



Introduction to CAD/CAM/CNC

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Target Audience: K-12 STEM & STEAM students

Agenda

- TLAs
- The Future is today – this class could not have happened five or ten or 25 years ago
- Focus on STEM and STEAM
- Digitalization & miniaturization
- Costs drop; access increases; Maker movement rises; compress the design/build chain
- Design is everywhere – great, good, and bad
- Manufacturing – offshore; more custom
- CNC – from industrial niche to garages
- Practical Application – design, build, test, cut

Learning About TLAs

- The Three Letter Acronym (TLA)
- Computer-aided Design (CAD)
- Computer-aided Manufacturing (CAM)
- Computer Numeric Control (CNC)
- More acronyms coming soon – BIM, ABS, DoE, STEM, STEAM, DoD, DARPA, GPS, etc.
- Not sure why technology uses so many TLAs, but that is the state of affairs

The Future is Today

- Design & manufacturing costs plummet over time
- Software democratizes from the niche: architects and manufacturers to anyone
- Ubiquity of apps, specialized internet sites, and practical how-to videos
- Miniaturization of hardware
- Focus on STEM as the US loses international competitiveness

Focus on STEM and STEAM

Programme for International Student Assessment (2009)^[7]

(OECD members as of the time of the study in boldface)

- Back to the Future – shop classes and hands-on fell out of favor since the 1980s
- Quantifiable testing results below many countries
- Educators realize STEM and STEAM can be fun, useful, and interesting
- Other countries are doing this already
- K-12 & college students now compete with other countries who were not competitors even a short while ago
- Specializing any any or all of these disciplines makes a student far more marketable

Maths		Sciences		Reading	
1.	China (Shanghai) 600	1.	China (Shanghai) 575	1.	China (Shanghai) 556
2.	Singapore 562	2.	Finland 554	2.	South Korea 539
3.	Hong Kong, China 555	3.	Hong Kong, China 549	3.	Finland 536
4.	South Korea 546	4.	Singapore 542	4.	Hong Kong, China 533
5.	Taiwan 543	5.	Japan 539	5.	Singapore 526
6.	Finland 541	6.	South Korea 536	6.	Canada 524
7.	Liechtenstein 536	7.	New Zealand 532	7.	New Zealand 521
8.	Switzerland 534	8.	Canada 529	8.	Japan 520
9.	Japan 529	9.	Estonia 528	9.	Australia 515
10.	Canada 527	10.	Australia 527	10.	Netherlands 508

Digitization & Costs

- Old way: proprietary hardware & expensive software
- New way: hardware anywhere – tablets, phones, inexpensive laptops; open source software and open source hardware
- Formerly huge CNC machines can now fit on a student's desk
- Subtractive: CNC machines control a router in a very precise manner and remove material
- Additive: 3D printers use special raw materials to build something from nothing



The Rise of the Maker Movement

- Nerdy is now cool
- Computer Science majors contribute to many technical advances
- Anyone at any age can learn to code at CodeAcademy, code.org, etc.
- The original term “hacker” meant someone who fixes and invents things – it’s back
- Social media also helped the movement explode
- Maker Spaces are in many cities – no need to buy hardware, just rent it

Design is Everywhere

- Architects will still design buildings via CAD
- Other designers are now anyone with access to open source software and hardware
- Access does not necessarily mean beauty
- Design is both art and science
- How-to sites and videos are practical and everywhere
- Think about the physical object you intend to create – size, shapes, thickness

Manufacturing is Everywhere

- Old way: major production runs for a select few; most likely in a US factory; over a pretty long time
- New way: On your desktop; anywhere in the world; in minutes and hours
- Simulation and modeling of what you are about to cut – saves time and materials before you CNC

Introduction to CNC

- Design in CAD software (Autodesk, Vectric, etc.)
- Design does not know what a toolpath is – you need CAM to design your router toolpaths to “connect the dots”
- Simulate what you are about to cut for testing
- Fail fast, fail cheap – in the software, not the CNC
- A router with specialized bits will cut what you intend to cut