

REPORT DOCUMENTATION PAGE			Form Approved OMB NO. 0704-0188		
The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA, 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 20-11-2014		2. REPORT TYPE Final Report		3. DATES COVERED (From - To) 3-Jun-2014 - 2-Dec-2014	
4. TITLE AND SUBTITLE Final Report: 2014 Princeton-CEFRC Summer School on Combustion			5a. CONTRACT NUMBER W911NF-14-1-0252		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER 611102		
6. AUTHORS Chung K. Law			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAMES AND ADDRESSES Princeton University PO Box 36 87 Prospect Avenue, Second Floor Princeton, NJ 08544 -2020			8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS (ES) U.S. Army Research Office P.O. Box 12211 Research Triangle Park, NC 27709-2211			10. SPONSOR/MONITOR'S ACRONYM(S) ARO		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S) 65801-EG-CF.1		
12. DISTRIBUTION AVAILABILITY STATEMENT Approved for Public Release; Distribution Unlimited					
13. SUPPLEMENTARY NOTES The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.					
14. ABSTRACT The Princeton-CEFRC Summer School on Combustion (also referred to as the Summer School) is part of the outreach program of the Combustion Energy Frontier Research Center (CEFRC), which was established by the Department of Energy in 2009. The goal of the Center is to develop a validated, predictive, multi-scale, combustion modeling capability to optimize the design and operation of evolving fuels, especially biofuels, in advanced engines for transportation applications. The Summer School program was conceived by recognizing that while combustion is an interdisciplinary subject					
15. SUBJECT TERMS combustion, summer school, outreach, CEFRC, EFRC					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT UU	b. ABSTRACT UU	c. THIS PAGE UU			Chung Law
					19b. TELEPHONE NUMBER 609-258-5271

Report Title

Final Report: 2014 Princeton-CEFRC Summer School on Combustion

ABSTRACT

The Princeton-CEFRC Summer School on Combustion (also referred to as the Summer School) is part of the outreach program of the Combustion Energy Frontier Research Center (CEFRC), which was established by the Department of Energy in 2009. The goal of the Center is to develop a validated, predictive, multi-scale, combustion modeling capability to optimize the design and operation of evolving fuels, especially biofuels, in advanced engines for transportation applications.

The Summer School program was conceived by recognizing that while combustion is an interdisciplinary subject, due to limitations at individual institutions the training received by most combustion researchers has not been sufficiently comprehensive to equip them to make breakthrough discoveries. The Summer School therefore aims to offer advanced graduate level courses to remedy this deficiency.

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Received

Paper

TOTAL:

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

Received

Paper

TOTAL:

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Number of Presentations: 0.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received Paper

TOTAL:

Number of Manuscripts:

Books

Received Book

TOTAL:

Received Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Graduate Students

<u>NAME</u>	<u>PERCENT_SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Names of Post Doctorates

<u>NAME</u>	<u>PERCENT_SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

NAME

PERCENT SUPPORTED

FTE Equivalent:

Total Number:

Names of Under Graduate students supported

NAME

PERCENT SUPPORTED

FTE Equivalent:

Total Number:

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: 0.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:..... 0.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 0.00

Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense 0.00

The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields: 0.00

Names of Personnel receiving masters degrees

NAME

Total Number:

Names of personnel receiving PHDs

NAME

Total Number:

Names of other research staff

NAME

PERCENT SUPPORTED

FTE Equivalent:

Total Number:

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

Progress and Accomplishments

The Summer School was held at Princeton University from June 22 through June 27. It offered a one-week, intense program of advanced graduate-level courses in combustion science with the goal of empowering the participants with a comprehensive, interdisciplinary knowledge base needed to make transformative discoveries in combustion energy science. The academic program consisted of 15-hour courses delivered over a five-day period. Participants comprised of senior graduate students and professionals from academia, industry and government labs. All lectures were videotaped and distributed free to the public via YouTube. Lecture notes were distributed in advance in hardcopy format and also provided online at <http://www.princeton.edu/cefr/combustion-summer-school>.

- Academic program: 15-hour lectures offered over 5 days, with 3 hours in the morning and 3 hours in the afternoon. Courses on Combustion Theory, Combustion and Fuels Chemistry, and Reciprocating Engines were offered as 5-day lectures and Unsteady Combustor Processes and New Developments in Combustion Technology were offered as 3-day and 2-day lectures respectively. These courses and their respective lecturers were:
 - ? Combustion Theory: Heinz Pitsch of RWTH Aachen University
 - ? Combustion and Fuels Chemistry: William H. Green of MIT
 - ? Reciprocating Engines: Rolf D. Reitz of the University of Wisconsin-Madison
 - ? Unsteady Combustor Processes: Timothy C. Lieuwen of the Georgia Institute of Technology
 - ? New Developments in Combustion Technology: George A. Richards of NETL, DOE;
- Participants lived in comfortable dormitory setting, and had meals together in the student cafeteria, providing opportunities for networking.
- Room and meals for all US students were covered by the Center.

Participant Statistics

- 180 participants (139 students, 41 professionals)
- 25 states
- 66 academic institutions

Relevance to Army

Many participants were involved in research projects supported by, or of interest to, ARO and the DOD. The enrichment of their knowledge in combustion will benefit the progress of these research projects. Furthermore, it is anticipated that many of the graduate students will become active researchers in combustion and propulsion in the future, some assuming leadership positions. This Summer School experience will undoubtedly prove useful as they carry out their responsibilities.

Technology Transfer

Project Summary - W911NF-14-1-0252
(Reporting Period: June 2014 – December, 2014)
2014 Princeton-CEFRC Summer School on Combustion

Chung K. Law
Department of Mechanical and Aerospace Engineering
Princeton University, Princeton, NJ 08544

Abstract

The Princeton-CEFRC Summer School on Combustion (also referred to as the Summer School) is part of the outreach program of the Combustion Energy Frontier Research Center (CEFRC), which was established by the Department of Energy in 2009. The goal of the Center is to develop a validated, predictive, multi-scale, combustion modeling capability to optimize the design and operation of evolving fuels, especially biofuels, in advanced engines for transportation applications.

The Summer School program was conceived by recognizing that while combustion is an interdisciplinary subject, due to limitations at individual institutions the training received by most combustion researchers has not been sufficiently comprehensive to equip them to make breakthrough discoveries. The Summer School therefore aims to offer advanced graduate level courses to remedy this deficiency.

Progress and Accomplishments

The Summer School was held at Princeton University from June 22 through June 27. It offered a one-week, intense program of advanced graduate-level courses in combustion science with the goal of empowering the participants with a comprehensive, interdisciplinary knowledge base needed to make transformative discoveries in combustion energy science. The academic program consisted of 15-hour courses delivered over a five-day period. Participants comprised of senior graduate students and professionals from academia, industry and government labs. All lectures were videotaped and distributed free to the public via YouTube. Lecture notes were distributed in advance in hardcopy format and also provided online at <http://www.princeton.edu/cefrc/combustion-summer-school>.

- Academic program: 15-hour lectures offered over 5 days, with 3 hours in the morning and 3 hours in the afternoon. Courses on Combustion Theory, Combustion and Fuels Chemistry, and Reciprocating Engines were offered as 5-day lectures and Unsteady Combustor Processes and New Developments in Combustion Technology were offered as 3-day and 2-day lectures respectively. These courses and their respective lecturers were:
 - ❖ Combustion Theory: Heinz Pitsch of RWTH Aachen University
 - ❖ Combustion and Fuels Chemistry: William H. Green of MIT
 - ❖ Reciprocating Engines: Rolf D. Reitz of the University of Wisconsin-Madison
 - ❖ Unsteady Combustor Processes: Timothy C. Lieuwen of the Georgia Institute of Technology

- ❖ New Developments in Combustion Technology: George A. Richards of NETL, DOE;
- Participants lived in comfortable dormitory setting, and had meals together in the student cafeteria, providing opportunities for networking.
- Room and meals for all US students were covered by the Center.

Participant Statistics

- 180 participants (139 students, 41 professionals)
- 25 states
- 66 academic institutions

Relevance to Army

Many participants were involved in research projects supported by, or of interest to, ARO and the DOD. The enrichment of their knowledge in combustion will benefit the progress of these research projects. Furthermore, it is anticipated that many of the graduate students will become active researchers in combustion and propulsion in the future, some assuming leadership positions. This Summer School experience will undoubtedly prove useful as they carry out their responsibilities.

Princeton CEFRC Summer Conference

C.K. Law, Princeton University

Objective: Conduct advanced graduate-level courses in combustion theory, chemistry and experimentation to enrich the knowledge base of graduate students and research professionals from academia, industry and government labs.

Accomplishments:

- Academic program: Three 15-hour courses plus one 9-hour and one 6-hour course over 5 days
- Participant statistics: 139 graduate students; 41 professionals; 66 institutions; 25 states.



Army Relevance: Many participants work on research supported by the ARO or DOD; these programs will be benefited by the enriched knowledge.

Funding profile: June, 2014–November, 2014, \$12K

Grant # W911NF-14-1-0252

PI Contact information: cklaw@princeton.edu