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The Decline of the Car Enthusiasts: Implications for Undergraduate Engineering Education

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Abstract

Hands-on, project-based engineering education is alive and well. However, anecdotal evidence indicates that we are seeing fewer undergraduate engineering students who arrive on campus already knowing how to 'use their hands'—having familiarity with tools and mechanical devices, knowing how to connect things, savvy about avoiding leaks in fluid systems, wary of stripping a screw thread or shearing a bolt head—the kinds of things that an archetypal car enthusiast would have learned in high school. For design-build-test project-based engineering educational experiences, having at least one car enthusiast has proven invaluable: more time can be spent on testing and re-designing, rather than getting bogged down in the initial selection of means to satisfy an engineering design function. Also, it seems that the design space can be expanded; students are aware of more ways to satisfy design functions, and less likely to eliminate potential designs due to ignorance of building techniques. Car-enthusiast skills also come in handy during the building process, rather than relying on inexperienced students who may be picking up tools for the first time. Why the decline in these do-it-yourself-ers? Evidence shows that fewer Millennials own and drive cars. This may be affecting their experiences with car maintenance. Millennial culture also includes a type of perfectionism that may be affecting their desire to use their hands, either in fixing things, or in traditional ways of building. The existence of on-board diagnostic computer interfaces is perceived to have an effect, though it is arguable. Many gadgets, especially electronic devices such as mobile phones, PDAs, and gaming systems, are designed and manufactured in ways that make them difficult to open up and repair, but new sites such as iFixit do provide teardowns and repair manuals. I will explore these issues, especially their implications on current undergraduate engineering pedagogy, present 'practical work' experiences from Canterbury and Imperial College, and suggest potential ways of improving beginning engineering students' hands-on skills.

Introduction

Car ownership was once a defining event in a young person's life. A car might have been seen as a symbol of freedom and power (especially to those of us who grew up listening to the Beach Boys, Bob Dylan, Bruce Springsteen or Golden Earring); an indication of material wealth or status (The Great Gatsby); and to many budding engineers of previous generations, an aesthetically-pleasing machine that felt, smelled, and sounded good. However, to the Millennial (or Generation Y) cohort--usually defined as those born in the 1980s and 1990s—interest in cars is declining.

Many nations, including the United States, show a decline in car mobility (miles driven and ridden), car ownership, and obtaining of a driver's license. USDOT reported a leveling-off of car usage since 2005[1]; R.L. Polk & Co. reported[2] in mid-2012 that new vehicle buyers in the age group 18-34 only accounted for 11% of all new vehicle buyers (down from 17% five years ago); total car mobility in the Netherlands has not increased since 2005, while mobility for young persons (aged 18-29) has decreased by 27%[3]; and BITRE[4] reports a saturation in traffic growth in Australia and 24 other countries.

A number of reasons for the decline in car usage and ownership by members of the Millennial generation have been proposed, mainly focusing on the changes in culture caused by mobile internet, urbanization, and the economy. Cultural changes due to mobile internet are seen as a central factor: "The broad implementation of (mobile) Internet in society (e-working, e-shopping, e-commerce, use of social networks) is leading to a reduction in physical (car) mobility[3]." Also, in 2011, CISCO[5] reported that two-thirds of Millennials would choose having internet access over having a car. Urbanization and changes in Millennials' attitude is believed to have led to increased use in bicycling, public transportation, and walking: "In 2009, the 16- to 34-year-old age group took 24-percent-more bike trips than in 2001, even as its population shrank by 2 percent. The same age group walked to more destinations in '09 than in '01, and the distance it traveled by public transit increased 40 percent[6]." JD Powers mentions that economic factors, such as the price of fuel and cost of car maintenance, have lessened Millennial's desires to take on the financial burden that car ownership entails[7].

A car enthusiast, in contrast, shows great appreciation, respect, and knowledge of motor vehicles. Some characteristics of a car enthusiast are the interest and ability in performing their own car maintenance; do-it-yourself installation of aftermarket parts; and understanding the mechanics of automobiles.

Does The Millennial Car Enthusiast Exist?

The demographics show that car enthusiasts do not include a significant number of Millennials. About.com noted, "The average age of the historic vehicle hobbyist is 55. And 75% of the hobby is 46 years old or more. Social, economic and technical forces conspire to divert the interest of youths away from the automobile. If these trends are left unabated we will continue to see the hobby age, declines in the number of enthusiasts and the value of vehicles, clubs will shrink and support services will become scarcer as more enthusiasts exit the hobby than enter it[8]."

Car enthusiasts often perform their own car maintenance, and take apart and put together their cars, sometimes to perform repairs or maintenance, to install aftermarket parts, or simply to gain more understanding of the mechanics of the vehicle. In undergraduate engineering education, students with a car-enthusiast background are very valuable, especially in the context of hands-on, design-build-test projects. These car enthusiasts generally have experience with tools and their use; don't panic if they strip the threads off a screw, or torque the head off a bolt—and even better, often have the knowledge to avoid just those situations!—are familiar with fabrication techniques, and have intuition involving mechanisms that elevated designs and analyses over those of less-experienced students. Especially for capstone design projects, having a 'car guy' or 'car gal' on the team is very desirable.

Over the past five-to-ten years, I have been seeing fewer car enthusiasts in our undergraduate engineering student population. Students who have practical skills such as welding are almost nonexistent now, where five years ago there would commonly be a handful of students who could weld, and had prior machining experience. I can't fault our Admissions department, as they are quite aware of our need for students "who can use their hands", and thus Admissions looks for and prioritizes that trait, knowing how important it is for Engineering. One possibility is that there are fewer budding engineers who are also car enthusiasts.

Some might suggest that fewer undergraduate students work on their own cars because it's too difficult on modern cars, and that these cars aren't meant to be opened up, diagnosed, and repaired, especially by a DIYer. The emergence of on-board diagnostics stemming from the 1991 California Air Resources Board (CARB) requirement certainly has changed car maintenance, but a good number of car enthusiasts will claim that the existence of on-board diagnostics code readers and scan tools, rather than making DIY impossible, actually makes it easier. (Many auto parts stores will run free scans for customers, and the cost of scan tools for moderate DIY use is under $60.) What is more likely is that the design of some vehicles has made accessibility difficult, with engine covers and undertrays needing removal before one can get to the engine, and more importantly, having less space in which to maneuver tools and hands[9].

Research suggests that cultural changes are likely to have affected the chances of a Millennial being a DIYer car enthusiast. In addition to the mobility and ownership issues cited earlier in this paper, car leasing may have had an effect, with fewer cars being "handed down" to young adults by their parents. It's also possible that leased vehicles aren't worked on in the same way an owned vehicle is, thus causing less DIY car maintenance in general. Ted Cardenas, Vice President of Marketing in the Car Electronics Division at Pioneer Electronics, suggests that changing attitudes among Millennials is also a factor: teenagers would prefer to be "driven by their parents in the Escalade, rather than driving themselves in a beater car[10]." He also believes that Millennials have a perfectionist attitude that may be affecting their attitudes towards hands-on skills, describing how they might try to make something (say, laying up carbon fiber, or machining a part) exactly once, and be so disappointed in how their first try looks that they never attempt it again. He finds that Millennials are increasingly more apt to make things with 3D printing technology, although he noted that the things they print are usually not often for use on vehicles, but 'just personal stuff, objects.' Personal digital fabrication items such as these can be found on Thingiverse[11], and microproduction and the "democratization of manufacturing" is put forth as a "promise[s] to revolutionize the means of design, production and distribution of material goods and give rise to a new class of creators and producers[12]."

Implications for Undergraduate Engineering Education

In undergraduate engineering education, it is typical for junior and senior students to take courses involving design-build-test projects. Some of these projects can involve the construction and fabrication of mechanical systems, for example ASME's Human Powered Vehicle Challenge[13]; the American Solar Car Challenge[14]; and Virginia Tech's Battery Operated Land Transport[15] team participating in the TTGXP Electric Motorcycle Racing series. In addition, many institutions conduct engineering design clinics[16] and capstone courses[17] that often involve students needing practical skills. As mentioned previously, having car enthusiasts on these projects is a real boon, and anecdotal evidence seems to indicate that we are seeing fewer of these types of undergraduate engineering students.

It is possible to argue that undergraduate engineering students are gaining practical skills as they work on these types of projects, and therefore there is no need for concern: students are getting these skills and they will enter the workforce prepared and knowledgeable. However, what I am seeing in my team-based clinic projects is not just a slowing of progress (a good amount of time is spent learning practical skills, and extracting themselves from situations where they've broken things due to inexperience) but an actual cutting-off of entire design paths. It is not uncommon to see students choose alternative designs based on what they think they can build, and a narrowing of design space due to students not being familiar with typical mechanical devices. Faculty advisors can combat the design-space-narrowing by pointing students toward already-existing devices and solutions that might help them, but even with that level of faculty vigilance, students still seem less likely to explore those design options. For years-long projects such as design competitions, it is possible that these types of problems can be lessened or overcome, but in a 9-month-long engineering clinic (or especially in a one-semester project) design choices are made earlier, and can't be modified as easily (or at all.)

There are also changes in skills among the engineering faculty as institutions continue to prioritize scientific research and publishing over practical engineering skills and experiences. Faculty without industrial experience or practical skills may not recognize these problems in their students, or if they do, may not give it great weight, since they were successful without possessing these skills. However, some in industry are recognizing this situation: "After NASA's Jet Propulsion Lab noticed its new engineers couldn't do practical problem solving the way its retirees could, it stopped hiring those who didn't have mechanical hobbies in their youth[18]."

It is of great educational value for students to learn practical skills (and break—and fix!—things in the process), and thus get more intuition of how things work, but I find that we can meet design and capstone learning objectives better when undergraduate students gain practical experience in using their hands before their 3rd and 4th years. Next I will summarize two examples of undergraduate engineering education experiences for 1st-year students.

Examples of Practical Work in Undergraduate Engineering Education

At the University of Canterbury in Christchurch, New Zealand, undergraduate engineering students have a Practical Work[19] requirement. This includes a 35-hour workshop, and a minimum of 800 hours working in the engineering industry. The basic workshop is where students learn the use of hand tools, drilling, milling, turning, brazing, and welding. Requirements for the 800 hours of industrial experience vary by discipline, but include items such as manual work, mechanical workshop, process plant operation, and professional practice. The description of work satisfying the 'manual work' requirement reads: "Civil labouring in the field on engineering construction; survey assistant; manual work in mining, farm or horticulture, forest or food industry. Lab work may qualify if it is routine testing or if it involves gathering information in the field. (In short, 'getting your hands dirty'.) Ensure work is relevant to degree as not all manual work is acceptable (eg farm work is acceptable for Natural Resources but not Civil)." The description for mechanical workshop skills is notable in that it requires "working in close contact with skilled mechanical engineering trades people (eg, as a fitters mate involved in plant maintenance, or where they help machine tool operators and trades people involved in metal forming, welding or foundry processes)[19]", thus ensuring that the engineering student gains valuable practical skills experience from practitioners in the field. The Canterbury basic workshop must be completed before the undergraduate engineering student enters their 2nd year, thus giving them practical experience early on.

Imperial College in London, England, also has a 1st-year mechanical workshop requirement[20]. This workshop introduces students to machine elements, and the manufacture of metal, composites, and polymer-based products. Machine element topics include introductions to bearings, gears, and power transmission. The manufacturing segment includes manual and CNC methods in turning, milling, and profiling; hole making and thread production; forging, casting, moulding; mechanical assembly; fasteners and connectors; welding; brazing and soldering; and "Practical hand prototyping and its application to conceptual design development; external turning; internal turning; milling; drilling and threads; sheet working; dismantling an assembly[20]."

There are also offerings for middle school and high school students, often associated with a university engineering school. Techsplorers[21] is an example of a summer program for middle school and high school students. Techsplorers is associated with the Burroughs-Wellcome-funded Techtronics[22] program of the Duke University Pratt School of Engineering. Techsplorers offers workshops where kids learn to take apart (and put back together) a lawnmower engine, and an entire motorcycle, including the engine. Tech Academy[23] of Silicon Valley is associated with San Jose State and Santa Clara University, and offers a "hands-on & high tech" course for middle school kids, inspired by "by hands-on childhood experiences—whether working on farms and repairing water pumps, tractors and machinery, or in more urban settings, tinkering with mechanical objects and cars and building crystal radios[24]."

I find the idea of taking motor vehicles apart and learning to use tools and make machinery to be exciting and useful, and grew up working on cars alongside my father, and with various peers throughout high school and university. Some of my fondest memories include fixing various vehicles, and then, of course, taking the test drive after putting things back together, but I was born well before the Millennial generation, and grew up in a different culture. What might Millennials respond to, in order to gain practical skills?

iFixit[25] is a website that provides repair manuals and teardown documentation for various consumer electronics and gadgets. They also sell toolkits and repair parts appropriate for these devices. Although many Millennials treat their devices as disposable, it is possible that budding engineering students might respond to educational experiences involving repair or teardown of their electronic devices. Although this will not give them experience with larger machinery and tools, it may help students develop more intuition into how devices work and are put together. Given the transportation literature pointing out that Millennials are increasingly using bicycles for transportation, courses involving bicycle design and maintenance may also be of interest. Stanford offers an upper division engineering technical elective in bicycle frame design/fabrication course[26], which, although it doesn't solve the problem of teaching students practice skills before their capstone courses, looks to be a very engaging and useful course for Millennial engineering students.

3D printing[27] and "fab labs[28]" are being used as engineering outreach for young kids; like iFixit, these offering are likely currently restricted to smaller devices and gadgets, but again, may be of more interest to the Millennial generation. Fab Lab course offerings describe the use of desktop milling machines, and basic CNC router wood engraving.

Summary

The Milllennial, or Generation Y cohort, are less likely to drive, own their own cars, and thus, tend not to be car enthusiasts who have practical experience in performing car maintenance and understanding the mechanics of vehicles. They also seem likely to have less experience with using their hands, and knowing how to use tools and shop machinery. This has deleterious effects when these students reach their 3rd and 4th year engineering design experiences, not only in slowing down progress when it comes to building prototypes or proofs-of-concept, but in narrowing the design space, and restricting design choices to those that the students feel comfortable in building. Practical Work experience can be gained by undergraduate students before they reach the upper-level courses; examples from Canterbury and Imperial College were presented. Further work in exploring culturally-appropriate Millennial options, such as work with personal electronics devices and gadgets, fab labs, and 3D printing, may be of use in engaging this generation in more hands-on learning.

Bibliography

1) USDOT, Traffic Volume Trends, U.S. Department of Transportation, 2010, retrieved Janaury 10, 2013 from www.fhwa.dot.gov/ohim/tvtw/10aprtvt/10aprtvt.pdf
2) T. Libbey, Young Buyers Are Few and Far Between, June 21, 2013, retrieved January 10, 2013 from http://blog.polk.com/blog/blog-posts-by-tom-libby/young-buyers-are-few-and-far-between
3) Jan Van Der Waard, Ben Immers, and Peter Jorritsma, New drivers in mobility: What moves the Dutch in 2012 and beyond? Discussion Paper No. 2012-15, Prepared for the Roundtable on Long-Run Trends in Travel Demand, 29-30 November 2012.
4) BITRE, Traffic Growth: Modelling a Global Phenomenon, Report 128, retrieved on January 10, 2013 from http://www.bitre.gov.au/publications/2012/files/report_128.pdf
5) CISCO. Cisco. (2011). Cisco Connected World Technology Report. The Future of Work: Information Access Expectations, Demands, and Behavior of the World's Next-Generation Workforce. San Jose: USA. Denstadli, J.M., Julsrud, T.E. & Hjortol, R.J. (2012). Videoconferencing
6) Todd Lassa, Why Young People are Driving Less: Is the Automobile Over? Motor Trend, August, 2012, retrieved on January 8, 2013 from http://www.motortrend.com/features/auto_news/2012/1208_why_young_people_are_driving_less/
7) J.D. Power and Associates Press Release, October, 2009, retrieved on January 8, 2013 from http://businesscenter.jdpower.com/news/pressrelease.aspx?ID=2009226
8) Top Threats to the Classic Car Hobby, retrieved on January 8, 2013 from http://classiccars.about.com/od/owningaclassic/a/Top-Threats-To-The-Classic-Car-Hobby.htm
9) DIY car servicing: is it still possible? Retrieved on January 8, 2013 from http://www.telegraph.co.uk/motoring/caraccessories/9354955/DIY-car-servicing-is-it-still-possible.html
10) Personal communication, December 24, 2012.

11) Thingiverse, retrieved on January 8, 2013 from http://www.thingiverse.com/
12) Catarina Mota, The rise of personal fabrication, Proceedings of the 8th ACM conference on Creativity and Cognition, pp. 279-288, ACM, New York, NY, USA 2011
13) Human Powered Vehicle Challenge, retrieved on January 10, 2013 from http://www.asme.org/events/competitions/human-powered-vehicle-challenge-%28hpvc%29
14) American Solar Challenge, retrieved on January 10, 2013 from http://americansolarchallenge.org/
15) Bolt Electric Motorcycle, retrieved on January 10, 2013 from http://www.bolt.org.vt.edu/
16) Bright, A., & Phillips, J. R. (1999). The Harvey Mudd Engineering Clinic Past, Present, Future. Journal of Engineering Education, 88(2), 189-194.
17) Dutson, A. J., Todd, R. H., Magleby, S. P., & Sorensen, C. D., A review of literature on teaching engineering design through project-oriented capstone courses, Journal of Engineering Education, 86, 17-28, 1997.
18) Why Your Teenager Can't Use a Hammer, retrieved on January 10, 2013 from http://www2.macleans.ca/2011/08/25/why-your-teenager-cant-use-a-hammer/
19) Introduction to Practical Work Experience, retrieved on January 8, 2013 from http://www.engf.canterbury.ac.nz/practical/
20) ME1-HDMF-Design and Manufacture, retrieved on January 8, 2013 from http://www3.imperial.ac.uk/mechanicalengineering/study/subjects/year1/me1hdmf
21) Techsplorers, retrieved on January 10, 2013 from http://www.techsplorers.com/index.html
22) TECHTRONICS: HANDS-ON EXPLORATION OF TECHNOLOGY IN EVERYDAY LIFE by Paul A. Klenk, Gary A. Ybarra, Rodger D. Dalton. Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition Copyright © 2004, American Society for Engineering Education
23) Tech Academy Background, retrieved on January 10, 2013 from http://techacademysv.com/background.html
24) Tech Academy Hands On & High Tech, retrieved on January 10, 2013 from http://techacademysv.com/hands-hightech.html
25) Ifixit.com, retrieved on January 14, 2013 from http://www.ifixit.com/
26) ME 204, Bicycle Design and Frame Building, retrieved on January 14, 2013 from http://www.pureirishstout.com/ClassInfo.html
27) Inspiring next gen inventors: teens, engineering education and 3D printing, retrieved on January 13, 2013 from http://triplehelixinnovation.com/inspiring-next-gen-inventors-teens-engineering-education-and-3d-printing/2234
28) FAB LAB at Fox Valley Technical College, retrieved on January 14, 2013 from http://www.fvtc.edu/public/content.aspx?ID=1873&PID=1