: Bloomberg.com Tesla Model 3 in Fremont Factory



FUTURE OF MANUFACTURING?

The capabilities of manufacturing will definitely continue to expand. The emphasis will most likely be placed on flexibility, because not only is it very hard to compete in cost or rate with traditional manufacturing methods, but we are also at a point in society where labour is more costly than most material or processes. Cutting out the middleman in manufacturing becomes more and more of a priority as modelling capabilities and amount of small gadgets increase. The rise of 3-D printing only did occur after it became more economical to print small parts than to machine them.

The future holds not only faster and bigger 3-D printers, but possibly 3-D printers that can simultaneously print metal and polymers, home CNC machines that can fit on desktops, and entire machining processes generated and controlled by AI. The job of manufacturing could be shifted to consumers. Entire industries (such as car manufacturing) would choose to not produce physical products, but rather designs that consumers could pay for and customize. Then the consumers will order the raw materials needed and print the car in their garage. Such an arrangement would be more economical and accessible to both manufacturers and consumers. Ultimately, the future of manufacturing, like any other industry, is reliant on providing value to where there’s a need, with the need here being a simplified manufacturing process.

A device that can combine the advantages of a 3D printer: low cost, autonomy, and zero waste with a more applicable material, that has high strength and low weight, such as composites. The device would be scalable, and be able to manufacture large components, such as car doors or an entire car chassis.

BIG DATA IN MANUFACTURING

- Big Data: Collection and analysis of data sets too large for traditional storage and processing methods
- Fast computing/Neural networks offer ability to combine isolated data sets & look for connections

Relation to Manufacturing: Optimization and Prediction

- Average cost of downtime in automotive factory is $22,000 per minute (15% of a Jeff Bezos)
  - Can predict failures based on statistical models only: Capgemini predicts recurrent chassis failure in welding robots 1 to 2 days prior

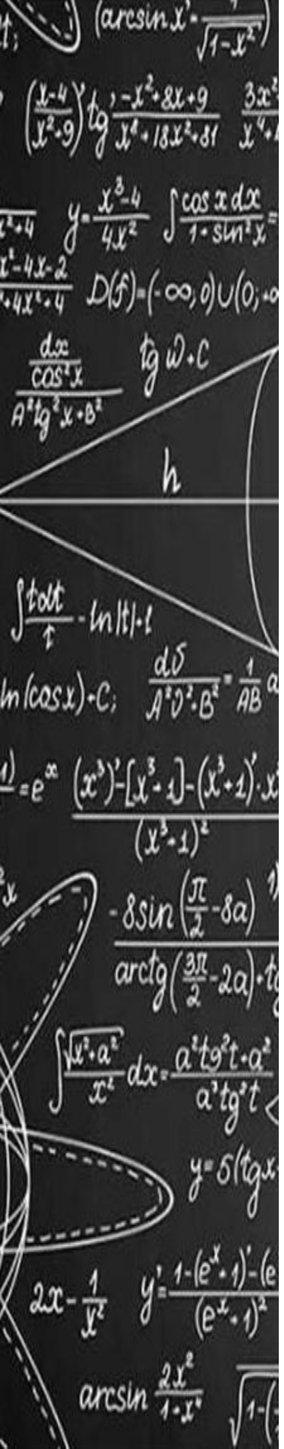
- Speed of production
  - Intel uses big data to increase reliability of fewer quality control checks

https://news.thomasnet.com/companystory/downtime-costs-auto-industry-22k-minute-survey-481017

https://www.mckinsey.com/business-functions/operations/our-insights/how-big-data-can-improve-manufacturing

https://www.capgemini.com/2018/11/big-data-potential-to-eradicate-challenges-in-the-manufacturing-industry/

https://www.intel.com/content/dam/www/public/us/en/documents/white-papers/increase-product-yield-and-quality-with-machine-learning-paper.pdf

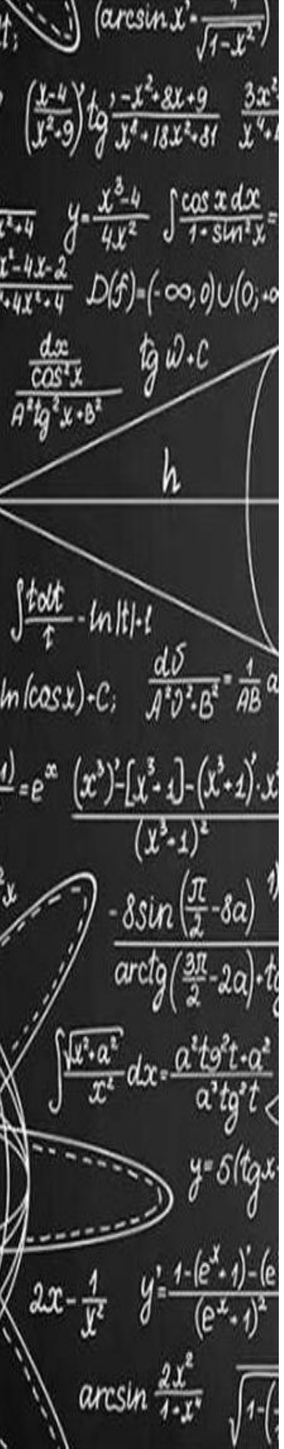


WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

While CNC machines have greatly lowered the barrier to producing parts with complex geometries out of all sorts of materials, it is still a largely manual process. There is still a lot of manual labor involved with manufacturing custom parts

As computer vision and related AI fields evolve, it should become possible to replace human verification of manufactured parts with AI systems that automatically verify part tolerances and structural integrity (check that layers have properly bonded in additive manufacturing, etc.).

Toolpath generation also still has lots of room to improve. Being an NP-hard problem, it is unlikely that an analytical solution to fully automatic toolpath generation will ever be found. However, AI can be taught heuristics that will allow it to take shortcuts towards generating shorter toolpaths with less human intervention.

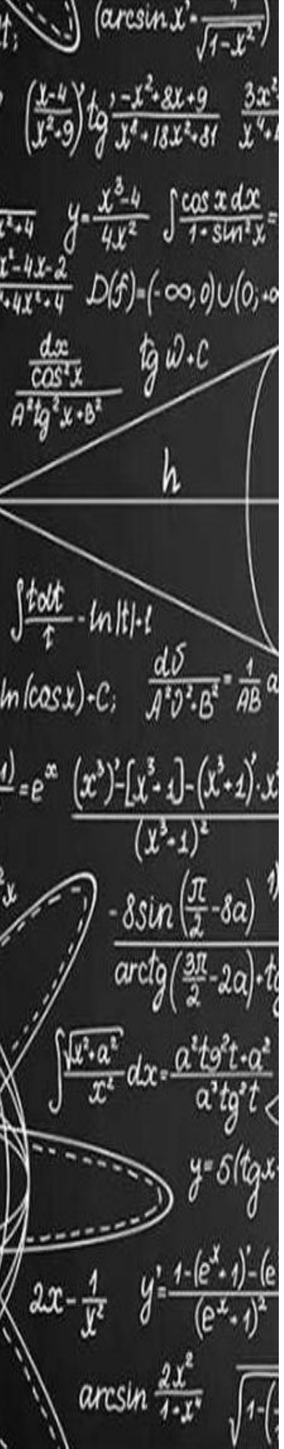


WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think that 3D printing holds a lot of potential, largely because it the eliminates huge amounts of material waste that occur in subtractive manufacturing methods.

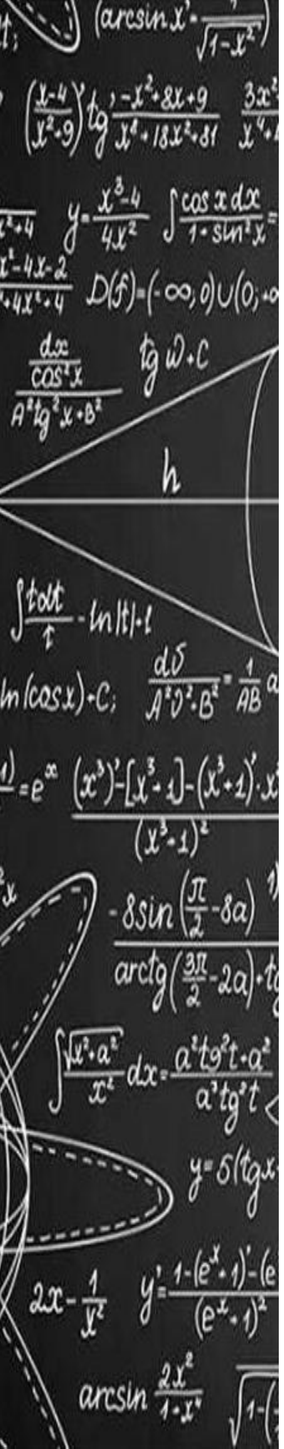
As 3D printing becomes more precise, and as a wider range of materials are made available to print, I anticipate seeing a lot more things being made using 3D printing, including things like ships or buildings.

I can also see more people investing in their own personal 3D printers, just like how most households nowadays have a regular printer.



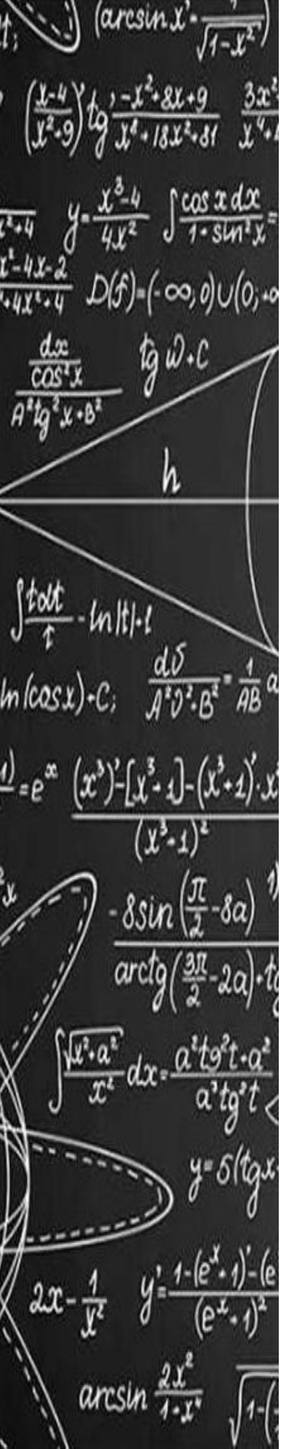
WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think in the future, manufacturing will be commonly used as a household term. With the increase in technology and advancements, manufacturing will evolve to be faster, cheaper, and more efficient. I see 3D printers in every home, where people utilize additive manufacturing to create their own belongings. I see 3D printers also more successful with manufacturing human tissue. I also see humans in Mars, discovering new ways to manufacture in the new environment!



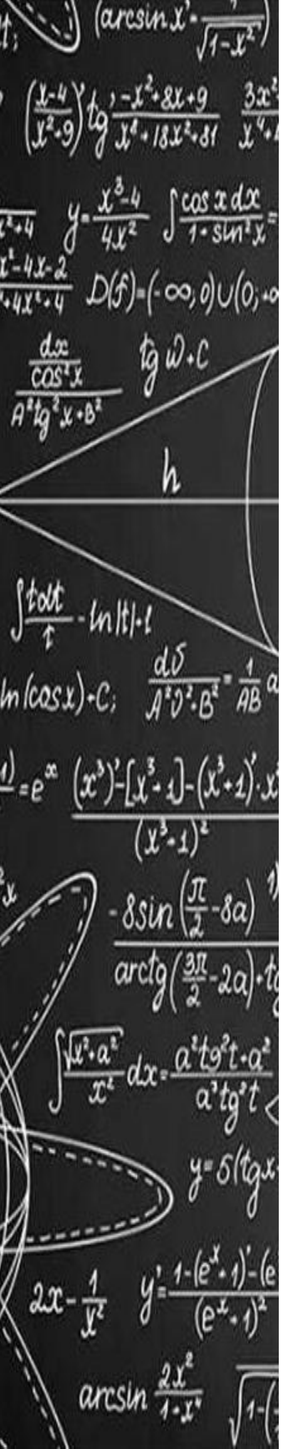
WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

With the new breakthrough in technologies specifically rapid prototyping such as 3d printers, I think manufacturing techniques will become economical and accessible for more people and not just companies. The idea of having various manufacturing tools in the backyard of your house is technically possible and designing your own components and installing them is far more satisfying than buying off the shelf (doesn’t match) stuff.



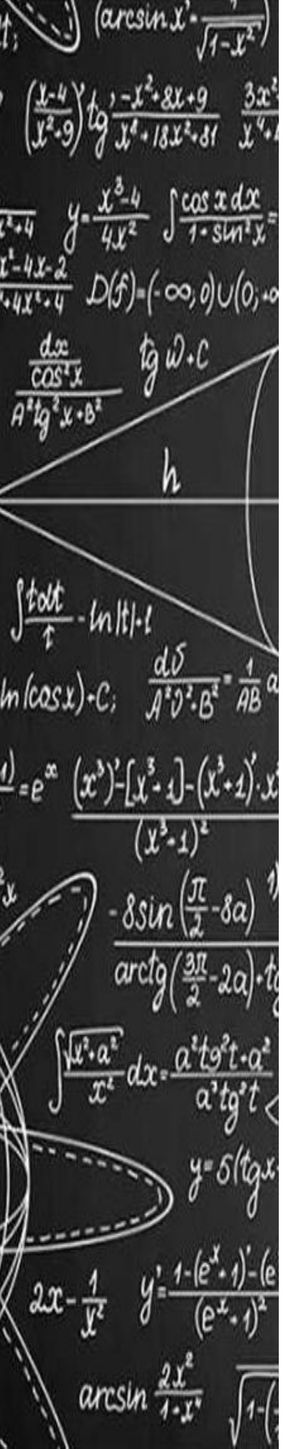
WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I envision the future of manufacturing to involve further small-scale personal 3D printers. Many tech enthusiasts today invest in at home 3D printing for personal use; I see this trend growing. I envision small scale printers capable of printing multiple materials such as using the same printer to print a part which involves both metal and plastic. This advancement would be allowed for individuals to print highly complex and a large variety of parts not currently available for production for the average person. I also see the modeling software for printing to become simpler to use for average users, with little prior knowledge required, using more advanced computing to fill in the gaps.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think the manufacturing in the future will be more dependent on automation instead of work force. There may be a sort of machines that are able to implement small manufacturing processes at home, such as 3D printing, small CNC machining, plastic molding and so on. These development in manufacturing will give people more flexibility and convenience. Even though the technologies related to manufacturing will be more advanced in future, less material and energy sources are able to be taken advantage of. Therefore, I believe that manufacturing in the future will be more dependent on clean energy and renewable resources.

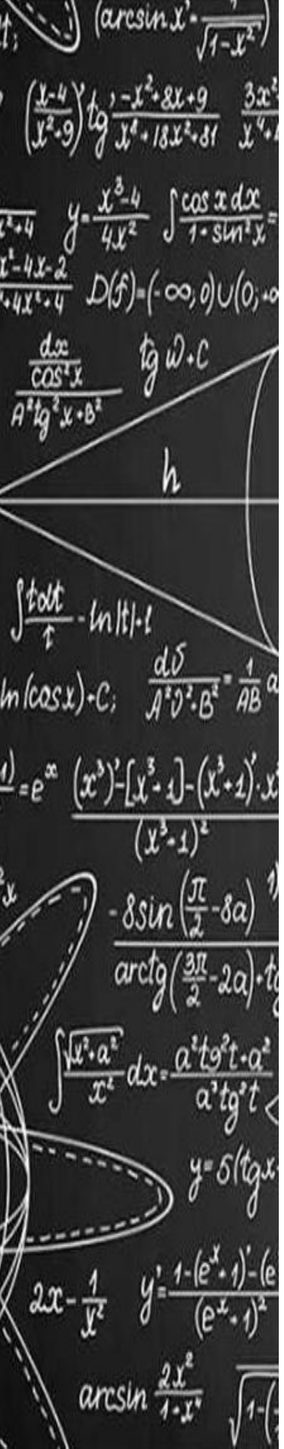


WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think this is an exciting time to work in manufacturing; possibilities are becoming unlimited, the 3D printing, desktop water-jet cutter, small CNC machines, availability of materials, and many other opportunities. **In a few sentences describe your version of the future of manufacturing.**

I believe the future of manufacturing will move toward automation. Robotic arms will gain more dexterity such that it can replace human jobs. These jobs include doing general assembly for a car manufacturing line to sewing 3D garments for clothes.

Vision based machine learning will have to improve to understand context of the situation and robotic arms will have to gain high torque to weight ratios to replace conventional motors that may not have as much precision and torque. This means there will be smaller factories producing a bigger variety of personalized objects instead of mass producing a specific product.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I believe that more and more materials will be available in terms of quantity and cost. People can make a lot of personalized products at home in a short period of time.

There will be machines that can modify or manufacture furniture easily, to make it suitable for the style and dimension. (Needs to be cheaper than IKEA somehow)

VR technology will be available to predict some manufacturing flaws. Workers will put on glasses and “walk” inside the machines to see if everything is position at the right place. They can also see how the product is being use in a longer period and modify the current design.

In terms of addictive manufacturing, I hope that there will be a 3D printer that makes a variety of food so I can eat whatever I want all the time.

WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

1) Closed-Loop, Adaptive (Smart), Automated Control Systems

There is continued investigation into integrated multi-component systems which use programmable goals for entirely automated process monitoring and optimization. There are three classes of sub-component systems within this integrated network.

The first class of systems take-in, detect, and/or communicate to one another various physical process variables for closed-loop optimization.

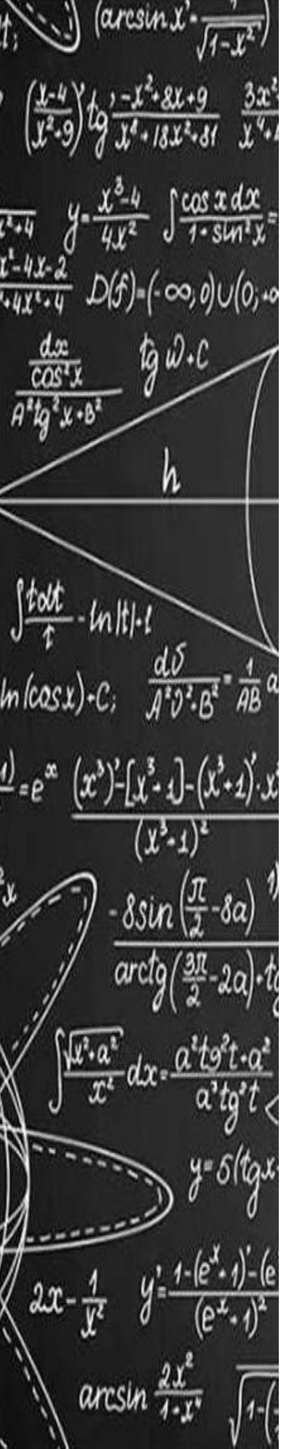
The second class of systems is concerned with invisible process variables (tool wear, equipment degradation, etc.), and how they effect the efficiency of the process. These systems determine how physical process variables should vary to off-set the evolution of such invisible parameters, and subsequently feeds the information back to the first class of system.

The last class of systems monitor operation failures and can be programmed to either automatically hault production or set off an alert to personnel in the case of failure.

2) Geometrically Complex & Customizable Mass Production

Additive manufacturing (AM) offers unlimited geometrical complexity of parts, making it an extremely attractive technology. An excellent example of mass production using AM is the recent partnering of Carbon3D (a DLP manufacturer) and Adidas to manufacture the midsole of Adidas' Futercraft 4D shoe. Adidas decided AM was the only feasible method through which they could achieve their desired complex shape. As AM technologies advance their cost continues to fall, making them more and more accessible for such applications.

The other valuable quality of AM is its unmatched process flexibility, offering the potential for customizable mass production. Some such examples already exist, where customers can design their own phone or laptop cases and a 3D printing company will fulfill the order.

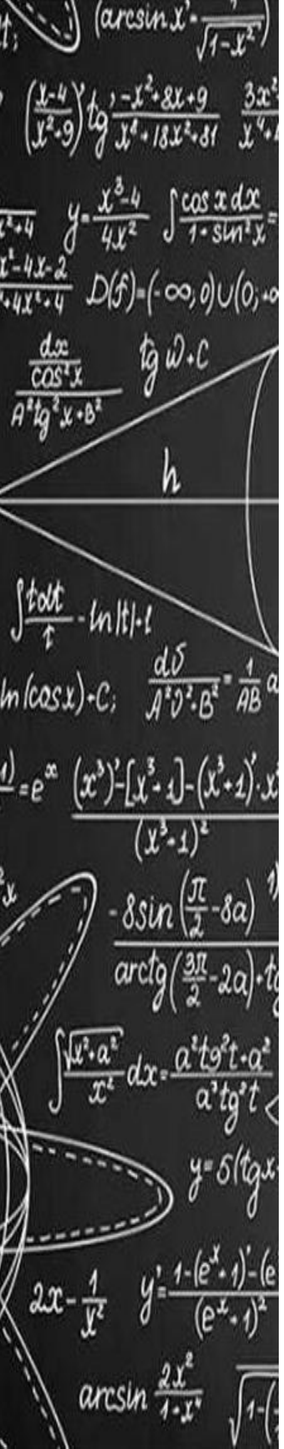


WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I believe in the future there will be 3D printers that will be able to build onto prebuilt structures with a variety of materials. These machines may also have lasers to heat material post addition to allow for a smoother material. They may also be able to mill away extra material.

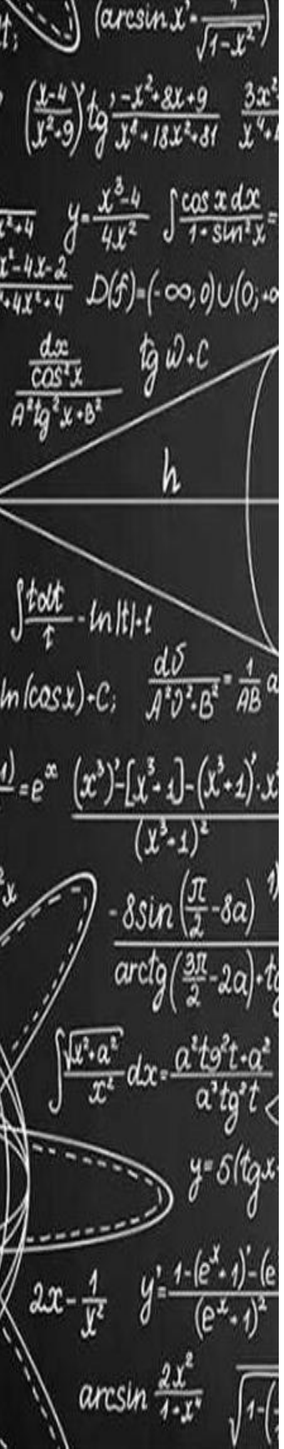
These machines may also be able to switch mill cutting bits out and repair the unattached cutting bits with the additive process and laser heat treatment, followed by cutting away with a different cutting bit to allow for a sharper edge.

I believe the future of manufacturing would consist a lot more of 3D printing processes. 3D printing technology may be able to process a larger variety of materials, adding to the current large range of 3D printing materials. Innovations such as 3D printing houses with cement are already showing up around. 3D printing may also be more commonly combined with other manufacturing processes. For example, it may be more common to 3D print molds in the future for injection moulding.



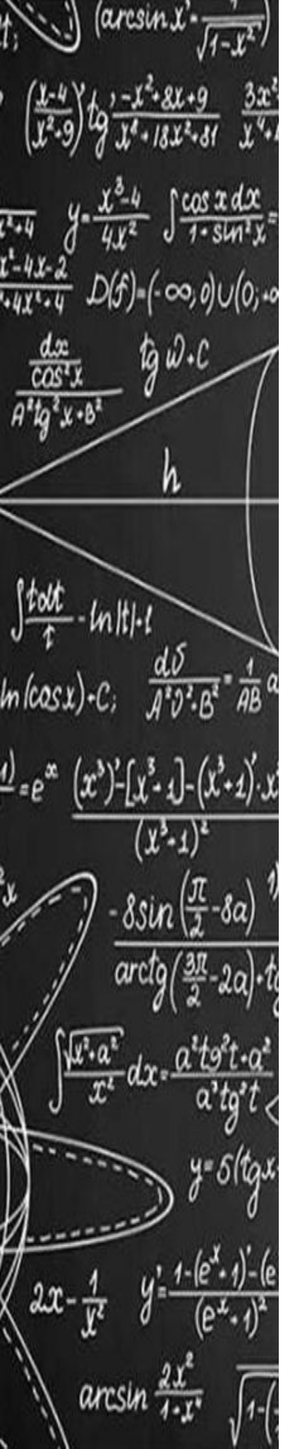
WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think the future of manufacturing is metal 3D printing allowing us to create more complicated shapes that are optimized for the application. Also 3D printing will become more and more affordable and user friendly that anyone can develop their own models and print anything they can think of in their own kitchen. In addition, I think that the current popular and high throughput manufacturing processes like injection molding and casting will not go away since they are so cheap and well understood. However, I think the materials we use in manufacturing will change due to the current views on climate change and environmental sustainability, as a result more emphasis will be put into developing “greener” materials.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

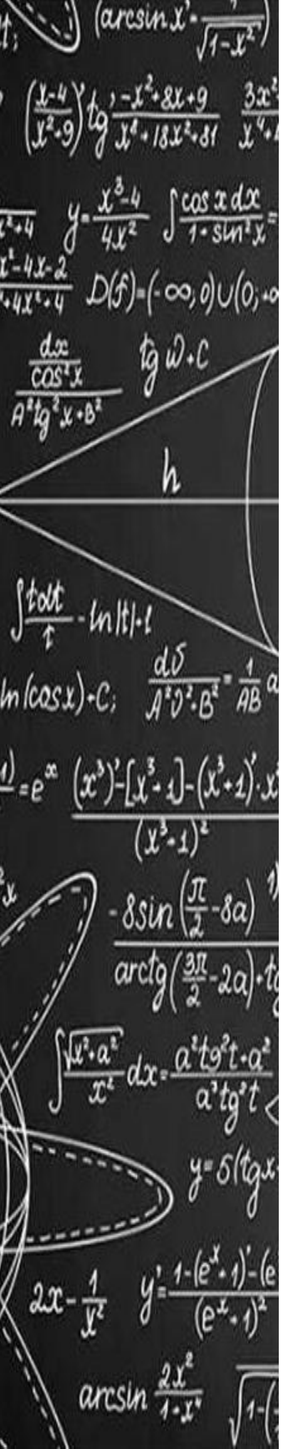
I think the future of manufacturing is smart additive processes. Manufacturing custom parts in various materials with machinery that can create/correct pathing based on the limitations of the equipment and detect errors in the build. I imagine this type of manufacturing would take parts from an assembly and detect the general use of the item and ensure that the build does not hinder the movement of the assembly in any way, responding with an error for correction if the intent is not met. Ideally, the manufacturing process would be continuous for the assembly, removing parts from the print area and continuing with any selected parts to be printed, so one could upload the assembly and the minor parts would be queued and completed in a given timeframe.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think recently there has been massive development in rapid-prototyping technologies (3D printing, waterjet cutting, etc.). I think engineering firms will acquire a lot more of this style of equipment to speed up their design processes, but there will still be a necessity for large scale manufacturing.

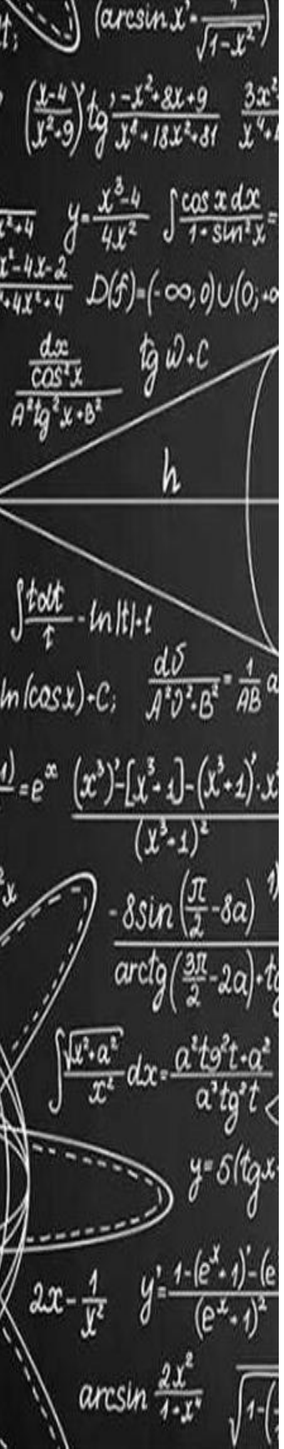
I believe automation will have a large role in the future of large-scale manufacturing. Right now there is quite a lot of automation involving moving components around during the manufacturing process, but I expect in the future advancements will be made so that more complex processes are automated as well, such as the product inspection phase.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think Manufacturing is not going away anytime soon. People need to have manufactured goods regardless of how technologically advanced we are in the future. The difference that I could imagine would be the more involvement of robots and Artificial Intelligence (AI) in manufacturing processes. For example, an automated machinery that can-do machine learning in order to improve efficiency during each iteration of a production line would certainly help companies in their manufacturing productivity. Other ways that manufacturing could change would be the ease of manufacturing. In the future, I am certain that manufacturing will be a lot easier, faster and more flexible.

In terms of the product that they will be manufacturing, I would see the shift towards a more technological aspect of manufacturing. There would be a lot smarter devices being produced than the everyday object simply to satisfy our needs and wants in the nearest future.

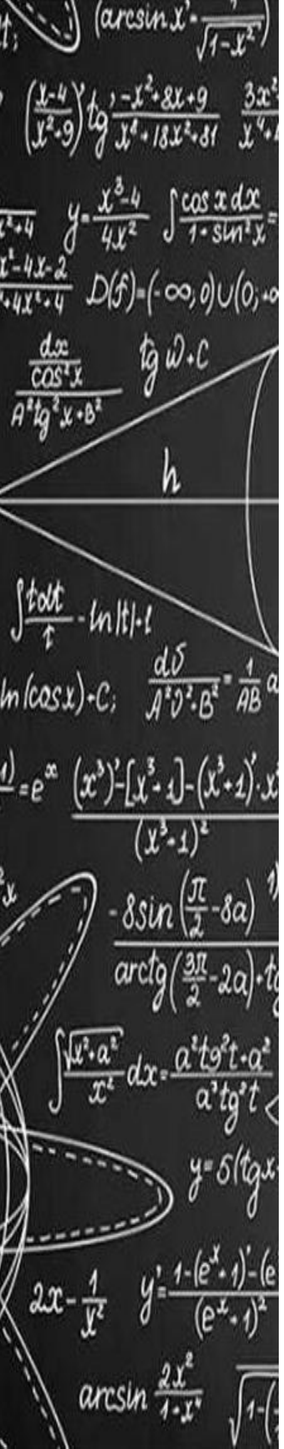


FUTURE OF MANUFACTURING

My version of the future of manufacturing is a combination of additive manufacturing and post-processing. For example, a technology that can 3D print a part and post-process (cutting, drilling, trimming, sanding, painting, etc.) it to produce a final piece. This technology will make manufacturing from home easily accessible to everyone. As a result, online shopping for products might become obsolete since everyone will be shopping for CAD models.

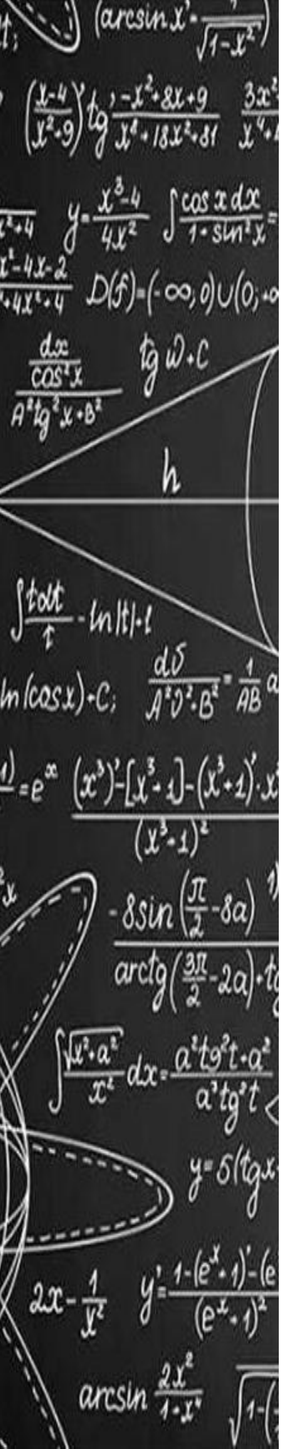
THE FUTURE OF MANUFACTURING

With the emergence of 3d printing it would be cool to see parts being made faster using this technology. Where we could make our own parts at home relatively quickly with a range of materials, not just the normal plastic/ABS printers. With a decrease of time to make this parts with printing we could also have industries having less stock of parts as these could just be printed quickly on demand which would be good for a lot of smaller businesses.



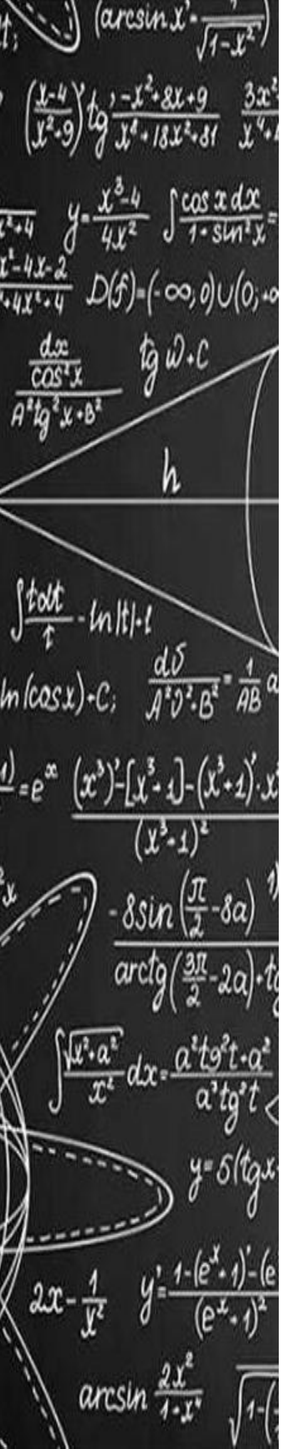
WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think the future of manufacturing will involve nano robotics. I think there are so many future uses for nano robots such as nano robots that target and kill cancers, ones that can be used for surveillance etc. I think that manufacturing will make use of these as well. Manufacturing nano robots may require some sort of laser and metal technology like laser metal sintering. Once nano robots can be manufactured, they may be able to self replicate and act as mini factories, creating more versions of themselves. This could create a problem if they begin to replicate out of control.



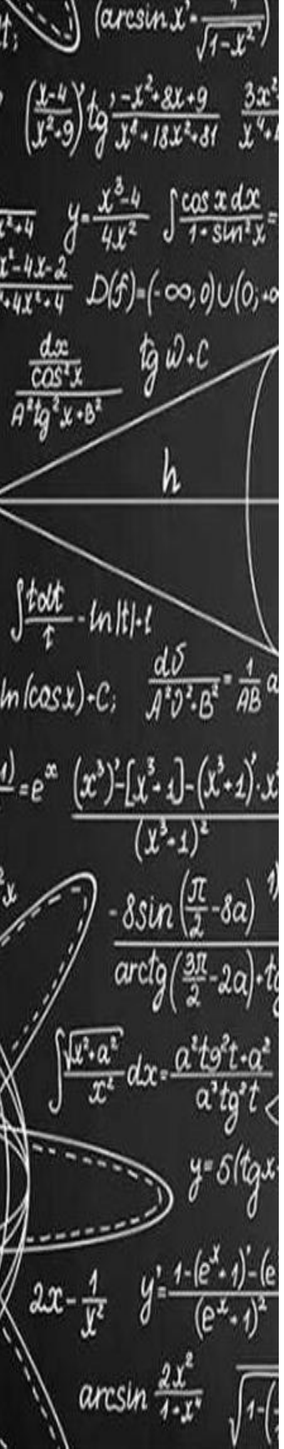
WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

- Automation for most manufacturing processes with a higher accuracy and lower production times.
- Smart sensors that are able to adjust in the moment to ensure peak performance. (The Internet of Things)
- More readily available manufacturing processes for the general public with the rise of 3D printing and other additive manufacturing.



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think automation will be the future of manufacturing. Slowly factory workers will be phased out and machines will take over. 3D printing will become much faster and create parts with much more precision.

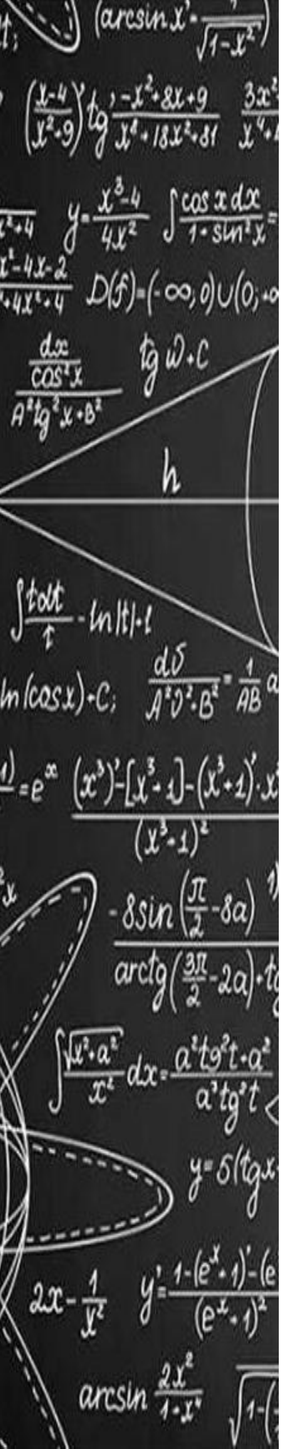


WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

I think the future of manufacturing lies in developing new methods for manufacturing high quality products out of renewable materials. A major part of these changes is the development of improved 3D printing as this enables complex geometry and patterns to be produce which affects the behavior of the part, allowing new materials to perform existing roles.

With how easy it is for people to become a supplier for 3D printed parts now, it wouldn’t be surprising if manufacturing, altogether, ends up heading that way. We can kind of see this already with 3D printing metal and small footprint CNC machines. With these tools, it could be very possible many engineering firms to have their own in-house manufacturing team. While the more dedicated/larger scale machine stops would all be automated and would still be the go-to for bulk part orders.

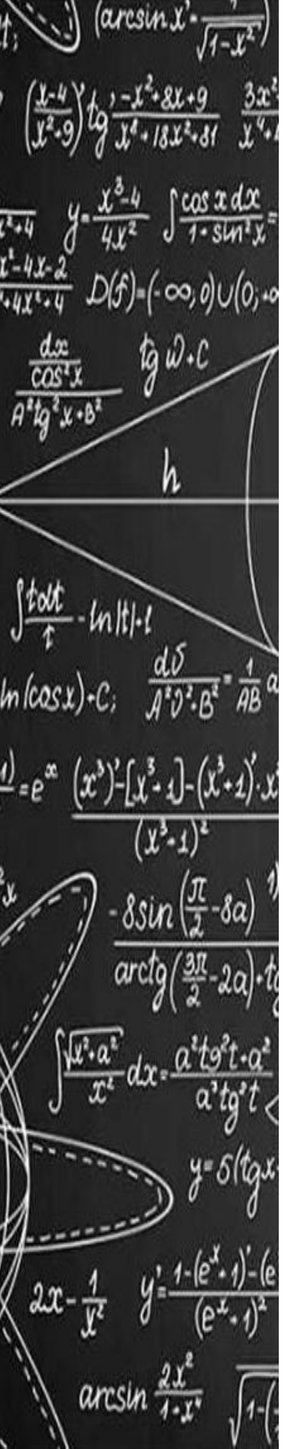
For the machines itself, I believe injection molding still has a lot of improvements to be made for it to become a more flexible and environmentally friendly manufacturing process (i.e. the molding tool).



WHAT DO YOU THINK WILL BE THE FUTURE OF MANUFACTURING?

With the development of IoT, complex manufacturing processes in the future can be monitored and optimized by analyzing the data using connected devices. The production cost for manufacturing (e.g. CNC machining) will be reduced due to low inventory costs and search time.

Metal additive manufacturing will be greatly applied to aerospace industry to produce complex parts. Fuel nozzle tip geometry is complex and hard to manufacture by casting. LEAP engines use metal additive manufactured fuel nozzles to help reduce the weight and improve functionality for the engines.



FUTURE OF MANUFACTURING?

The capabilities of manufacturing will continue to expand. The emphasis will most likely be placed on flexibility, because not only is it very hard to compete in cost or rate with traditional manufacturing methods, but we are also at a point in society where labor is more costly than most material or processes. Cutting out the middleman in manufacturing becomes more and more of a priority as modelling capabilities and amount of small gadgets increase. The rise of 3-D printing only did occur after it became more economical to print small parts than to machine them.

The future holds not only faster and bigger 3-D printers, but possibly 3-D printers that can simultaneously print metal and polymers, home CNC machines that can fit on desktops, and entire machining processes generated and controlled by AI. The job of manufacturing could be shifted to consumers. Entire industries (such as car manufacturing) would choose to not produce physical products, but rather designs that consumers could pay for and customize. Then the consumers will order the raw materials needed and print the car in their garage. Such an arrangement would be more economical and accessible to both manufacturers and consumers. Ultimately, the future of manufacturing, like any other industry, is reliant on providing value to where there’s a need, with the need here being a simplified manufacturing process.