



**Oregon
University
System**

**Out-of-School Programs for Project-Based Learning in
Engineering and Applied Sciences
2009-2011 Biennium**

OUS Campus:	Oregon State University	
Proposal Title:	Center for Outreach in Science and Engineering for Youth (COSEY) Summer Camps	
Abbreviated Abstract: <i>(please provide a short description of program)</i>	Out of school programs, such as the Boys and Girls Club and 4-H programs, are ideal venues for engaging rural and underserved students in science and engineering activities. The Center for Outreach in Science and Engineering for Youth (COSEY) is developing a library of project-based activity kits with a sustainability theme (biodiesel reactor, fuel and solar cell cars, wind power, etc.) that will be used to engage 4 th -8 th grade students in multi-day summer camps to be held in communities throughout Oregon. Trained college student instructors will deliver sixteen summer camps over the course of two summers, reaching over 700 students in locations ranging from Ontario to Coos Bay. The activity kits developed in this project will serve as valuable long-term resources for out-of-school programs and educators who can borrow them through the COSEY lending library.	
Amount Requested:	\$ 99, 619	Awarded:

Campus ETIC Member	Ron Adams
Title:	Dean, College of Engineering
Phone and Email:	Ronald.lynn.adams@oregonstate.edu ; (541) 737-7722

Program Contact:	Skip Rochefort, Ph.D.
Title:	Associate Professor, Chemical Engineering Director, COE and OSU Precollege Programs
Address:	Center for Outreach in Science and Engineering for Youth Oregon State University, 147 Batcheller Hall, Corvallis, OR 97331-2409
Phone and Email:	Skip.rochefort@oregonstate.edu , (541) 737-2408

Accounting Contact:	Luke McIlvenny
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2) Assumptions

Out of school programs, such as the Boys and Girls Club (B&GC) and 4-H Latino Summer Camps, are ideal venues for engaging underserved students in science and engineering activities. B&GCs play a particularly important role in rural and economically disadvantaged communities where they provide affordable quality programming. Demographically, the majority of B&GC students are from minority families (65% nationally) and many members are below the poverty line. For example, 95% of children enrolled in the B&GCs of Salem qualify for the free and reduced lunch program (2008 Annual Report B&GC Salem).

The important role B&GCs play in poor and rural communities is accentuated during summertime when many families rely on B&GCs for affordable daycare and Clubs swell to capacity. In addition, the 4-H Latino Summer Camps operating in our target rural locations are also fully subscribed. The peak *summer* period is an *ideal time to engage students* with challenging, project-based activities that change their daily routine, generate excitement about science and engineering and refresh concepts and skills they learned during the school year.

The Center for Outreach in Science and Engineering for Youth (COSEY) proposes to leverage proven OSU youth outreach resources to create a set of project-based science and engineering activity kits that will be delivered to B&GCs in Oregon through a series of multi-day summer camps. These summer camps fill a critical need in B&GCs and 4-H programs in rural and economically challenged communities which often lack the resources to deliver project-based science and engineering experiences.

The activity kits designed for this project will align with the new Oregon science and engineering standards and reinforce critical concepts through hands-on applications. Alignment with Oregon standards provides additional opportunities to engage students with diverse learning styles and *strengthens connections between their out-of-school and in-school experiences*. The activity kits will be developed for national dissemination through the TeachEngineering.org web site (see example curriculum module on hydrogen fuel cell cars). The activity kits will be held in the COSEY lending library and will be made available to educators throughout the region long after the period of the grant ends.

3) Project Plan

a) Resources

This project is a collaborative effort between four proven youth outreach organizations at OSU, thirteen B&GCs and three 4-H Latino Summer Camps in rural Oregon. The collaborating OSU organizations are: the Center for Outreach in Science and Engineering for Youth (COSEY), the Office of Precollege Programs, the Hinsdale Wave Research Laboratory and Saturday Academy. The collaborating B&GCs are located in Corvallis, Albany, Lebanon/Sweet Home, Coos Bay and Salem. The 4-H programs are located in Salem, Ontario, and Medford.

The people involved in designing and implementing the summer camps are listed in Table 1: Human Resources. The project will be overseen by Professor Rochefort and Dr. Cole. Dana Beck, the Precollege Programs Coordinator, will be the primary project administrator, coordinating the camps and supervising the student Instructors. Cori Hall, the Director of

Saturday Academy, will design the training curriculum and train the student Instructors as part of the Saturday Academy E-Camp course. Ellen Momsen, Director of Women and Minorities in Engineering, will recruit the student Instructors and assist with training. Alicia Lyman-Holt, Outreach Coordinator for the Wave Lab, will assist in designing modules. Mario Magaña, 4-H Regional Extension Educator, will be the liaison with the Ontario, Medford and Salem 4-H chapters.

Four minority and/or female undergraduate students majoring in science or engineering will be hired as Instructors for ten weeks to implement the Camps. Dana Beck and Cori Hall will receive partial salary support from the grant, while all other personnel efforts and use of facilities in the project will be paid for through in-kind support from OSU, participating Boys and Girls Clubs and 4-H.

Table 1: Human Resources

Name	Title	Role
Skip Rochefort*	Associate Professor, Chemical Engineering, Director of COSEY and OSU Precollege Programs	Lead development of the engineering activity kits and lending library.
Kyle Cole*	Assistant Director, Precollege Programs	Grant and partnership administration, assessment and evaluation.
Dana Beck*	Program Coordinator for OSU Precollege Programs	Program administration, collaboration liaison, scheduling and support (Salary: 0.2 FTE)
Cori Hall*	Director of Saturday Academy at OSU	Lead student instructor training and program management (Salary: 0.1 FTE)
Ellen Momsen*	Director of Women and Minorities in Engineering	Recruitment of student Instructors.
Alicia Lyman-Holt*	Outreach Coordinator for the Hinsdale Wave Research Laboratory	Activity kit development.
Mario Magaña*	4-H Regional Extension Educator	Liaison to 4-H Programs
Camp Instructors (4 TBD)	OSU college students majoring in science or engineering.	Deliver camps at B&GC & 4-H locations, collect assessment data, assist in report writing.
Boys and Girls Club Directors (16)	Directors of B&GCs at locations in Oregon (e.g., Helen Higgins: Corvallis, Jason Yutzie: Lebanon/Sweet Home, Denise Gould: Coos Bay)	Advertise camps, coordinate programming.
*Biographies appended to end of proposal		

b) Budget

Proposal Budget			
Oct. 1, 2009 - Sep. 30, 2011			
	10/1/09 - 9/30/10	10/1/10 - 9/30/11	10/1/09 - 9/30/11
Salary Expenses (for those to be assigned to project)			
Saturday Academy Director (0.10 FTE)	\$ 4,017.60	\$ 4,017.60	\$ 8,035.20
Precollege Program Coordinator (0.20 FTE)	\$ 5,600.00	\$ 5,600.00	\$ 11,200.00
Other Payroll Expenses for above	\$ 6,170.00	\$ 6,170.00	\$ 12,340.00
Undergraduate Instructors	\$ 16,000.00	\$ 16,000.00	\$ 32,000.00
Student OPE	\$ 1,900.00	\$ 1,900.00	\$ 3,800.00
Subtotal	\$ 33,687.60	\$ 33,687.60	\$ 67,375.20
Services (to be subcontracted)			
Marketing and publications	\$ 500.00	\$ 500.00	\$ 1,000.00
Subtotal	\$ 500.00	\$ 500.00	\$ 1,000.00
Supplies (to be consumed during project period)			
Consumable Activity Materials	\$ 1,500.00	\$ 1,500.00	\$ 3,000.00
Subtotal	\$ 1,500.00	\$ 1,500.00	\$ 3,000.00
Equipment (to be retained after project period)			
Engineering Module Materials	\$ 6,000.00	\$ 6,000.00	\$ 12,000.00
Subtotal	\$ 6,000.00	\$ 6,000.00	\$ 12,000.00
Travel			
Enterprise minivan rental	\$ 2,710.00	\$ 2,710.00	\$ 5,420.00
Lodging	\$ 2,712.00	\$ 2,712.00	\$ 5,424.00
Meals	\$ 2,700.00	\$ 2,700.00	\$ 5,400.00
Subtotal	\$ 8,122.00	\$ 8,122.00	\$ 16,244.00
Grand Total	\$ 49,809.60	\$ 49,809.60	\$ 99,619.20

Budget Narrative

\$4,018 in salary and \$2,222 in OPE for Director of Saturday Academy at OSU at 0.10 FTE will cover training of instructors and module testing through SA's Engineering Camp.

\$5,600 in salary and \$3,948 in OPE for Precollege Program Coordinator at 0.20 FTE Dana Beck's duties include: i) Lead coordinator with the B&GC and 4-H site contacts throughout Oregon, including initial contacts, team meetings (OSU and site coordinators), site selection for camps (with local contacts), community involvement for Family Science and Engineering Nights following each camp, and primary daily contact for any of the branch locations throughout the year. ii) Assessment – coordination of data collection for analysis by evaluator and team. iii) Coordinate purchase of supplies for activity kits and for camps. iv) Supervise and provide daily support (primary contact) for undergraduate instructors during the

summer months, and in particular coordinate travel, meals, housing arrangements, and compensation.

\$16,000 in student wages and \$1,900 in OPE for undergraduate COSEY camp Instructors. Each undergraduate would be paid at a rate of \$10 per hour for 40 hours per week for ten weeks of the summer. These instructors will collaboratively teach the activity modules during the 8 weeks of the program and work with Dr. Skip Rochefort to develop activities and assemble modules for dissemination throughout the state.

\$500 for marketing materials to develop and print flyers and to purchase a set of magnetic signs for the van traveling during the summer.

\$1500 in consumable activity materials for five activity modules per year.

\$6000 in reusable activity materials for five activity modules per year. Each module will incorporate 10 sets of activities, to serve a group of 24 students working in groups of three with two extra sets. Example materials include fuel cells, solar cells, lab equipment and materials and prototype construction materials.

\$2710 for Minivan rental using the current OSU rates through Enterprise Rent-A-Car. The cost through Enterprise Rent-A-Car, to pick up the van on a Monday, use it for 8 weeks during the summer, and return the van on a Friday, is a total of 5 days at \$59/day and 7 weeks at \$345/week.

\$2712 for Lodging using the OSU per diem rate of \$113 per day. During three of the weeks of the program, the instructors will stay overnight for four nights during the week. This total covers two hotel rooms for four instructors for twelve nights.

\$2700 for Meals using the OSU per diem rate of \$45 per day per person. During the three weeks of distant travel in this project, full meals will be needed for four instructors during the 5 days during the week of the project.

c) Other Collaborators

Boys and Girls Clubs and 4-H Latino Summer Programs: The COSEY summer camp will strengthen connections between proven OSU outreach organizations and the 4-H and B&GC communities in Oregon. We plan to work with thirteen different B&GCs Directors and three 4-H extension outreach coordinators. We have gotten enthusiastic endorsement from several Directors (see letters of endorsement). The first year of the grant, camps will be held at B&GCs in Corvallis, Albany, Lebanon/Sweet Home, Coos Bay, and Salem, and 4-H groups in Salem, Ontario, and Medford.

Camp locations for the second summer will be determined following our first-year assessment of community needs and project outcomes (See Table 4: Evaluation Plan Timetable).

d) Project Activities

Table 2: Project Activities illustrates the connections between project resources, activities, outputs, outcomes and impacts. Briefly, ETIC resources would be used to:

- Develop project-based activity kits with a sustainability theme (biodiesel reactor, fuel and solar cell cars, wind power, etc.) that align with Oregon Science and Engineering standards. The kits will be developed and beta tested through the established Saturday Academy middle school Engineering Camp. The kits will serve as valuable long-term resources for out-of-school programs and educators as part of the COSEY lending library. Ten different activity kits would be developed over two years and ten copies constructed of each kit for a total of 100 kits available through the COSEY lending library.
- Deliver sixteen multi-day camps over the course of two summers, reaching over 700 students in Corvallis, Albany, Lebanon/Sweet Home, Coos Bay, Salem, Ontario and Medford. Camp schedule: 1 day travel (Mon), 3 days of programming at each site culminating in a Family Science and Engineering Night (Tu-Thr), 1 day travel (Fri).

Table 2: Project Activities

Resources	Activities	Outputs	Outcomes	Impacts
1. ETIC funding a. Administration b. Activity modules c. Camps d. Assessment	Recruit and hire student camp Instructors (2c) Develop and build project-based activity kits (1b, 2b)	>700 minority and economically disadvantaged B&GC and 4-H members in 4-8 th grade gain multi-day project experience.	Camp participants show increased interest and comprehension of science and engineering concepts.	Increased numbers of under-represented students interested in careers in engineering and applied science.
2. OSU Support a. Administration b. Activity modules c. Recruit and train Instructors	Develop curriculum and train student Instructors (2c)	>8000 Instructor/student contact hrs. 100 project-based activity modules deposited in COSEY lending library.	Participants enroll in middle and high school pre-engineering, science and math classes.	Enhanced interaction between B&GC and 4-H communities and OSU outreach programs in engineering and applied science.
3. Boys and Girls Clubs a. Advertising b. Facilities	Coordinate advertising, programming and facilities with B&GC and 4-H partners (1a, 2a, 3, 4)	Minority and female OSU student Instructors receive leadership and teaching experience.	Activity kits are widely disseminated to educators.	
4. 4-H Extension Programs a. Advertising b. Facilities	Travel to Camp location and deliver multi-day programs culminating in Family Science and Engineering Night (1c) Assessment and reporting (1a, 2a)	Instructors are exposed to diverse applications of engineering and learn curriculum skills. Relationship built between OSU and B&GC and 4-H communities.	Instructors develop leadership and teaching skills, become engaged in outreach community and serve as near-peer role models for youth. Increased Community involvement and awareness leads to further programs.	

d) Project Activities Cont'd

- Employ student camp Instructors for ten weeks (1 week of training in conjunction with the Saturday Academy middle school Engineering Camp, 8 weeks of program delivery and 1 week of summative reporting).
- Perform formative and summative evaluations that result in module and program refinement and best practices dissemination.

e) Schedule

The project schedule is detailed in Table 3 below.

Table 3: Project Schedule

Quarter Ending	Planned Activity and Outputs	Responsible persons by name	Milestones & target dates
Dec. 2009	<ul style="list-style-type: none"> • Select activities for five modules • Identify and secure program liaisons in partner sites 	<ul style="list-style-type: none"> • Rochefort, Lyman-Holt • Cole, Beck 	<ul style="list-style-type: none"> • Modules selected and liaisons secured by 12/1/09
Mar. 2010	<ul style="list-style-type: none"> • Design, build and test each of the five activity modules • Coordinate with partners to set year one summer program dates 	<ul style="list-style-type: none"> • Rochefort, Lyman-Holt • Beck 	<ul style="list-style-type: none"> • All modules ready for kits and dates set by 3/26/10
Jun. 2010	<ul style="list-style-type: none"> • Recruit and hire student instructors • Finalize and construct kits • Train instructors in conjunction with Saturday Academy Engineering Camp 	<ul style="list-style-type: none"> • Hall, Rochefort, Momsen • Rochefort, Beck, instructors • Rochefort, Hall, Beck 	<ul style="list-style-type: none"> • Instructors recruited by 5/15/10 and hired by 6/1/10 • Modules finalized by 6/4/10 & constructed by 6/18/10 • Instructors trained the week of 6/21/10-6/25/10
Sep. 2010	<ul style="list-style-type: none"> • Deliver COSEY camps across the state • Year one summative assessment 	<ul style="list-style-type: none"> • Beck, Instructors • Instructors, Rochefort, Beck, Cole, Hall, Lyman-Holt 	<ul style="list-style-type: none"> • Camp delivery: 6/28-8/20/10 • Post-camp eval. 8/23-27/10 complt. assess. by 9/30/10
Dec. 2010	<ul style="list-style-type: none"> • Implement lending Library and submit activities to teachengineering.org website • Re-evaluate partnerships and confirm contacts for year two • Modify first set of five modules and begin second set of modules 	<ul style="list-style-type: none"> • Rochefort, Lyman-Holt, Beck • Cole, Beck • Rochefort, Lyman-Holt 	<ul style="list-style-type: none"> • Lending library for first set of modules implemented by 11/15/10 • Set two of modules selected and liaisons confirmed by 12/1/10
Mar. 2011	<ul style="list-style-type: none"> • Design, build and test second set of five activity modules • Coordinate with partner sites to set year two program dates 	<ul style="list-style-type: none"> • Rochefort, Lyman-Holt • Beck 	<ul style="list-style-type: none"> • All modules ready for kits and dates set by 3/25/11
Jun. 2010	<ul style="list-style-type: none"> • Recruit and hire student instructors • Finalize and construct kits • Train instructors in conjunction with Saturday Academy Engineering Camp 	<ul style="list-style-type: none"> • Hall, Rochefort, Momsen • Rochefort, Beck, instructors • Rochefort, Hall, Beck 	<ul style="list-style-type: none"> • Instructors recruited by 5/15/11 and hired by 6/1/11 • Modules constructed by 6/17/11 • Instructors trained 6/20/10-6/24/11
Sep. 2011	<ul style="list-style-type: none"> • Deliver COSEY camps across the state • Begin final summative Assessment 	<ul style="list-style-type: none"> • Beck, instructors • Instructors, Rochefort, Beck, Cole, Hall, Lyman-Holt 	<ul style="list-style-type: none"> • Camp delivery: 6/27-8/19/11 • Post-camp evaluative meeting 8/22-26/11
30 days after	<ul style="list-style-type: none"> • Final report including summative evaluation 	<ul style="list-style-type: none"> • Beck, Rochefort, Momsen, Hall, Lyman-Holt 	<ul style="list-style-type: none"> • Final report due 10/30/11

4) Intended Results

a) Outputs

Table 2: Project Activities illustrates the intended project Outputs which include:

- **>700 students served** (16 camps x 48 students = 768 students). Eight Camps will be held at different locations each summer for a total of sixteen camps over two summers. Each camp will contain three days of programming and will be divided into a three hour morning session for 4-5th graders and a three hour afternoon session for 6-8th graders. The Instructors can accommodate 24 students per session for a total of 48 students per camp location. The Instructor:Participant ratio will be 1:8. Each student will receive 11 hours of contact with the Instructor for a total of (768 students x 11hrs) = **8448 total contact hours**.
- Four minority and female undergraduate students will receive leadership and teaching instruction in 40 contact hours with science outreach professionals (Hall, Momsen, Beck). Instructors receive valuable teaching and leadership experience through **176 contact hours with 4th-8th grade students**.
- Ten sustainability project-based activity kits will be developed and ten copies of each kit (**For a total of 100 kits**) will be deposited in the COSEY lending library.
- A strong **partnership** is built between OSU outreach organizations and the B&GC and 4-H communities.

b) Outcomes

Table 2: Project Activities illustrates the intended project Outcomes which include:

- Camp participants will show **increased interest in, and comprehension of**, science and engineering **concepts** (as determined in the formative assessment plan, see Table 4).
- Participants will show **increased interest in** enrolling in middle and high school pre-engineering, science and math **classes**.
- Activity **kits will be widely disseminated** to educators through the COSEY lending library.
- Instructors **develop** leadership and teaching **skills**, become **engaged in the youth outreach** community and serve as near-peer role models for the camp participants.
- **Increased B&GC and 4-H community involvement** and awareness of science and engineering programs leads to further collaboration and establishment of new programs.

c) Impacts

Table 2 illustrates the intended project Impacts which include:

- **Increased numbers of under-represented students** interested in careers in engineering and applied science.
- Enhanced **interaction and long-term partnerships** between B&GCs and 4-H communities and OSU youth outreach programs in engineering and applied science.

5) Evaluation Plans

Table 4: Evaluation Plan Timetable illustrates the evaluation methods and timing for this project. Formative evaluations will be performed at several stages to gauge our program outputs and outcomes. Early evaluations will enable us to optimize the activity kits to our target audiences.

Some of the evaluation tools that will be used for this project include:

- Regular participant surveys collecting information during the camps to gauge the quality of experience, changes in attitudes towards science and engineering and suggestions for program improvement.
- Tracking student attendance and persistence of participation.
- Tracking increases in knowledge, skills and confidence, and attitude towards subject matter.
- Collecting student demographic personal data to enable long-term tracking of further involvement in precollege and youth programs.

Summative evaluations will be performed to gauge the success of our project outputs and outcomes. The number of participants, their demographic information, contact time, and the results of pre and post surveys will be summarized. In addition, staff and instructors surveys will be used to evaluate and improve the program for smoother future operations.

Table 4: Evaluation Plan Timetable

Activity and Measurable Outputs	Evaluation Plan	Target dates
<ul style="list-style-type: none"> • Design, build and test each of the five activity modules • Finalize and construct kits 	<ul style="list-style-type: none"> • Formative assessment of activity for engagement, age-appropriateness, content, ease of use, efficacy. • Beta test kits during E-Camp. 	<ul style="list-style-type: none"> • Iterative assessments begin Jan. 2010 and results in finalized design by 3/26/10
<ul style="list-style-type: none"> • Train instructors in conjunction with Saturday Academy Engineering Camp 	<ul style="list-style-type: none"> • Pre and post training formative assessments will be given to student Instructors to gauge improvement in teaching skills and content knowledge related to the activity kits. 	<ul style="list-style-type: none"> • Formative surveys given during training week 6/21/10-6/25/10 • Results summarized in quarterly report
<ul style="list-style-type: none"> • Deliver COSEY camps across the state • Year one summative assessment 	<ul style="list-style-type: none"> • Instructors will collect student personal and demographic data, track attendance, assess participant changes in attitude and improvement in content knowledge. Information will be recorded in database. 	<ul style="list-style-type: none"> • Assessment during camp delivery: 6/28-8/20/10 • Post-camp evaluation 8/23-27/10 and complete summative evaluation report by 10/30/10.
<ul style="list-style-type: none"> • Re-evaluate partnerships and confirm contacts for year two • Modify first set of five modules and begin second set of modules 	<ul style="list-style-type: none"> • Summative data will be evaluated and discussed in a meeting of partners, instructors and staff. • Develop year-two plan based on evaluation data and feedback. • Identify and contact new partners. 	<ul style="list-style-type: none"> • Lending library for first set of modules implemented by 11/15/10 • Set two of modules selected and liaisons confirmed by 12/1/10

Note: Year Two evaluation plan will be developed following analysis of Year One outputs and outcomes.

6) Commitment Form from OSU

Proposing Organization Commitment Form

Name of submitting department and campus:

College of Engineering, Oregon State University

Our organization will commit to implement the project as described in this proposal if it is accepted and funded.

Comments:



Signature of authorized official

9/23/09

Date

Print Name: Jim Lundy

Title: Executive Associate Dean COE

Phone: (541) 737-5235

Email Address: Jim.Lundy@Oregonstate.edu

Mailing Address:

Chemical Engineering Department
Oregon State University, Gleeson Hall,
Corvallis, OR 97331

7) Commitment Form from B&GC

Collaborating Organization Commitment Form

Legal Name of Organization: Boys & Girls Club of Corvallis

Our organization will commit to participating in the project described by this proposal if it is accepted and funded.

Comments:

I am writing on behalf of the Boys & Girls Club of Corvallis in support of the grant proposal, ***Center for Outreach in Science and Engineering for Youth (COSEY) Summer Camps.***

At the Boys & Girls Club of Corvallis, we know firsthand the impact of out-of-school programs and project-based learning for students of all ages as it is a central part of our mission in allowing each member to reach their full potential and become productive, responsible and caring citizens. Additionally, introducing youth to science and engineering through fun and instructive hands-on activities aligns with our dedication to career development and education programming.

The Boys & Girls Clubs of America reach over 4.5 million youth in 4,300 locations in all 50 states. The majority of these (65% nationally) are from minority families and many members qualify for free and reduced lunch at their schools. The Boys & Girls Clubs are committed to offering assistance and inspiration to the youth who need it the most.

The Boys & Girls Club of Corvallis serves nearly 10,000 youth across our community and represents a diverse population, including approximately 30% minorities. Additionally, 45% of our members qualify for free/reduced lunch at their schools. Finally, 49% of our members are female.

Other Oregon Clubs vary in their demographic makeup and range in location from urban centers (Portland) to rural outposts (Madras). However, all branches reach out to underrepresented and minority populations to give them a safe place to learn and grow.

Why do we support this initiative?

As described above, Boys & Girls Clubs represent a diverse population of students who benefit the most from our blend of academic, athletic, creative, and life-enhancing programs. The Boys & Girls Clubs are ideal markets to expose minority, underrepresented and/or at-risk youth to the applied science and engineering fields.


The Corvallis clubhouse hosted 800 unique participants during the summer of 2009 in a variety of structured and informal programs that ranged from art, recreation, ceramics to learning how to work in an audio mixing lab. We lack the ability to offer science based programs during the summer and often during the school year. Our Club enthusiastically supports this collaboration as a way to support science education and bring these unique opportunities to the youth who would not have access without this program.

Additionally, the Summer Camps will connect college undergraduates with members of the B&GCs. These university students serve as informal role models for students who may be first generation college students.

The creation of project kits for science and engineering activities and stored in a lending library of resources ensures that the Corvallis Boys & Girls Club will be able to utilize the materials on a long term basis. The project kits and hands-on activities will tie into the Oregon state content standards for science for each grade level, providing a much needed link between out-of-school programming and state assessment.

In summary, by introducing applied science and engineering concepts through project-based learning in an out-of-school environments, students will be more engaged and intrigued than in a classroom-based setting. As free-choice learners in a familiar locale, members are open to new content, which often sparks a passionate interest in a particular subject. By offering the COSEY Summer Camps at B&GC's throughout the state, we believe students will explore science and engineering through interactive activities to pique their interest for future studies.

Sincerely,
Helen Higgins
CEO
Boys & Girls Club of Corvallis

Signature:  Date: 9/29/2009

Print Name: Helen Z Higgins

Title: CEO Phone: 541.757.1909 x201

Email Address: hhiggins@bgccorvallis.org

Mailing Address:
1112 NW Circle Blvd Corvallis, OR 97330

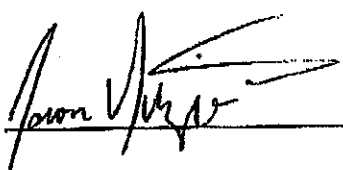
7) Commitment Form from B&GC

Collaborating Organization Commitment Form

Legal Name of Organization: Boys & Girls Clubs of the Greater Santiam

Our organization will commit to participating in the project described by this proposal if it is accepted and funded.

Comments:

Signature:  Date: September 30, 2009

Print Name: Jason Yutzie

Title: Chief Professional Officer Phone: 541-258-7105

Email Address: Jason@bgcleveland.org

Mailing Address:
305 S. 5th
Lebanon, OR 97355



BOYS & GIRLS CLUBS
OF THE GREATER SANTIAM

I am writing on behalf of the Boys & Girls Clubs of the Greater Santiam in support of the grant proposal, *Center for Outreach In Science and Engineering for Youth (COSEY) Summer Camps*.

At the Boys & Girls Club, we know firsthand the impact of out-of-school programs and project-based learning for students of all ages as it is a central part of our mission in allowing each member to reach their full potential and become productive, responsible and caring citizens. Additionally, introducing youth to science and engineering through fun and instructive hands-on activities aligns with our dedication to career development and education programming.

The Boys & Girls Clubs of America reach over 4.5 million youth in 4,300 locations in all 50 states. The majority of these (65% nationally) are from minority families and many members qualify for free and reduced lunch at their schools. The Boys & Girls Clubs are committed to offering assistance and inspiration to the youth who need it the most.

The Boys & Girls Clubs of the Greater Santiam serves 2900 youth in the community and represents a diverse population, including 15% minorities. Additionally, 35% qualify for free/reduced lunch at their schools. Finally, 51% are female members.

Other Oregon chapters vary in their demographic makeup and range in location from urban centers (Portland) to rural outposts (Madras). However, all branches reach out to underrepresented and minority populations to give them a safe place to learn and grow. Why do we support this initiative?

As described above, Boys & Girls Clubs represent a diverse population of students who benefit the most from our blend of academic, athletic, creative, and life-enhancing programs. The Boys & Girls Clubs are ideal markets to expose minority, underrepresented and/or at-risk youth to the applied science and engineering fields.

The Lebanon & Sweet Home Clubs had average Daily attendance of 150 participants during the summer of 2009 in 3 programs that ranged from music lessons to the newspaper Club. However, there were not any summer programs offered that touched on scientific themes. Hence, there is a real need for more programming that engages young people in STEM fields outside of school.

Additionally, the Summer Camps will connect college undergraduates with members of the B&GCs. These university students serve as informal role models for students who may be first generation college students.

The creation of project kits for science and engineering activities and stored in a lending library of resources ensures that Oregon B&GCs will be able to utilize the materials on a long term basis. The project kits and hands-on activities will tie into the Oregon state content standards for science for each grade level, providing a much needed link between out-of-school programming and state assessment.

In summary, by introducing applied science and engineering concepts through project-based learning in an out-of-school environment, students will be more engaged and intrigued than in a classroom-based setting. As free-choice learners in a familiar locale, members are open to new content, which often sparks a passionate interest in a particular subject. By offering the COSEY Summer Camps at B&GC's throughout the state, we believe students will explore science and engineering through interactive activities to pique their interest for future studies.

Sincerely,
Jason Yutzie
Chief Professional Officer

The Positive Place For Kids

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Dear ETIC Proposal Review Board,

I am writing on behalf of the Oregon 4-H Youth Development Program in support of the grant proposal, *Center for Outreach in Science and Engineering for Youth (COSEY) Summer Camps*.

At 4-H, we know firsthand the impact of out-of-school programs and project-based learning for students of all ages as it is a central part of our mission to help young people **learn** and **grow** through an intentional process that builds competence, confidence, connection, compassion and character. At 4-H we are committed to experiential education, and “learning by doing,” especially in the fast-growing areas of science, engineering and technology (SET).

4-H currently provides 5.9 million youth in urban, suburban and rural communities across the country with hands-on learning experiences that foster exploration, discovery, and passion for the science (4-H Science, Engineering & Technology Program Report, 2008). 4-H has said they want to involve one million new young people in SET projects over the next five years (National 4-H Council, 2007).

Oregon’s 4-H program boasts offices in all 36 counties, reaching over 126,000 students. 4-H is committed to diversity, including 9.6 minorities and 67% female. For example, in 2004 the 4-H program created the *International Latino Summer Camp* that brought 64 youth to the 4-H Center in Salem, OR. By the year 2009, the camp has gained such status among children and families that this year we brought more than 320 students in 3rd to 12th grades, leaving at home dozens of students on our waiting list unable to attend; 55 high school volunteer camp counselors, and about 80 adult volunteer parents and professionals. Additionally, 25% of Oregon's Latino families live below the federal poverty level, according to the 2007 American Community Survey, compared with 9% of non-Latino white families. 4-H holds an especially esteemed position in rural communities, with 71% rural population.

The young people that participate in 4-H programming come from a diverse array of locations and backgrounds with differing levels of accessibility to SET project-based learning. By working with the COSEY summer camps, we would be introducing these underrepresented populations to valuable skill sets that tie into future learning opportunities. In 2008, 4-H SET programs covering 20 counties focused on electronic media, GIS/GPS, rocketry, Lego robotics, and renewable energy. However, we are always looking for new ways to engage participants in more subject areas as well as in more county locations. The creation and dissemination of

project kits for science and engineering activities and stored in a lending library of resources ensures that Oregon 4-H offices will be able to utilize the materials on a long term basis. The project kits and hands-on activities will tie into the Oregon state content standards for science for each grade level, providing a much needed link between out-of-school programming and state assessment. Additionally, the Summer Camps will connect college undergraduates with members of 4-H. These university students serve as informal role models for students who may be first generation college students.

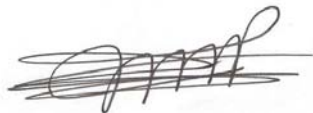
Our faculty and partners all over the state are our key contacts to connect with minority and rural students in Oregon. In Ontario, Carlos Nuñez from the Ontario School District; and in Medford, Alexandra Steiner from Jackson County Extension Service are committed to collaborate in our programs, and we will facilitate those interactions. Their contact information is provided below:

Carlos Nunez: cnunez@ontario.k12.or.us
Ontario School District, Ontario , OR 97914
Phone: 541-889-5374

Alexandra Steiner
OSU Extension Service, 569 Hanley Rd. Central Point, OR 97502
Phone: 541-776-7371

In summary, by introducing applied science and engineering concepts through project-based learning in an out-of-school environment, students will be more engaged and intrigued than in a classroom-based setting. As free-choice learners in a familiar locale, members are open to new content, which often sparks a passionate interest in a particular subject. By offering the COSEY Summer Camps at 4-H Centers throughout the state, we believe students will explore science and engineering through interactive activities to pique their interest for future studies.

Sincerely,

A handwritten signature in black ink, appearing to read 'Mario A. Magaña', with a stylized flourish at the end.

Mario A. Magaña
OSU Associate Professor and 4-H Regional Educator
Founder and Director, International Latino Summer Camp
Mario.Magana@oregonstate.edu

BIOGRAPHIES (alphabetical order)

DANA BECK works as the Coordinator in the Office of Precollege Programs at Oregon State University and is responsible for Middle School Visits, a program that brings over 2500 mostly underrepresented and minority students to campus for an early and engaging college experience. A graduate of Wesleyan University with a B.A. in History, her expertise with youth programs was honed working as the marketing director and an administrator for an overnight summer camp. She is a part-time graduate student in OSU's College Student Services Administration program.

KYLE COLE has over 17 years of science teaching experience and currently serves as the Assistant Director of Precollege Programs at Oregon State University. His responsibilities include strategic planning, grant writing, program oversight, assessment design and data collection and analysis. His education experience includes numerous teaching appointments, most recently serving as a Lecturer in Applied Physics at Stanford University. While at Stanford, he served as the K-12 Education Director for an NSF nanotechnology research center. Kyle received his PhD in Biology from Yale University and proceeded to explore new applications for DNA microarrays as a Research Manager at the biotech company Affymetrix prior to returning to academia.

A. CORI HALL Director of OSU's Saturday Academy program, has six years of experience in university outreach at Oregon State University. She has a B. S. in General Biology from U. C. San Diego and Ed. M. in College Student Services and Administration from OSU. Cori oversees the OSU-based satellite Saturday Academy office, with a mission of inspiring young people to explore their world through hands-on learning with community experts and professionals. Her primary role includes managing the classes and workshops program and local high school Apprenticeships in Science and Engineering (ASE) program, securing funds for the sustainability of the program, maintaining a strong partnership with the Saturday Academy chartering non-profit organization in Portland, and working collaboratively with faculty, students, and local professionals engaged in outreach to youth. Cori worked for three and a half years at OSU's (SMILE) Science and Math Investigative Learning Experiences Program, coordinating science and engineering programs for rural teachers and 4th – 12th grade students of underrepresented populations. She lead teacher workshops in middle school engineering curriculum, managed the college student mentor program, and was the lead advisor for a summer bridge program for incoming OSU students. Cori also spent a year in the rural south with Americorps National Civilian Community Corps and worked professionally as a winery laboratory technician. As recipient of the OSU College of Education Four C's of Caring award in 2005 and the Americorps NCCC Southeast Region Humanitarian Award in 2002, Cori brings a commitment to service and passion for bringing university level research to K-12 audiences to her daily work.

ALICIA LYMAN-HOLT is the education and outreach coordinator at the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) Tsunami Research Facility housed at the O.H. Hinsdale Wave Research Laboratory at Oregon State University (OSU). Her experience with education and outreach began as a college undergraduate where she volunteered in local elementary schools in Walla Walla, WA. She participated in an NSF GK-12 Fellowship teaching elementary school science and volunteering at outdoor schools; this experience solidified her dedication and enthusiasm to education and outreach. She earned her BA in Biology/Environmental Science from Whitman College and her MS in Environmental Soil

Science from Oregon State University. She has led tours for the general public and K-12 at the OSU NEES site, serving over 3000 visitors a year. She has developed hands-on activities to enhance the educational tours, served as the NEES site-wide REU coordinator, and served on numerous NEES education and outreach committees. In 2006, she received the NEES “Most Effective Education, Outreach and Training Activity” award.

ELLEN MOMSEN has been active in science/mathematics education for over twenty years. As Director of the Women and Minority in Engineering Program, she has developed and manages the freshman research experience, an active REU program, the women in engineering orientation class, and a pilot supplemental instruction program for freshman courses. During her high school teaching career, her area of special interest has been in working with under-represented students and assisting them in achieving in science and mathematics. She motivated secondary students to continue in scientific studies by promoting and coaching science competitions, including the Science Olympics, the Academic Pentathlon, and Orienteering. As MESA advisor, she directed academic enrichment activities. Ellen was recognized for her teaching skills and named as Mentor Teacher for newly hired secondary science and mathematics teachers for Los Angeles Unified School District, and instructed the required Science Methods course for novice teachers. She has been active in promoting activity based learning programs. In 2002, Ellen was named as Oregon’s first Physics Teacher in Residence, one of only 6 such teachers honored in the United States. She spent a year on the campus of Oregon State University assisting professors in the Physics Department develop interactive lessons for undergraduate students. Currently, Ellen is employed as the Director of the Women and Minorities in Engineering Program at Oregon State University. As the first director of this program, she is responsible for developing and implementing activities and programs to recruit and retain more women and minority students to the College of Engineering.

SKIP ROCHEFORT is currently an Associate Professor of Chemical Engineering and the Director of OSU and COE Precollege Programs (<http://oregonstate.edu/precollege>) at Oregon State University. In addition to teaching and research, he has served as both the Head Advisor and First Year Student Advisor for Chemical, Biological, and Environmental Engineering. He has taught the Introduction to Engineering course for the last 10 years. He is an OSU Honors College faculty and has been recognized for his teaching and advising activities with numerous COE, OSU and National awards, such as: 2009 Outstanding Honors College Research Mentor; 2005 OSU Lorne D. McKinley Science Educator Award; 2004 OSU Dar Reese Excellence in Advising Award; 2004 College of Engineering Austin-Paul Outstanding Advisor Award; 1998 National AIChE Outstanding Faculty Advisor; 1998 ASEE Dow Outstanding New Faculty Award ; 1997 University Faculty Advisor of the Year (ASOSU); 1996 COE Loyd Carter Outstanding Teacher Award. His research interest for the last 30 years has been in all areas of Polymer Engineering and Science, and for the last 15 years, Engineering Education. His passion is K-12 outreach for the recruitment and retention of women and minorities into engineering, with the current focus on introducing engineering science at the middle school and high school levels. He has been active in the Saturday Academy ASE program (19 student interns), and as founder and director of the Summer Experience in Science and Engineering for Youth program, which has served over 450 high school students since summer 1997.

Activity: Hydrogen Fuel Cells

Summary

In this activity, students will work together in small groups to build a K'nex car that can travel a short distance using a hydrogen fuel cell. There will be a competition among all of the groups to see which groups' car can travel the closest to 20 feet. Students will learn how to use hydrogen fuel cells and the science behind them. They will also learn to problem solve in a group.

Engineering Connection

Engineers around the world are working to make hydrogen fuel cells a viable alternative to oil based fuels. Chemical, Electrical and Mechanical Engineers are all involved in this research area. Chemical Engineers have been working on hydrogen fuel cells since the very first one in the 1960s. Electrical and Mechanical Engineers are applying this technology to cars today. This project allows students to integrate the chemistry of fuel cells with mechanical and problem solving challenges. Students will redesign their cars and change the amount of fuel they use as they try and reach an exact distance. This allows them to incorporate control as well as basic mechanical design into their project.

Contents

1. [Learning Objectives](#)
2. [Materials](#)
3. [Introduction/Motivation](#)
4. [Procedure](#)
5. [Attachments](#)
6. [Troubleshooting Tips](#)
7. [References](#)

Grade Level: 6-8

Group Size: 2-3

Time Required: 4 hours

Activity Dependency ⓘ:None

Expendable Cost Per Group ⓘ: US\$ 134 (once)

Keywords: hydrogen, fuel cell, water, sustainability

Reviews: [Read Reviews](#) | [Be the First to Write a Review](#)

Related Curriculum ⓘ:

subject areas [Science and Technology](#)

lessons [Generators: Three Mile Island vs. Hoover Dam](#)

Educational Standards ⓘ:

Related Standards for Oregon

- Oregon Science ▾

- Design, construct, and test a possible solution to a defined problem using appropriate tools and materials. Evaluate proposed engineering design solutions to the defined problem. (6-8)
- Describe examples of how engineers have created inventions that address human needs and aspirations. (6)
- Define a problem that addresses a need and identify constraints that may be related to possible solutions. (7-8)
- Explain how new scientific knowledge can be used to develop new technologies and how new technologies can be used to generate new scientific knowledge. (7)
- Describe and evaluate the environmental and societal effects of obtaining, using, and managing waste of renewable and non-renewable resources. (7)
- Explain how creating a new technology requires considering societal goals, costs, priorities and trade-offs. (8)

Learning Objectives [\(Return to Contents\)](#)

After this activity, students should be able to:

- To understand how hydrogen fuel cells use oxygen and hydrogen to produce water and electricity
- How this chemistry can be used to engineer sustainable transportation
- Learn how to design a electro-mechanical device
- Practice trial and error, redesign and control of the vehicle
- Learn the difference between fuels that produce green house gases (such as CO₂) and ones that do not.

Materials List [\(Return to Contents\)](#)

For students:

- 2 AA battery pack (3 Volts)
- Batteries (AA rechargeable best)

- Four alligator clips
- Knex kit with:
 - 20 blue circles
 - Four small wheels with treads
 - Extra small wheel
 - Basic rods and connectors for building purposes
- Three thin rubber bands
- Four zip ties
- 1.5 Volt DC motor
- Fuel cell with storage tanks
- DI water beaker
- DI water syringe
- Photocell
- Photocell banana plugs
- Paper towels
- Zip-lock bags (one per group)

For instructors / helpers

- Tape measure
- Meter or yard stick (preference)
- Stop watch (two for large classes)
- Paper and pencil or spread sheet for recording distances and times
- Masking tape
- Sharpie
- Calculator
- Prizes for winning team (optional)

Introduction/Motivation [\(Return to Contents\)](#)

Today, fuel is a very important issue, due to rising oil prices, oil dependency and the pollution caused by oil. The world needs a new fuel that is easily assessable, cheap and clean. Is there an easy solution? The solution may be in one of the most abundant elements on earth, hydrogen! Hydrogen is easily produced from water, through a process called electrolysis, where an electrical current splits the hydrogen and oxygen atoms. Though Electricity is needed to split water into its components, solar cells can be used to capture and convert the suns light into electricity. Hydrogen fuel cells have been created to use hydrogen gas and oxygen gas as fuel. They use a proton exchange membrane, PEM, to strip the

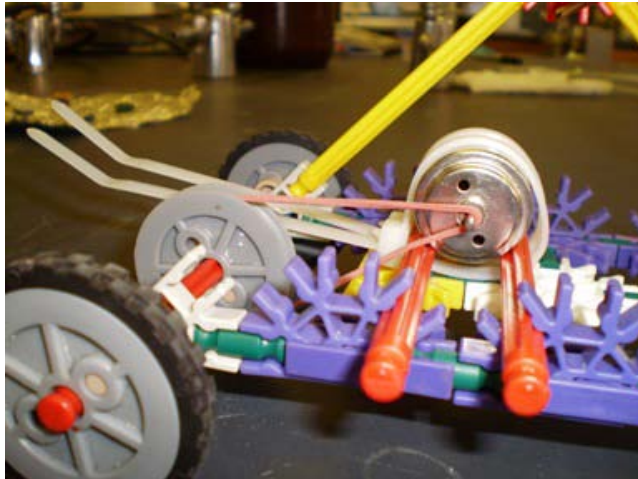
electrons from the hydrogen, creating an electrical current. Once the electrons have been used they recombine with the hydrogen and the oxygen to create water. No pollution is created by a hydrogen fuel cell, only water!

Have you ever been in a large city with really noisy buses and cars? With hydrogen fuel cell cars most of the noise from these cars and buses would be eliminated. The smell that is emitted from the exhaust of the vehicles would also be eliminated! Hydrogen and oxygen can both be easily extracted from water which is very abundant on the earth's surface. With water as the only product of hydrogen fuel cells, they provide an excellent alternative to gasoline. In this activity, you learn about the applications of hydrogen fuel cells and the chemistry behind the fuel cells.

Activity [\(Return to Contents\)](#)

Students will be given a kit that contains all the parts to build a car that is powered with hydrogen fuel cell. For this project, students are placed in groups of two or three and design a fuel cell powered car that can travel exactly 20 feet. This goal helps to enforce the engineering principle of redesign and control. Groups will have to consider how much fuel to use, how many pieces to use and how to place their motors in order to reach the exact goal of 20 feet. This often requires students to reflect on the model they have built and ask the question "how can I improve my vehicle"? Secondary prizes can also be rewarded to cars that go the farthest and cars that go the fastest.

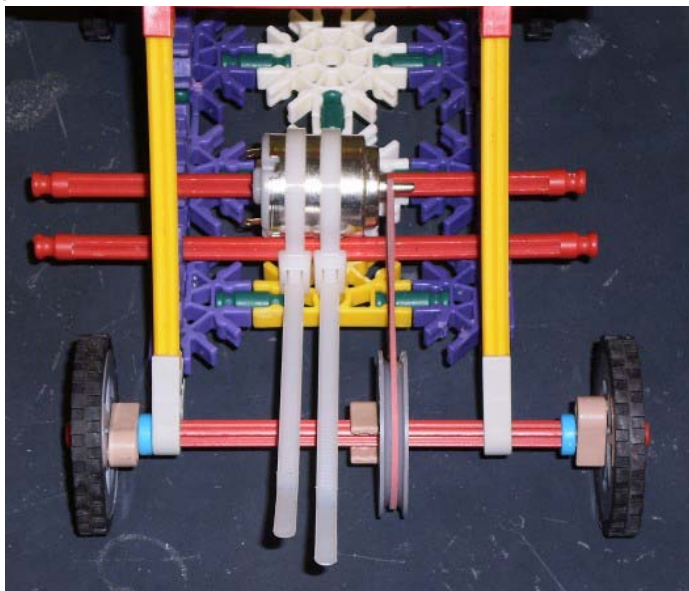
The most challenging part of this project is creating the drive train mechanism. The fuel cells do not provide enough power to turn the axles by themselves. A system to increase the mechanical advantage must therefore be used. The best way to do this is to use a motor with a small spindle, a rubber band and a spare wheel that can be used as a pulley to drive the axle.



The wheels will need to be attached to the drive train axle using the small tan connectors. This will ensure that the wheels will transfer motion from the motor to the vehicle.

The best way to attach the motor is to zip tie it to two parallel rods. This will ensure that the motor will not tilt towards the axle due to the tension in the rubber band. If this happens, the rubber band usually falls off.

These cars should be small in size. Students building large cars with many pieces should be redirected to build cars that are lighter.



Procedure [\(Return to Contents\)](#)

Before the Activity

- Set up K'nex kits with the appropriate number of pieces.
- Prepare the electronic and non-K'nex pieces in a zip-lock bag (motor, alligator clips, battery pack, zip ties, rubber bands and syringe)

- Prepare handouts on fuel cell operation and trouble shooting, “What is a fuel cell” and “fuel cell fun facts” (see attachments).
- Prepare a track for the students to race using masking tape markers every 3 feet or 1 meter (depending on preference)
- Obtain DI water and prepare one container for each group

Pre-activity discussion and introduction to fuel cells (45 – 60 minutes)

- Introduction to fuel cell chemistry
- Advantage over conventional gasoline engines (no CO₂ produced)
- Proton Exchange Membrane (PEM) discussion
- Current use of fuel cells today
- Introduction to competition
- Hints for building cars with proper drive train and power

Fuel Cell Operation instructions (10-15 minutes):

Here is the proper way to perform hydrolysis on your fuel cell:

- Pass out all the DI water, fuel cells and electronic components
- Fill the **bottom** of both cylinders with DI water. Get them as full as possible. Put the lid back on. If a large bubble appears, remove lids and try again.
- Put a paper towel underneath your fuel cell
- Connect the **POSITIVE** side of the battery pack to the **RED** lead and the **NEGATIVE** side of the battery pack to the **BLACK** lead.
- The hydrolysis process has now started. The gases will displace the water in both cylinders, causing the water to rise up through the top portion. Hydrolyze until a desired amount of fuel has been reached or until the cylinders are full. When there is enough fuel, disconnect the battery.
- The fuel cell is now charged with hydrogen and oxygen. The fuel cell can now be connected to your car or motor (reversing polarity will reverse direction of rotation)

The hydrogen fuel cells you are using are extremely vulnerable to contamination is handled incorrectly. To use your hydrogen fuel cell safely, make sure that:

- Only **clean DI water** is used for operation
- Put water on both the **hydrogen and oxygen side of the cell**

- Make sure to connect the terminals to the proper polarity (**negative to black and positive to red**)
- Avoid dropping and large impacts
- Use a battery pack that does not exceed the recommended voltage for the fuel cell. For these cells, no more than 3 volts should be used.
- Run fuel cells only when you need to. Repeated use causes them their power to diminish temporarily.

Car design (50 – 75 minutes)

- The students will split up into groups
- Mentors should observe groups and help them develop the proper power train system
- Allow students to practice using battery packs before installing the fuel cells to make sure their rubber band will power their car without slipping off
 - Note that the batteries will be at least twice as powerful as the fuel cell. This is just to make sure the car travels straight and without rubber band slippage
- Make sure to include space in the car for the fuel cell itself
- Once the students have a car that can move, allow them to connect the fuel cell

Competition (45 – 60 minutes)

- Allow students to practice on the track. The actual competition can be done in two different ways (or another depending on teacher preference). These are the ways it has been done before
 - As many trials as you can get:
 - Let them record every trial as an official run
 - Advantages:
 - If fuel cell or car stop working they will for sure have some good data
 - Easy to organize
 - Disadvantages
 - Less thought into specific runs
 - Students try and get as many trials as possible (can get crowded)
 - Two or Three real runs max (not including practice)
 - Advantages:

- Students can be more precise on actual runs
- Less data recording (for the instructors)
- Less crowded track
- Disadvantages:
 - Repeated practice may cause fuel cell power to diminish
 - Fuel cells are not necessarily repeatable to one or two feet with the same amount of hydrolysis
- (We usually let the students record every run as an official run due to fuel cell repeatability)
- Designate at least one person to record distances and times. For large groups, use two tracks.
- If possible, use a spreadsheet that can record distance and time and automatically calculate speed (see attachments)
- Students should also record all their own distances and times on their own paper

Post activity discussion and awards (15 -20 minuets)

- Students with most accurate cars can receive a prize (dollar tree works best)
- Lead discussion on what worked and what didn't work for car design
- Discuss the importance of the trial, error, redesign and control method
- Congratulate everyone on a job well done

Attachments [\(Return to Contents\)](#)

- [Hydrogen Fuel Cells Today! Power Point](#)
- [Hydrogen Fuel Cell Fun Facts](#)
- [What is a Fuel cell](#)
- [Car Run Times Spreadsheet](#)
- [Fuel Cell Instructions and Troubleshooting](#)

Troubleshooting Tips [\(Return to Contents\)](#)

Here are some things to try that may increase the performance of your car and your cell

- Problem: Car Does not move
- Cause: Car is too heavy
 - Solution: Redesign car to have few pieces. Try removing elaborate canopies and replace them with simple trusses (triangle sides)

- Cause: Rubber band has too much tension or keeps falling off
 - Solution: Try repositioning the rubber band closer to the axle. If your rubber band is falling off, try zip-tying the motor to two parallel sticks to keep it in place
- Cause: Too much friction in wheel
 - Solution: Try spacing out the wheels from the frame using small blue circular pieces
- Cause: Fuel cell does not work
 - Solution: If you can prove that the problem is not any of the above, we may be able to find you a replacement cell
- Problem: Car moves only a few inches or feet:
- Cause: Any of the above reasons could also be applied to a car that only moves a little. Please refer to the solutions above
- Cause: Fuel cell needs more power
 - Solution: Leave battery on a little longer to obtain more gases. If the tanks are already filling up all the way, consider building a lighter car
- Cause: Waited too long after hydrolysis, hydrogen has diffused out of membrane
 - Solution: Only perform hydrolysis just before you are about to run
- Problem: Car travels too far:
- Cause: Too much fuel
 - Solution: Leave the battery on for less time so that less gases are created

Design your own kit: To order fuel cells, visit www.fuelcellstores.com and click on fuel cell education. The best fuel cell to use is number 80050 (\$104.00)

To order K'nex kits, go to <http://www.knex.com/Multi-Model-Sets/>. We recommend the 400 piece value tub (\$21.00)

The total cost for one kit, including cost of zip ties (\$0.75), the motor (\$2.00), the alligator clips (\$1.00) Rechargeable batteries (\$5.00) and rubber bands (\$0.05), is about \$134.00. DI costs not included.

References [\(Return to Contents\)](#)

Fuel Cell Store

<http://www.fuelcellstore.com/cgi-bin/fuelweb/view%3Ditem/cat%3D3/subcat%3D6/product%3D204/action%3Dav/vid%3D18836>

Green Car website

<http://www.greencar.com/articles/5-facts-hydrogen-fuel-cell-cars.php>
<http://www.greencar.com/articles/honda-fcx-clarity-zero-emissions-fuel-cell-car.php>

American History of Fuel Cells

<http://americanhistory.si.edu/fuelcells/pem/pemmain.htm#hist>

Media Centre Canada

http://mediacentre.canada.travel/content/travel_story_ideas/hydrogen-fuel-cell-buses-hit-2010-winter-games

Fuel Cell Today

<http://www.fuelcelltoday.com/online/news/articles/2009-07/California-plant-pairs-food-wast>

<http://www.fuelcelltoday.com/online/news/articles/2009-07/Shell-opens-second-hydrogen-fill>

Idaho National Engineering and Environmental Laboratory

http://www.w2agz.com/SG%20%20Proceedings/7b%20Southworth%20Nuclear_Breakout_Southworth.pdf

Owner [\(Return to Contents\)](#)

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Contributors

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