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Nord Grant Application

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Experiential Learning of Structural Systems for Undergraduate Engineering Students

Start Date: July 2012

Purpose and Educational Impact

The instruction of engineering principles applied to complex structural systems often relies on simple sketches and photographs of actual structures to initiate analysis of structural systems such as frames, trusses, arch and cable structures, etc. In the field of structural engineering, instructors have the benefits of having examples all around our students that form our built infrastructure (buildings, bridges, etc.) however the magnitude of the physical forces required to illustrate structural behavior even in a large laboratory is not possible and economically feasible for class-room instruction. Therefore, scaled models are used to illustrate basic concepts of the behavior of structural systems such as load paths, deformations, ultimate strength, and dynamic response. A company called PASCO makes educational scaled models for many purposes including illustrating and investigating engineering concepts such as statics, dynamics, material mechanics, and structural vibrations. This grant would be used to purchase a number of the engineering education sets for use in undergraduate engineering courses such as ECIV 320 and ECIV 322 and which may also have use in graduate courses such as ECIV 425 which many structural engineering undergraduates also take as a senior year technical elective. The sets allow erection of many different structural systems such as building frames, truss bridges, arch trusses, cable-stayed and suspension bridges, cranes, etc. These sets can be loaded statically through mass plates or dynamically through an advanced wave driver capable of inducing free and forced vibrations. Instruments are used to measure structural forces, deformations, and vibrations. A few samples of the model tests are shown in Fig. 1 however note that the model components can be constructed into a nearly endless number of different forms including the arch truss bridge and multi-story building frame shown.

These sets will first be implemented into ECIV 320 (Structural Analysis I) by assigning the set-up, testing, and reporting of results for different structural systems to illustrate fundamental theory taught in the course. Each group consisting of four students will be asked to conduct a test per semester and prepare a report and briefly present to the class the findings of the model testing. The report and presentation will include comparison with the fundamental theory and require students to reflect on the model and test conditions with the idealized theoretical conditions. Additionally the students will be exposed to basic planning and conduction of experimental structural testing. Such hands-on experience and demonstrations in the course should help stimulate enthusiasm for course material and provide visual aids for description of structural behavior beyond those already included in course materials. Implementation into ECIV 320 will impact every civil engineering graduate from CWRU since it is a required core course in the department.

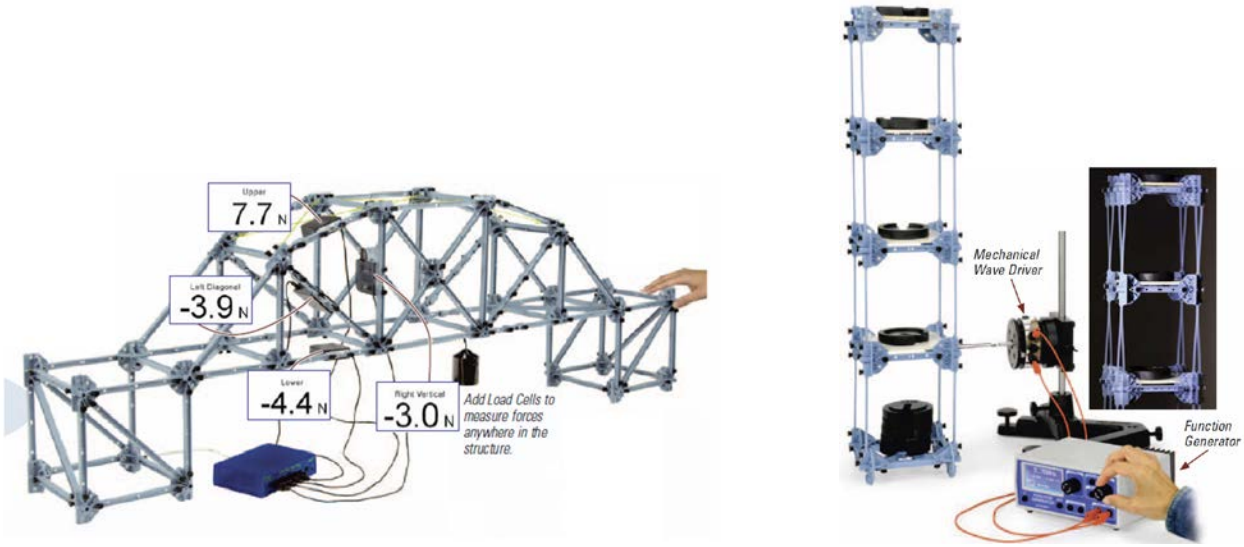

Figure 1. Examples of a Few Structural Model Set-ups that can be Tested (adapted from PASCO Engineering Catalog, http://store.pasco.com/pdfs/Eng_5856726091_D.pdf)

BUDGET

The total budget requested is $5,232. The budget will be used to cover support for student assistance and supply costs. An undergraduate student will be hired over summer 2012 or during the 2012-2013 academic year to assist in the set-up and documentation of experiential modules that will be used in student assignments and class-room demonstrations. The anticipated student support costs are estimated to be $1,725 (see Table 1). The expected supplies costs are tabulated in Table 2 and consist of the PASCO supplies needed. These supplies will allow investigation of structural behavior for a significantly wide range of structural systems under both static and dynamic loading.

Table 1. Personnel Costs				
Item	**Work Description**	**Cost/hr**	**Total Hours**	**Total Cost**
Lab Assistant	Set-up and Document Instructional Modules	11.50	150	1725

Table 2. Supply Costs				
PASCO Item	**Unit Cost ($)**	**Quantity**	**Cost ($)**	**Website Address**
Large Structures Set	659	1	659	http://pasco.com/prodCatalog/ME/ME-7003_large-structures-set/index.cfm
Advanced Structures Set	399	1	399	http://pasco.com/prodCatalog/ME/ME-6992_advanced-structures-set/index.cfm
Load Cell and Amplifier Set	499	1	499	http://pasco.com/prodCatalog/PS/PS-2199_load-cell-amplifier-set/index.cfm
Displacement Sensor	199	2	398	http://www.pasco.com/prodCatalog/PS/PS-2204_pasport-displacement-sensor/
USB Link	59	2	118	http://pasco.com/prodCatalog/PS/PS-2100_usb-link/index.cfm
Wave Driver	249	1	249	http://www.pasco.com/prodCatalog/SF/SF-9324_mechanical-wave-driver/
Function Generator	659	1	659	http://www.pasco.com/prodCatalog/PI/PI-8127_function-generator/#featuresTab
Motion Sensor	80	2	160	http://www.pasco.com/prodCatalog/PS/PS-2103_pasport-motion-sensor/index.cfm
PAScar	98	1	98	http://www.pasco.com/prodCatalog/ME/ME-6950_pascar-set-of-2/
PAStrack	75	2	150	http://www.pasco.com/prodCatalog/ME/ME-6960_pastrack/#includesTab
Large Slotted Mass Set	59	2	118	http://www.pasco.com/prodCatalog/ME/ME-7589_large-slotted-mass-set-2-kg-set/index.cfm

Total Supply Costs = $3507

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