



CIVE 356, Geotechnical Engineering Laboratory. The focus of this proposal is to upgrade three of the six laboratory stations with DAQ capabilities plus an additional DAQ setup that will provide backup capabilities in the event electronic issues are encountered in any of the critical components of the system. A previous ESTC proposal provided seed funding to introduce three DAQ setups into the CIVE 356 lab. A photograph of the developed system is shown in Fig. 1. The use of DAQ for collection data has been well-received by the students and the current ESTC proposal is intended improve hands on learning of DAQ technologies in the CIVE 356 lab by upgrading the three remaining laboratory stations; currently lab groups are combined, which limits student exposure to DAQ.

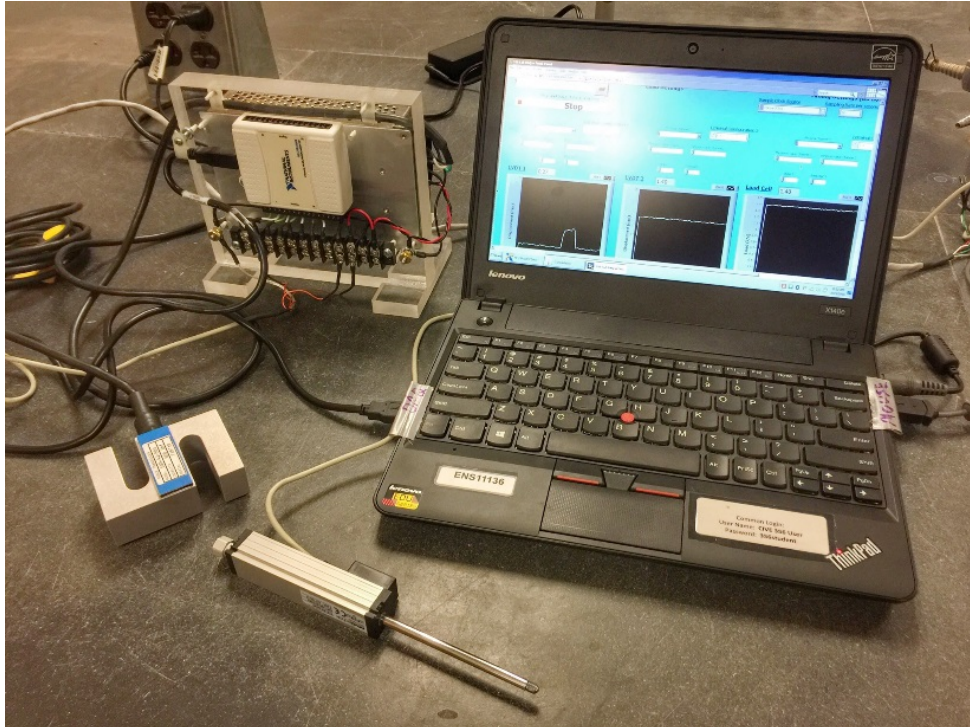


Fig. 1. Photographs of the developed data acquisition equipment for the CIVE 356 lab.

Data acquisition equipment that will be purchased for this proposed project is included in Table 1. Each laboratory station will be equipped with a Microsoft Windows-based laptop, National Instruments DAQ board, 12-V external power supply, two linear potentiometers, and a load cell with signal conditioner. This equipment will provide the necessary measurement capabilities to support testing for the evaluation of engineering properties of soils. Additional miscellaneous items will be purchased and/or fabricated at Colorado State University to support integration of the DAQ equipment. These miscellaneous items include connectors to hold the linear potentiometers, interface load cells with the existing equipment, wires and additional electrical connections to wire the entire DAQ system appropriately, and a mounting block to hold the power supply and external DAQ board.

Table 1. Data acquisition equipment to be purchased for the proposed project.

<b>Item</b>	<b>Manufacturer</b>	<b>Model</b>	<b>Cost per setup</b>
Laptop	HP	ProBook 11 EE G1 Notebook PC	\$600
Multifunction DAQ	National Instruments	NI USB 6009 DAQ board + accessories	\$345
12-V External Power supply	Circuit Specialists/ PowerSupply1	12-V, 5-Amp single output	\$18
1 x 25-mm stroke length DC LVDT	Novotechnik	TRS-0025	\$155
1 x 50-mm stroke length DC LVDT	Novotechnik	TRS-0050	\$162
500-lb Sealed S-Type Load Cell	Interface	SSM-AJ-250	\$288
In-Line Signal Conditioner	Interface	500 In-Line Signal Conditioner	\$280
Protective case	Pelican Products, Inc.	Pelican 1450 Case with Foam	\$95
Connectors & Holders	In-house at CSU	Miscellaneous materials	\$500
<b>Total Cost Per DAQ Setup =</b>			\$2,443
<b>Total Proposal Request for 4 DAQ Setups =</b>			\$9,772

*Dollar or percentage amount requested from ESTC: \$9,772*

### **5. Full description of proposal:**

The undergraduate Civil Engineering curriculum requires students to take Geotechnical Engineering Laboratory (CIVE 356), a 1-credit companion course to CIVE 355, Introduction to Geotechnical Engineering. The laboratory course is structured around a 3-hr laboratory session where students complete fundamental experiments to measure soil characteristics (e.g., composition) and engineering properties (e.g., shear strength). These exercises provide unique, hands-on learning opportunities that allow students to learn techniques in laboratory measurement, data analysis, and report writing while reinforcing and expanding on content covered in lecture (i.e., CIVE 355). During the fall semester of 2015 there were 36 students enrolled in CIVE 356 and there are currently 57 students enrolled for the spring 2016 semester. Thus, on an annual basis approximately 90 students can be expected to benefit from the proposed technology upgrade.

The focus on experiential learning in the laboratory course is highly beneficial to all Civil Engineering undergraduates. Laboratory exercises in CIVE 356 related to engineering property measurement have historically relied on manually reading dial-gage indicators to assess soil deformation and loading during testing. However, modern engineering laboratories incorporate data acquisition and control systems, which are analogous to those integrated into the CIVE 356 lab with the previous ESTC proposal. The objective of this proposal is to further upgrade DAQ in capabilities CIVE 356 to outfit the remaining three laboratory stations with modern DAQ

equipment plus develop an additional setup to provide backup to the DAQ systems in the event there is an electronic issue encountered during a given laboratory exercise.

Data acquisition has been integrated into CIVE 356 such that the DAQ equipment proposed for purchase in this proposal is used during nearly half of a semester. The current laboratory schedule for CIVE 356 is in Table 2. An introduction to DAQ laboratory session has been created to introduce students to their equipment and have them calibrate the displacement transducers and load cell. One of the key deliverables for the introductory session is the development of calibration curves for all sensors that the students will use in the subsequent exercises.

Following the introduction to DAQ laboratory exercise, the students in CIVE 356 use the DAQ equipment and their developed calibration curves for five weeks, which encompass three laboratory exercises: (i) consolidation, (ii) direct shear, and (iii) unconfined compression (Table 2). Each of these laboratory exercises incorporate the DAQ equipment and facilitate ease of data collection for post-processing and analysis. An additional benefit to the DAQ system is that the user interface in LabVIEW allows the students to see the engineering behavior of the experimental specimens in real time. A working knowledge of DAQ technology is critical for Colorado State University graduates understand and implement the methods used to collect data in current engineering practice.

Table 2. Laboratory exercise outline for CIVE 356.

Week	Proposed Laboratory Exercise Outline
1	Lab introduction
2	Soil identification & weight-volume relationships
3	Mechanical sieve & specific gravity
4	Atterberg limits
5	Compaction
6	Hydraulic conductivity
7	Seepage-induced stress (no lab report)
8	<i>Break</i>
9	Intro to data acquisition (DAQ)
10	Consolidation I (incorporating DAQ)
11	Consolidation II (incorporating DAQ)
12	Consolidation III (incorporating DAQ)
13	Direct shear (incorporating DAQ)
14	Unconfined compression (incorporating DAQ)
15	<i>No Labs</i>
16	<i>No Labs</i>

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Integrated camera	HP TrueVision HD camera

	resistant keyboard (tested to IP41 standard) with pick-resistant keycaps
Pointing device	Touchpad with on/off button, taps enabled as default, support multi gestures, two-finger scroll, pinch/zoom, edge swipe
Wireless	Intel Dual Band Wireless-AC 7260 802.11a/b/g/n/ac WiDi (2x2) WiFi and Bluetooth® 4.0 Combo
Power supply	40 W Smart AC adapter
Battery	3-cell, 36 WHr Li-ion
Energy efficiency	ENERGY STAR® certified
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#### Optional Accessories

##### Recommended Accessories

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- Output Overload Protection: 110-150%
- Output Over Voltage Protection: 115-150%
- Withstand Voltage: I/P-O/P: 3.0KVAC/1min; I/P-F/G: 1.5KVAC/1min; O/P-F/G: 0.5KVAC/1min
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- Hold Up Time: 20ms@full load (typical)
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- MTBF: 100,000 hours
- UL Ref. Number: E258719
- EMC Standards: GB9254, EN55022 classB, EN55024, EN61000-3-2,3, EN61000-4-2,3,4,5,6,8,11
- Cooling Method: Convection



Christopher Bareither <chrisbareither@gmail.com>

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1 message

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		Local Contact:	Steve Visosky
Phone:	(970) 491-4660	Phone:	(719) 266-1801
E-mail:	christopher.bareither@colostate.edu	E-mail:	stevev@elotek.com

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1	SSM-AJ-500	Model SSM Sealed S-type Load Cell 500 lbf Capacity with 10-foot Integral Cable	3	\$288.00	\$864.00
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