



# Green tricycle design through experiential learning — an open courseware enriching engineering curriculum and entrepreneurship

Kuang-Hua Chang and Jawanza Bassue

The University of Oklahoma, USA

## ABSTRACT

Aristotle once said, “For the things we have to learn before we can do them, we learn by doing them” [3]. In this paper, an open courseware that enriches engineering curriculum and entrepreneurship by designing a green tricycle through experiential learning is presented. A green tricycle, which provides short-range transportation at low cost, powered by green energy and human power, is employed as a platform to empower students with the practice that brings their idea into reality. This courseware composed of ten lessons guides students to design, analyze, and fabricate prototypes of green tricycles following an e-Design paradigm and modern computer-aided technology; as well as develop business plans to bring their ideas into practice through entrepreneurial activity. The end result is a great experience for young engineers who become confident in the value of their own ideas and have the tools necessary to bring their ideas into practice and eventually commercial products.

## KEYWORDS

Experiential learning; green tricycle; open courseware

## 1. Introduction

Engineering curriculum is compact at engineering schools in the U.S. Rushing through 130+ credit hours, many with heavy Math and Physics contents, in four years has become a norm to many engineering students who are provided little or no opportunity to put knowledge learned in classroom into practical use. A recent report from the Carnegie Foundation for the Advancement of Teaching [8] examined six U.S. engineering schools and noted a continuing and widespread emphasis on textbook-centric theory over hands-on practice, an approach that discourages many students and largely leaves them unprepared for solving problems beyond those of textbooks.

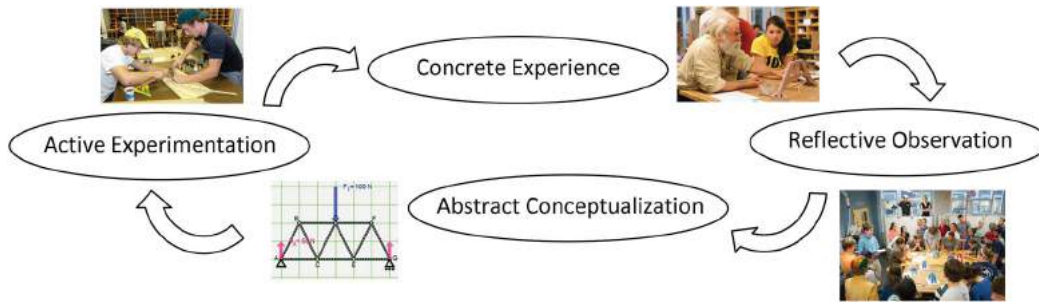
In order to enrich student learning experience, an open courseware that complements engineering curriculum and promotes entrepreneurship through experiential learning is being created. Experiential learning is learning through reflection on doing, a process through which students develop knowledge, skills, and values from direct experience outside a traditional classroom setting.

A standard experiential learning model that involves four distinct stages is illustrated in Fig. 1 [3]. In classroom, students learn theory and concept, for example force analysis and material strength in Statics and Solid Mechanics, respectively. With this experiential learning model, students use the theory and concept to design

a bridge, designated as the “abstract conceptualization” stage. Students then attempt to build a physical prototype of the bridge in the so-called “active experimentation” stage. In the “concrete experience” stage, students physically experience the bridge under loads. This experience forms the basis for observation and reflection, which provides students with an opportunity to consider what is working or failing (reflective observation). It also encourages students to think about ways to improve on the next attempt based on the theory and concept learned in classroom. Every new attempt is informed by a cyclical pattern of previous experience, thought and reflection.

Following the standard experiential learning model, an open courseware for the enrichment of learning experience that integrates engineering curriculum and promotes entrepreneur development and learning community engagement is being developed. Green tricycles, similar to those commercial products of Fig. 2, that provide short-range transportation, powered by green energy and human power, are employed as a platform for students to practice engineering knowledge, promote creativity, and pursue entrepreneurship.

The experiential learning model is implemented in varying ways across the globe and include examples such as the Society of Automotive Engineers’ Formula SAE [9], the KISS Institute for Practical Robotics’ (KIPR) Bot-Ball [6], and The American Institute of Aeronautics and



**Figure 1.** A standard experiential learning model [7].



**Figure 2.** A few commercial products of green tricycles (a) RAHTRACER ([www.rahtmobil.com](http://www.rahtmobil.com)), (b) ELF ([organictransit.com](http://organictransit.com)), (c) HP Velotechnik ([www.hpvelotechnik.com](http://www.hpvelotechnik.com)), and (d) LEPUS ([www.hasebikes.com](http://www.hasebikes.com))

Astronautics' (AIAA) Design/Build/Fly competitions [1], among others. Both KIPR and AIAA encourage students to design and fabricate projects that meet certain criteria for each year's competition. As these and other forms of experiential learning are mostly competition based, active sharing and cross-team communication is not encouraged – neither is there a platform created for collaboration. Promoting shared knowledge and community engagement is the focus of the “do-it-yourself” community with a popular example being “Instructables”, a website of user generated instructions, feedback and illustrations guiding visitors through completing projects ranging from gardening, to simple electronics, to motor powered go-karts [5]. There exists an opportunity to combine the experiences students gain from competition based undertakings and the enthusiasm of the do-it-yourself community. The combination of experiential learning and open community involved courseware around the design of green tricycles presents an ideal platform for enriching the engineering curriculum across institutions and promoting entrepreneurship as this project seeks to do.

## 2. Green tricycle

With the increasing awareness in environmental protection and energy preservation, the demand on green energy powered vehicles is on the rise. Electric or hybrid vehicles are gaining momentum and becoming more popular among consumers. However, battery technology (such as energy capacity), infrastructure (such as charging stations) and high product cost remain challenging in bringing electric cars to household in the U.S. One of the viable alternatives for short-range transportation is green tricycle of low cost, powered by green energy and human power.

A sample tricycle, designed by a student team shown in Fig. 3, is used as an example to illustrate the details in the design and manufacturing of the tricycle. The sample tricycle features a simple design that aims to keep manufacturing and maintenance costs as low as possible. An aluminum frame of mostly straight and some simply-bent tubing welded together provides structural support for the tricycle, rider and light cargo, making the entire cycle unloaded weigh about 115 lbs. The frame design



**Figure 3.** A sample green tricycle designed by a student team.

allows for a recumbent style seat to be adjusted back and forth accommodating riders of varying heights. The tricycle also utilizes a rear steering mechanism unlike most tricycles on the commuter market. This steering arrangement is accomplished by using “push & pull” handles mounted to the frame alongside the driver’s hips. The forward wheels are pedal-powered with adjustable gears for any riding condition. The rider is kept safe by the use of reflective tape placed in various places on the frame and bright LED brake lights and headlights. The design follows typical bicycle construction and off the shelf safety additions are widely available for use. In the event the vehicle’s battery is depleted, the rider comfortably completes the journey using pedal power only. Integrated into the rear wheel is a “Magic Pie 5 Vector” by Golden Motor ([www.goldenmotor.com](http://www.goldenmotor.com)) – a motor-and-brake system that is enclosed in a single package mounted to the rear axle, powered by a 2200 mAh battery. This system powers the vehicle forward on its own or with the front pedal assist, dependent on riding conditions (speed, slope, distance, etc.). The Magic Pie 5 Vector also allows the rider to track speed, distance and other metrics through a mounted smart device. The sample tricycle’s design is completed by swept-cut acrylic pieces providing a windshield and improved aerodynamics over an open frame design.

### 3. The courseware

This courseware of ten lessons supports engineering students to put what they learned in classroom into practice by designing and building green tricycles at their own pace. As shown in Table 1, the first lesson introduces the e-Design paradigm [4], which employs virtual prototyping (VP) for product design and fast prototyping, including CNC (computer-numerical control) and additive manufacturing (AM), for fabricating product physical prototypes, as shown in Fig. 4. In e-Design, a product design concept is first created in solid models by designers using CAD tools, supporting simulations for product performance, reliability, and manufacturability using modern computer tools. Product performance, quality, and cost obtained from multi-disciplinary simulations are brought together for design reviews and decision making by the cross-functional team. The product designed in the virtual environment can then be fabricated using CNC and AM for physical prototypes. The physical prototypes provide the cross-functional team with an effective means for design review and verification. Design change requests made at this point can be accommodated in the e-Design environment without high cost and delay.

This e-Design lesson is followed by six lessons aimed at guiding students to design, analyze, and prototype green tricycles using modern computer-aided technology that enriches engineering design curriculum. Each lesson starts with a short review on basic engineering knowledge taught in core engineering courses and targeting a specific aspect of the green tricycle design (for example, review of major course contents of Dynamics for the design of the tricycle suspension system), followed by sample designs or case studies, and then tutorial lessons that assist students to learn computer-aided design tools that support engineering analysis beyond hand-calculations. The last three lessons focused on the business aspect of engineering product development aimed at supporting and promoting pursue of entrepreneurship. These lessons include U.S. patent applications, business plan development, product cost structure and factory layout for mass production, and fund raising for capital investment.

The courseware soon after developed will be made available on-line for students around the world to review. Students will be able to use their laptops with the guidance of the courseware to design green tricycles using computer software tools. Some will be able to use the manufacturing facilities available to them to manufacture a prototype of the tricycle they designed. The prototype tricycles allow students to physically experience the design of the systems, which offer students the opportunity to consider what is working or failing, and to think about ways to improve on the next attempt based on the theory and concept learned in classroom. In addition, a successful prototype facilitates fund raising for capital investment in pursue of entrepreneurship.

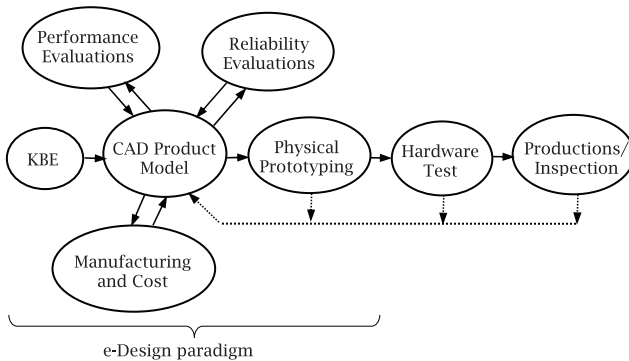
Students may go over the courseware at their own pace. They may choose to go over specific lessons as they march through the curriculum in four years, for example, designing suspension system of the tricycle while taking the sophomore Dynamics class. A student may spend a summer month of his/her junior year to design the tricycle and the remaining two months to manufacture a functional prototype. Moreover, instructors may use the courseware as complementary instructional materials and assign components or subsystems of the tricycle design as a final project to enrich students learning experience. Next, we use one lesson, Lesson 4: Kinematics and Dynamics, as an example to further illustrate the courseware.

### 4. A sample lesson

Using Lesson 4 Kinematics and Dynamics as an example, the courseware establishes a basic understanding

**Table 1.** A list of the ten lessons of the open courseware.

Lesson	Title	Objective	Tutorial	Project	OU courses
1	Engineering Design: e-Design Paradigm	Understand the engineering design concept, methods, and process	Solid modeling and assembly using CAD (computer-aided design) software, SolidWorks	Create concept designs of the tricycle, and analyze pros and cons of individual designs	ENGR1141 Freshman Engineering Experience
2	Solar Power	Understand solar power, energy storage and battery, and electricity system design	Solar energy and power supply calculations using spreadsheet	Create electricity system design of the tricycle	PHYS2524 General Physics and ENGR2431/2531/3431 Electrical Systems
3	Weight Distribution	Understand weight balance of mechanical system	Mass properties of parts and assembly using SolidWorks	Analyze the weight balance and design the chassis frame of the tricycle	AME2113 Statics
4	Kinematics and Dynamics	Understand kinematics and dynamics of mechanical system	Kinematic and dynamic analysis of mechanical system using SolidWorks Motion	Design the suspension of the tricycle	AME2553 Dynamics
5	Structural Integrity	Understand structural strength of load bearing components in mechanical system	Finite element analysis using SolidWorks Simulation	Design the major load carrying components of the tricycle	AME3143 Solid Mechanics
6	Mechanical Components	Understand mechanical components design, such as gear train systems, in mechanical system	Mechanism design using SolidWorks Motion	Design the steering and transmission systems of the tricycle	AME3353 Design of Mechanical Components
7	Manufacturing	Understand material selection and manufacturing process	CNC Machining using CAMWorks	Manufacture major components of the tricycle	AME2303 Materials, Design & Manufacturing Processes
8	Product Cost Estimating and Mass Production	Understand cost structure, develop factory layout, and estimate production and sale costs	Cost estimating using SEER-DFM software	Cost estimating for the mass production of the tricycle	AME4163 Principles of Engineering Design
9	US Patent Applications	Understand the value of intellectual properties and patent application process			
10	Business Plan Development	Understand how to write a realistic business plan, conduct fund raising for capital investment and pursue entrepreneurship			

**Figure 4.** The e-Design paradigm.

of Dynamics concepts like the Newton's Laws involving velocity, momentum, force, etc. This is presented in Microsoft PowerPoint format, easily accessible from the link of a website developed to guide students through the engineering design process. There has been much content created at various universities and education institutions that is made available to students free of cost, and the PowerPoint presentations link to these resources. An example of such content is the eCourses website

([www.ecourses.ou.edu](http://www.ecourses.ou.edu)), which (as seen in Fig. 5) hosts text-book quality content in basic engineering concepts (solid mechanics, dynamics, and so forth) along with examples and interactive tools.

This content exposes students to an entire university-level course including individual topics like Dynamics. Where the courseware excels however, is through instructed use of engineering tools to solve problems. For example, it is advantageous for students designing a green tricycle to understand how the suspension reacts dynamically to a disturbance (hitting a bump at speed for example). In Fig. 5 we see the dynamic theory of a spring-mass-damper system and some of the associated equations. For ideal rider comfort and vehicle stability/controllability, the suspension of a green tricycle should mostly be critically damped or slightly under damped after encountering a disturbance (bump). A poorly designed suspension can cause severe oscillations that lead to the rear wheel losing contact with the road or the driver feeling unsettled long after encountering a bump. With a basic understanding, students may use simulation tools, such as *SolidWorks Motion*, to analyze the performance of the suspension design.

$\zeta = 1$  Critically Damped  
 $\zeta > 1$  Overdamped  
 $\zeta < 1$  Underdamped

**Critically Damped ( $\zeta = 1$ )**  
 For  $\zeta = 1$ , the roots  $s_1$  and  $s_2$  are equal.  
 $s_1 = s_2 = -\omega_n$   
 The general solution to the differential equation is  
 $y(t) = (A + Bt)e^{-\omega_n t}$   
 The coefficients A and B are  
 $A = y(0)$   
 $B = \dot{y}(0) + \omega_n y(0)$

**Overdamped ( $\zeta > 1$ ) (Non-Oscillatory)**  
 For an overdamped system, general solution is  
 $y = Ae^{(-\zeta + \sqrt{\zeta^2 - 1})\omega_n t} + Be^{(-\zeta - \sqrt{\zeta^2 - 1})\omega_n t}$   
 OR  
 $y = e^{-\zeta\omega_n t} [Ae^{\sqrt{\zeta^2 - 1}\omega_n t} + Be^{-\sqrt{\zeta^2 - 1}\omega_n t}]$   
 The constants A and B are determined from the initial conditions.  
 $A = \frac{\dot{y}(0) + (\zeta + \sqrt{\zeta^2 - 1})\omega_n y(0)}{2\omega_n \sqrt{\zeta^2 - 1}}$   
 $B = \frac{-\dot{y}(0) - (\zeta - \sqrt{\zeta^2 - 1})\omega_n y(0)}{2\omega_n \sqrt{\zeta^2 - 1}}$

**DYNAMICS - THEORY**  
 In most mechanical systems, there is some type of damping effect when vibrations occur. It could be air or fluid resistance, shock absorber, or even molecule interactions. This damping effect can be effectively modeled as a force that is proportional to the objects velocity. This type of device is usually called a damper.  
 Similar to the simple mass-spring system (undamped) presented in the previous section, the equations of motion of a mass-spring-damper system (damped) can be developed by summing forces. Gravity effects will cancel out similar to the damped system, and are not included in this derivation.  
 $F_s + F_d = -m a_y$   
 substituting  $F_s = ky$  and  $F_d = c v = c(dy/dt)$  gives,  
 $m \frac{d^2 y}{dt^2} + c \frac{dy}{dt} + ky = 0$   
 Recall, solving any differential equation requires that a general solution is first assumed and then initial conditions are used to find the constants.  
 For an undamped system, both sin and cos functions were used in the solution. For the damped system, it is more convenient to use an exponential form as,  
 $y(t) = D e^{st}$   
 where A is an arbitrary constant, and s is a characteristic parameter. Substituting this into the equation of motion will give  
 $(ms^2 + cs + k) D e^{st} = 0$

Figure 5. A sample eCourse website explaining spring-mass-damper system.

Figure 6 shows a screen shot of *SolidWorks Motion* being used to analyze the motion of a simple unicycle suspension. Other included videos show testing the sample green tricycle created by students in a similar video. These screenshots are taken from narrated videos created using the *Atom Systems ActivePresenter* [2] program that guide students step-by-step through the process. The narrator provides a general overview of every action, as well as comments on possible pitfalls while using different tools. The narrated videos end by reminding students

how and where to ask for help with any issues that may arise along their utilization of the courseware.

As an example, we illustrate the design of a tricycle suspension that guides students through bump scenarios and determinations of the turning radius through a video. In Fig. 7(a), we see a finalized/high quality rendered version of the sample green tricycle while (b) shows a simplified model for motion analysis. We note that the seat, fairings and controls add unnecessary complex geometry to the simulation model and are

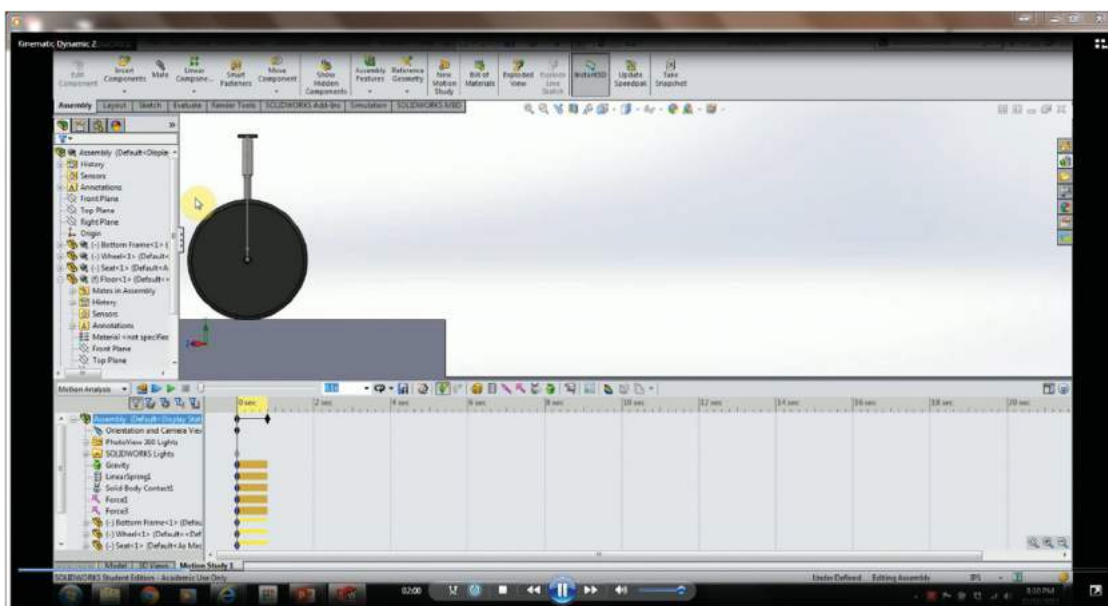
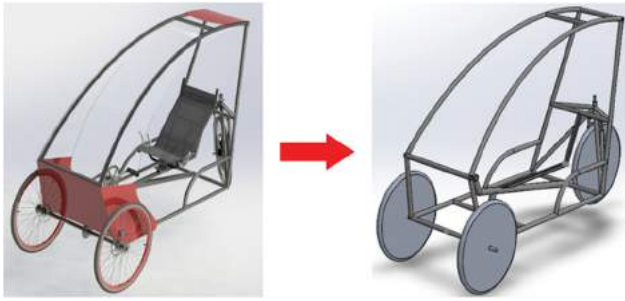


Figure 6. Narrated video instructions for a unicycle dynamic test.



**Figure 7.** : Detailed design of the sample green tricycle assembly vs. simplified version for Motion simulation.

suppressed. It is critical to note that in the simplified model, all moving components are allowed to go through full motions, restrained by mates in the assembly, without compromising the fidelity of the model in terms of critical engineering information acquired from the motion simulation.

With the assembly simplifications made as described above, motion simulations were carried out. As detailed in Lesson 4: Kinematics and Dynamics on the Green-Tricycle.com website, “bump” analysis can be conducted by using a large “floor” modeled in *SolidWorks* with a speed hump. As seen in Fig. 8, the simplified tricycle assembly is positioned with wheels above the floor or wheels made tangent to the floor (this mate is relaxed before the simulation is run). Component contacts were added between the rubber wheels and floor, and direction and magnitude of acceleration due to gravity are defined. In addition, an initial velocity to the vehicle is added before running a simulation that allows the tricycle to traverse the hump. This video tutorial reminds viewers of some lesser-known options included in the simulation setup, such as options within the component contact definition and accuracy settings of the simulation.

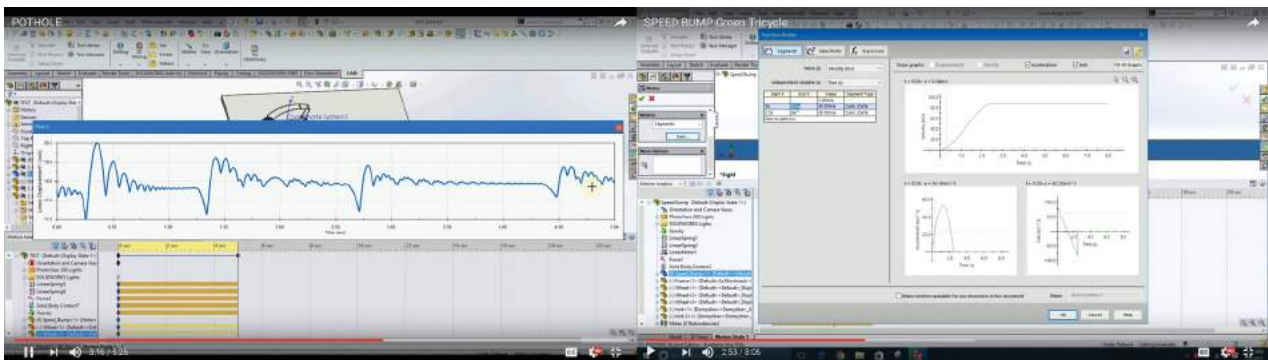
The results of the simulation (defined by motion and force graphs as well as visual inspection of the action) leads to the conclusion that the tricycle remains stable

over the bump at various speeds dictated by the initial conditions. We see in Fig. 9 that after a large disturbance by the speed hump, a point that represents the position of the seat returns to equilibrium without oscillating. Also note that different shapes, sizes and series of humps can be modeled as required and are highlighted in the associated video.

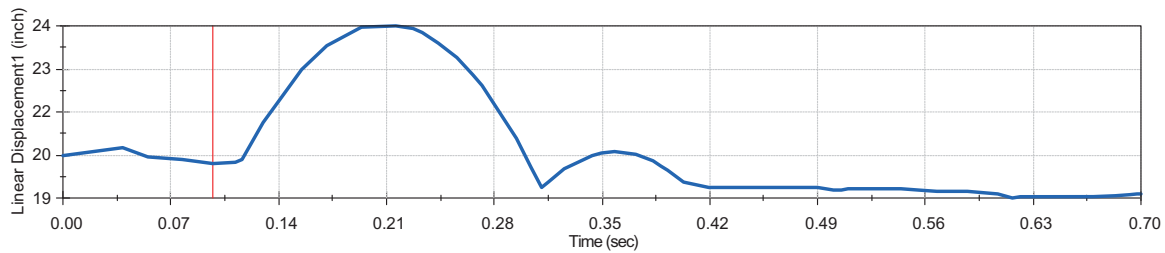
An important aspect of the overall design is rider comfort which is not easy to evaluate by observation. We use graphs of the vertical displacement (see Fig. 9) and acceleration (not shown), defined from a vertex that would be near the rider seat position, to judge the expected experience of the rider in these conditions. The simulation can be “confirmed” or validated with the use of experimental data and the narrator suggests that viewers safely replicate the reaction over a speed hump on a real tricycle. Using applications such as the free *Physics Toolbox Accelerometer* by Vieyra Software [10] for smartphones allows for acceleration to be plotted versus time and exported to.csv format for easy graphing in Microsoft Excel, using smartphones’ built-in accelerometers. Other measurements easily recovered from simulations include reactionary ride height (distance to the ground as the tricycle is loaded, and allowed to traverse uneven terrain), slalom performance and balance, braking distance and turning radius.

## 5. The website

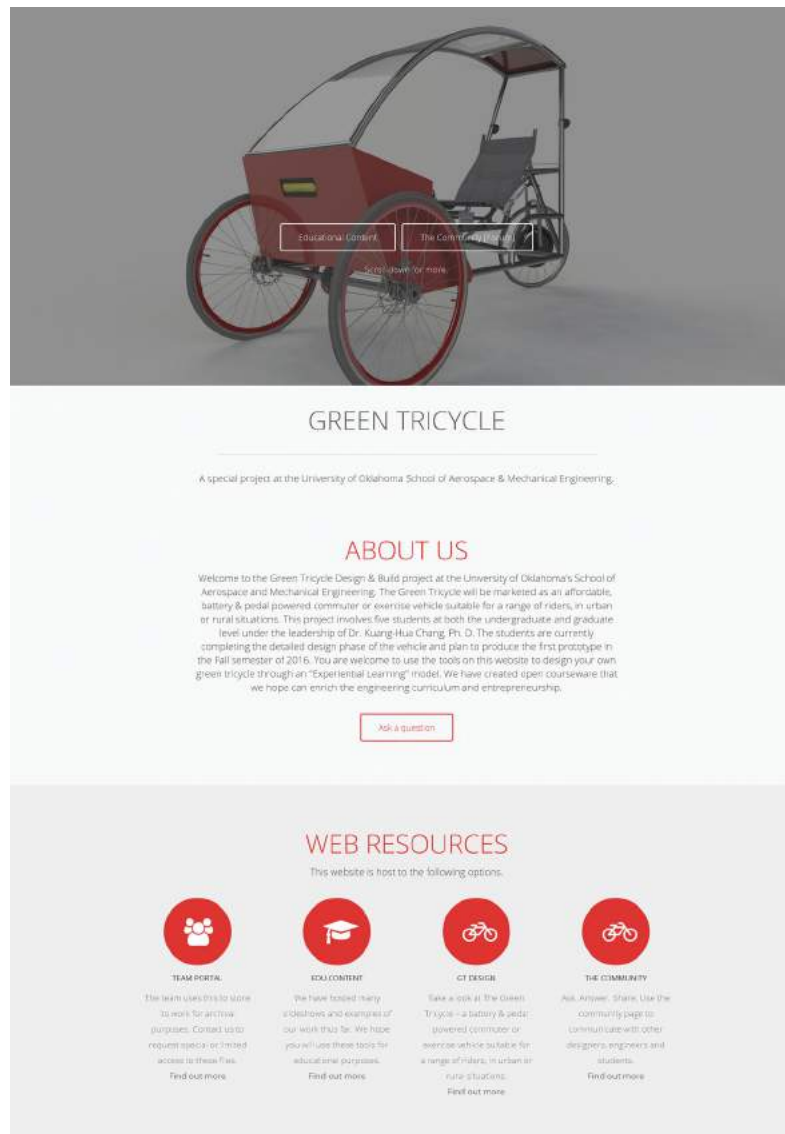
The project’s website (Green-Tricycle.com) with landing page seen in Fig. 10 facilitates a dual role as a free resource for all visitors but is also a system for managing the sample tricycle’s parts, assemblies and documentation, accessible only by students currently working on the design and prototype fabrication. It is built upon the WordPress platform (wordpress.com/create) that offers many content management tools for the average manager and web designer. The back-end contains themes and layouts to adjust the look and feel of the website making it



**Figure 8.** Motion simulation being conducted on the sample green tricycle.



**Figure 9.** Motion simulation results: vertical displacement at the driver seat.



**Figure 10.** The Green-Tricycle.com website landing page.

as user friendly as possible. It does not require a team of programmers or designers for maintenance and is easily modified and updated by an involved student or volunteer. An initial goal was set for a visitor to recognize every feature of the website simply by reading an element's title or seeing its associated symbol. This design with large pictures, icons and clean text attempts to create an

intuitive structure for engineering and non-engineering students and visitors alike.

As seen in Fig. 10, the main website sections are, "TEAM PORTAL" which is the management section for currently students active with the sample green tricycle, "EDU.CONTENT" which hosts educational content, i.e. courseware, "GT DESIGN" (only partially shown in

Fig. 11) which highlights the designs of the sample green tricycle and other tricycles designed alongside. The website continues to be developed as feedback is received – ensuring a user-friendly experience.

This website that hosts the courseware also serves as a means that creates a learning community, which encourages students to learn from each other, through “THE COMMUNITY”, which is an open platform for sharing and discussion. Students are required to register before downloading lessons and interacting with the community. There are three levels of users on the Green-Tricycle.com website – administrators, moderators and subscribers. The website administrators have complete access to the website’s functionality including theme and design, forum posts and uploaded content which is done through the WordPress back end on which the website is built. Moderators are given the opportunity to monitor and control forum operations only, with the ability to remove posts and offensive users. At the subscriber level, users can share content and openly or privately discuss topics with all other users.

Popular amongst the various hobbyist communities (automotive, aviation, computing, technology, sports, and so forth) is the forum style of engagement. This website retains this familiar feel and structure that these communities are built from and is the justification behind our selection of the platform. Examples of this style are seen in the smart-device modification and repair communities that are usually an amalgamation of crowd-sourced knowledge. The “XDA Developers Forum” (typically referred to as XDA) is a forum styled website that boasts over 6 million users, working together to modify, create and repair mobile devices and their operating systems. The forum styled chat room (see Fig. 12) is provided

for students to discuss ideas, post questions, exchange lessons learned, and share practical experiences. This platform uses features that are expected from any open and lightly moderated forum. For example, each user has the ability to track their own posts as well as the posts of others as discussion topics expand and develop. Furthermore, any registered member can contribute to any post on the website as we encourage open communication and sharing. Users are able to send private messages to others in hopes of networking and solving specific problems away from the open chat infrastructure. There is also search functionality to assist users in finding topics that have already been discussed and website administrators or forum moderators can designate “sticky” topics which are universally helpful and remain at the top of the forum and search index.

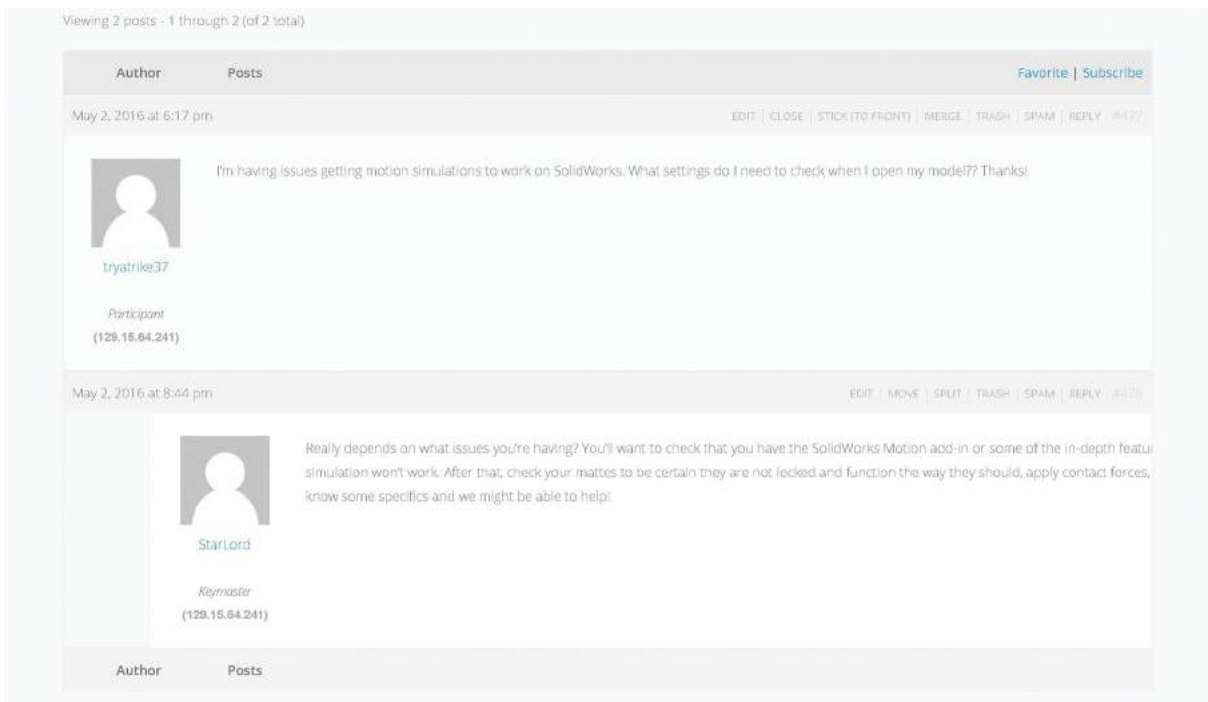
A learning community, however, should be free of cyber bullying, indecent behavior/language and spam. To combat this issue, an automatic forum monitoring feature flags suspicious behavior for review by website administrators or forum moderators. Forum users are also capable of “flagging” posts that they find offensive or that do not adhere to the expected code of conduct. As is standard practice in forum settings, users who intentionally refuse to conduct themselves properly will be ejected from the forum and have their email blocked from reregistering on the website.

The courseware on the website are separated into individual pages that have simple navigation and hosts the video tutorials and PowerPoint presentations in embedded holders. The embedded nature of the documents and videos allows a faster experience over downloading the content and is also accessible on mobile platforms. Similar to the Weight Distribution and Structural Integrity



**Figure 11.** The GT Design page.

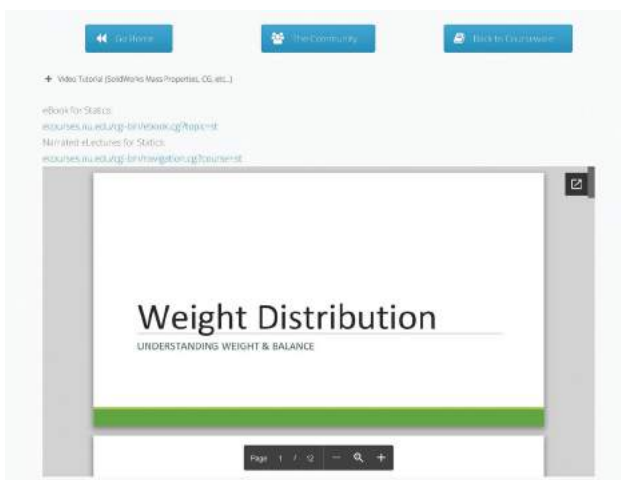




**Figure 12.** Post & Reply structure of the Green-Tricycle.com Forum – the Community.

courseware seen in Fig. 13, the other courses have differing numbers of videos, links and PowerPoint presentations ready to be accessed. Since the website is built on the easy to modify WordPress platform, students involved in the Green Tricycle project can easily add their own lessons learned to the courseware pages.

The website is designed to allow registered users to not only access the courseware, but also upload the designs, prototypes, lessons learned, technical data, and videos of working tricycles. To promote excellence, a green tricycle “hall-of-fame” page (GT DESIGN) is being created to showcase projects successfully completed.



**Figure 13.** The Weight Distribution courseware webpage.

These successful projects are incorporated as case studies into the courseware to further enrich student learning experience. For example, currently completed sample tricycle design is revealed in a set of high resolution renderings with shadowing, reflections, accurate component textures and lighting (using the *Photo 360* tool of *SolidWorks*). The sample design also features a topple-test examining the tricycle’s reaction to a tight turning radius at a moderate speed. Screenshots of these accomplishments are featured on the GT DESIGN tab of the website. This tab also has the ability to host YouTube videos and links to documents. While monitoring the forums and/or browsing the internet for examples, website administrators decide what content is hosted in the Green-Tricycle.com “hall-of-fame” as it promotes different academic goals.

## 6. Conclusions

We envision that this courseware and the associated website Green-Tricycle.com provide a great experience for young engineers in the U.S. and around the world a meaningful engineering project as well as an opportunity to pursue entrepreneurship. In addition, a webpage that facilitates the creation of an on-line learning community encourages students to learn from each other and promotes excellence. In the long run, as students go over the courseware they become aware of the opportunities to make an impact in the world and confident in the value of their own ideas and have the tools necessary

to bring their ideas into practice. Overall, the experiential learning experience enriched by the courseware, to the authors' knowledge, the first of its kind, will prepare students to meet global engineering challenges and become successful professionals contributing positively to the global community.

### Acknowledgement

The authors acknowledge the support of OU Center of Teaching Excellence through Faculty Fellows Awards.

### ORCID

*Kuang-Hua Chang*  <http://orcid.org/0000-0003-0156-0221>

*Jwanza Bassue*  <http://orcid.org/0000-0001-9745-1913>

### References

- [1] American Institute of Aeronautics and Astronautics: AIAA Design/Build/Fly. [www.aiaadbf.org](http://www.aiaadbf.org)
- [2] Atomi Systems Software: ActivePresenter. [atomisystems.com/activepresenter](http://atomisystems.com/activepresenter)
- [3] Bynum, W.-F.; Porter, R.: (eds) Oxford Dictionary of Scientific Quotations. Oxford University Press. Oxford, England, 2006.
- [4] Chang, K.-H.: e-Design: Computer-Aided Engineering Design, Academic Press, Elsevier Science & Technology, Burlington, MA, 2015.
- [5] Instructables: "Let's Make". [www.instructables.com](http://www.instructables.com)
- [6] Kiss Institute for Practical Robotics: Botball Educational Robotics Program. [www.kipr.org](http://www.kipr.org)
- [7] Kolb, D.: Experiential Learning: Experience as the Source of Learning and Development, Prentice Hall, Englewood Cliffs, NJ, 1984.
- [8] Sheppard, S.-D.; Macatangay, K.; Colby, A.; Sullivan, W.-M.: Educating Engineers: Designing for the Future of the Field, Jossey-Bass, San Francisco, CA, 2009
- [9] Society of Automotive Engineers: SAE Collegiate Design Series. [students.sae.org/cds/formulaseries](http://students.sae.org/cds/formulaseries)
- [10] Vieyra, C.; Vieyra, R.: Vieyra Software: Physics Toolbox Accelerometer. [www.vieyrasoftware.net/#!apps/clazx](http://www.vieyrasoftware.net/#!apps/clazx)