Caltech

COMMON APPLICATION SUPPLEMENT

Fall 2010

CA **Supplement**

Office of Undergraduate Admissions
Mail Code 1-94, Pasadena, CA 91125
626.395.6341

I am applying for *(check one of the following)*:

☐ **Early Action**
Must be submitted by November 2.

☑ **Regular Decision**
Must be submitted by January 4.

(International students applying for financial aid must apply Regular Decision.)

☐ Yes ☑ No I would like to be considered for the **Caltech-UC San Diego Medical Scholars Program**.
(Medical Scholar Candidates must apply Early Action.)

Personal Data

Program of Study

Although not binding, please indicate your proposed areas of study at Caltech. Please select from the options list (see the Caltech Application Instructions).

1. Computer Science 2. Electrical Engineering

Math and Science Activities *(school and non-school related)*

Please list in order of importance to you the math and science activities that are part of your life. Provide a brief description (positions held, accomplishments/achievements, etc.), check the school year(s) during which you participated, and indicate the number of hours per week and weeks per year spent on each activity. If you need additional space, please explain in the additional information section. Please do not refer us to an attached resume.

Math/Science Activities (school- and nonschool-related)

1. Activity: Programming Club Pres/VP of ACSL ☐ 9 ☑ 10 ☑ 11 ☑ 12 Hrs./Wk.: 6 Wks./Yr.: 50
   Description: Train students for CS contests, hire for professional work; ACSL All-Star '09
2. Activity: Botball member, VP, Pres; IARoC VP, Pres ☑ 9 ☑ 10 ☑ 11 ☑ 12 Hrs./Wk.: 20 Wks./Yr.: 14
   Description: Robot Ramble '06-'08, Botball '07-present, Int'l Autonomous Robot Competition '09
3. Activity: Independent Research/Science Fairs ☐ 9 ☑ 10 ☑ 11 ☑ 12 Hrs./Wk.: 8 Wks./Yr.: 25
   Description: Created algorithm/FPGA microchip for Intel STS; Sci Fair (Vacuum Dryer) won #1 San Diego, #5 CA

Summer Activities *(volunteer work, research, camp, travel, personal projects, if not already listed on the common application) —indicate years.*

'09: Learning to program FPGA microchip for Intel STS project. By reading online courseware & experimenting, learned Verilog hardware description language and nuances of programmable logic design; successfully implemented algorithm/microarchitecture I developed.
'09: Internat'l Autonomous Robotics Contest. As VP (now Pres) of team/head of software, coordinated the hardware, software, and documentation teams & designed AI. 1st pl.
'09: Working as Chief Technical Officer of It's a Beauty! Inc. Optimized database performance, loaded content, created new look and feel. Website www.itsabeauty.com
'09: Traveling to Palomar forest w/ tape recorder to gain inspiration for LPSNJ Nat'l HS Poetry Contest.
'08-'09: Professional web development & training/hiring other students.
'08: Developing novel computer graphical user interface and automatic help file generator w/ friend.
'01-'09: Volunteering at St. Vincent de Paul homeless shelter (serving food).

Research *(optional)*

If you have written a research paper or report on a math, science, or engineering project, you are encouraged to submit a copy of your work to be considered along with your application. Papers should be submitted as a PDF file and e-mailed to **papers@admissions.caltech.edu**. To assure consideration, papers should be submitted no later than the application deadline. Please indicate if you will submit a paper. ☑ Yes ☐ No

Test Information

The following tests are a required part of the application:

☐ SAT or ACT (with or without writing)
☐ SAT Subject Test: Mathematics Level 2
☐ One of the SAT Science Subject Tests: Biology (Ecological), Biology (Molecular), Chemistry, or Physics

1. For Early Action, all standardized tests must be completed by the October test series.
2. For Regular Decision, all standardized tests must be completed by the December test series.
3. Have your SAT , SAT subject tests, ACT and TO EFL results sent to the California Institute: **CEEB Code 4034** and/or **ACT Code 0182**. Official test scores must be sent directly to our office by the official testing agency. Caltech strongly recommends that students submit all SAT and SAT Subject test scores.

Essay

Interest in math, science, or engineering manifests itself in many forms. Caltech professor and Nobel Laureate Richard Feynman (1918-1988) explained, "I'd make a motor, I'd make a gadget that would go off when something passed a photocell, I'd play around with selenium"; he was exploring his interest in science, as he put it, by "piddling around all the time." In a page, more or less, tell the Admissions Committee how you express your interest, curiosity, or excitement about math, science or engineering.

Before answering this question, you might ask those around you—family, friends, or teachers—how they see you as a mathematician, scientist or engineer. They may offer insightful observations!

Short Answers

Limiting yourself to the space provided, please answer the following questions. Don't overanalyze. These aren't trick questions and there are no wrong answers. We are interested in learning more about your personality, values, and interests. We really are looking for short answers, not essays. Sometimes a few words will do, other times you may need as much as a paragraph.

1. What are three adjectives your friends would use to describe you?

Exuberant - YAY! About basically everything that is interesting or complex
Inquisitive - I make it a point to figure out as much as I can about the world
Recursive - In other words, I am recursive. (Oh, and CS->awesome())

2. Please list three books, along with their authors, that have been particularly meaningful to you. You need not confine yourself to math- or science-related texts.

•Surely You're Joking, Mr. Feynman - Richard Feynman. Through old-fashioned common sense and a bit of cleverness, the unquenchably curious but otherwise normal young Feynman became one of the highest achieving scientists in history. •Lord of the Rings/The Silmarillion - J. R. R. Tolkien. Simply incredible: "The…mountains, rising into peaks of jet, tipped with glimmering snows, flushed with the rose of the morning." •Gödel, Escher, Bach - Douglas Hofstadter: Discourse on how sentience arises from self-referential systems that fundamentally resonates with my thinking.

3. Members of the Caltech community live, learn, and work within an Honor System with one simple guideline, "No member shall take unfair advantage of any other member of the Caltech community." While seemingly simple, questions of ethics, honesty, and integrity are sometimes challenging. Share an ethical dilemma that challenged you. What did you do?

Double-period AP Chemistry at my high school was notorious for its brutality. Come the spring, my grade in the class was hovering at an 89% for the first time ever, in any subject.

When someone found the answers to the textbook problems online, there was a rush on the part of many students to use them. But I couldn't. We were assigned the bookwork for a reason, I reflected. It gave us fluency and breadth in our knowledge, and the all-or-nothing grading policy forced us to contend with the reality of science. I didn't look. Not once. I got a B, for the first time in my life. But I could accept that, because I had actually learned every concept along the way.

What happened the next year I did not expect. I entered my AP Chemistry project into the San Diego Science Fair, with modest expectations. The day of presenting was going quite decently – I thoroughly understood the principles I was discussing. But then the last judge came to my display and asked me a question whose answer I didn't recall: "Explain the derivation of the Clausius-Clapeyron relation." Then I remembered that I had brought my chemistry textbook. I remembered drilling through problem after problem on vapor pressure.

"If I can have one moment to review, I will tell you."

"Granted."

In seconds, my subconscious guided my hands to chapter 11, to the explanation over which I had struggled so many times. I skimmed the formulae and fluently responded.

The next day it was announced that I had won 1st place.

4. Caltech students have long been known for their quirky sense of humor and creative pranks and for finding unusual ways to have fun. What is something that you find fun or humorous?

Ah, the 3x3x3 Rubik's cube. Elegance unparalleled. Crisp, sharp, even, Lexan textured tiles. In supple and expectant hands I hold this hallowed item, preparing to solve. Feelings of anticipation. I feel the smoothness of the 30-weight lube that lines the clean black crevices. A familiar soft swishing caresses my ears as I tentatively turn the first face, beginning anew a journey into the unknown.

As if alive, the cube emits a quiet clicking, moving faster and faster in a vibrant blur of color as it becomes one with the fingers driving it, giving and receiving energy, filling its holder with focus and determination. Front-center-clockwise, right-counterclockwise, top-clockwise, my fingers beat in a blinding crescendo. Faster than the words describing their motion can form in my mind, they fly through algorithm after algorithm, engrained in comfortable patterns of antiquity, lost in memory. Orient last layer, FRUR'U'F'. I pause for breath, suddenly, I see the path! The 15-move algorithm flies not from my fingers, but seemingly from the cube itself, faster than thought, sound, or even light.

I throw the cube down, filled with triumph! Solved! Then, in trepidation, my months of work on the line, I lift the stopwatch. After veritable millennia, my eyes focus themselves on the digits, unable to process what they see. Then reality churns back into motion.

CRUD! Still 24.04 seconds! I slump back, defeated by something weighing less than 6 ounces…
I fish out my 5x5x5…

Over the phone, my dad described what was happening as he lifted the cover off of the viewing portal. Suddenly, he began to laugh uncontrollably: the robotic mousetrap I had built out of LEGO Mindstorms had actually caught a rat! On the other end of the line, my 8-year-old self also collapsed in laughter. That was the moment when my love for robotics and engineering became irrevocable.

I have been inventing and building things as long as I can remember; curious investigation has always led to practical application. Often, as I lie in bed in the mornings, fragments of thought coalesce into ideas - like the above machine to capture marauding rodents - and I feel an irrepressible urge to immediately jump up and implement them. Where the young Feynman would repair radios - the technology of his day - throughout elementary school, I would "piddle around" with robot mechanisms and computers, building and programming fun or useful devices out of my LEGOs, such as a crude but working photocopier or a machine to make perfect rainbow stripes on Easter eggs. Retrospectively, I see that this process cemented my lifelong fascination with creating nifty devices.

In middle school, my interests expanded from this foundation: I caught what Feynman referred to as the "computer disease" - an irresistible urge to play with programming. Leaping out of bed and coding up algorithms - writing an RSA encryptor or an anagram solver to beat a game - felt just like constructing robots, except in software you never run out of pieces. The knowledge I gained through this process empowered me to start my Web business.

So when high school rolled around, I saw no reason to stop learning math and science by having fun. I learned group theory by solving Rubik's cubes and I learned Java by programming the AI for battling digital robots. Then I joined the robotics team and applied the same class structures I had designed for virtual robots to the real machines. Here, I was also able to make use of my old experiences with physical mechanisms (like differential-ratchet drive shaft bifurcators) to help our hardware team achieve high functionality with few pieces.

The way I express my love of science, mathematics, and engineering is by musing on interesting problems and creating cool machines - virtual and physical. My '09 Science Fair entry - a device that can use the environment's energy to perform desalination - came from trying to figure out a way to quickly dry my surfing wetsuit. My Calculus BC project - a program that uses Fourier transforms to decompose musical chords picked up by microphone - came from an effort to generate piano sheet music from audio recordings. Studying the background information necessary to make these ideas into reality becomes a natural and exciting step as I journey to create my latest contraption or work with my friends on an enticing project.

I want to go to Caltech because everybody there has been able to answer the same question I am answering now - that is, they have been able to express their fascination with science or engineering in some way or another. I want to see what talents, passions, and ideas they bring to the table (or workstation), and join with the school's interconnected

community of active thinkers as we expand our knowledge together. I want to have fun creating our most in-depth and fascinating projects yet.

Footnote: to see the elementary school robots I describe above, such as the photocopier and rat trap, go to:
http://jacobsstuff.tpclubs.com/mindstormsrobots/

Inventing a Microchip

My Intel STS project originated while I was hiking during a thunderstorm. I was pondering, with some trepidation, what determines the paths of lightning bolts; I reflected that they must take some course of least resistance. Suddenly I was struck (by an idea): could an electronic hardware model of this physical phenomenon be used to solve the shortest path problem in graph theory (e.g. "What is the shortest route a car can take through a network of roads to arrive at its destination?")?

The lightning insight didn't pan out, but a week later, I found inspiration in a different natural phenomenon. While surfing, as I watched rivulets of water branching and re-fusing as they found their way down my surfboard, I realized that water molecules diffusing throughout a network could essentially function as thousands of identical-speed cars taking every possible path; the first "car" to reach the destination from the origin would have taken the shortest path. I simulated a graph with a network of paper towel strips, soaked one intersection of strips (the origin) in water, and watched the liquid diffuse through the network, marking which incident strip was the first to wet each subsequent intersection. Once water reached the destination, I could identify the path taken by the first molecules to arrive (i.e. the shortest path) simply by tracing the sequence of marked strips backwards from the destination to the origin.

This formed the basis of the parallel algorithm that I quantized, accelerated and then implemented synchronously on an FPGA microchip for the Intel STS; it ran on the order of 300 times faster than high-speed sequential approaches. Moreover, it generalized to solve the NP-complete (much harder) knapsack problem. I continue to investigate the paradigm's potential today.

My paper, entitled "Development and Synchronous FPGA Implementation of a Parallel Accelerated Propagation-Delay Algorithm for Shortest-Path Problem", can be found at: http://jacobsstuff.tpclubs.com/intelsts/ I would be much obliged if you would peruse it.