Pixar Scientist Links Math with Animation

By CHRISTINE CHANG

When many people think about mathematics, they remember the daunting voice of a high school teacher, the bewildering complexity of cryptic symbols and the countless hours spent attempting to understand it all. Departing from these experiences, they enter the world believing that mathematics can only apply to boring careers. Tony DeRose, however, utilizes mathematics everyday in his job, which is far from dull.

DeRose earned a Bachelor of Science degree in both Physics and Computer Science and spent many years teaching computer science as a professor at the University of Washington. However, after many years of teaching, he entered an industry that few would ever connect with mathematics and computer science: the film industry.

Currently, DeRose works at Pixar Animation Studios, the creators of such film hits as "Toy Story," "Monsters, Inc.,” and most recently "Finding Nemo." The company has already earned multiple Oscar awards for its innovative and groundbreaking animated films, as well as for its short films. DeRose himself helped in the creation of the Oscar winner "Geri’s Game."

In the making of these films, much planning using both mathematics and computer programming occurs over the course of four years. In the final presentation of the film, however, these painstaking hours of work are often hidden behind colorful characters and an entertaining plot.

“If you find yourself thinking about the technology, then we’ve failed,” said DeRose. Though not obvious, however, much work is placed into each film which is created. Four years before a film is revealed to the public, the director molds and refines the idea for the story before pitching the idea to the company.

Once the company agrees to fund the project, the story is made more concrete through the creation of story-books which contain images of important events. Then the editorial board steps in to put the film on reel. The editorial board repeats this process four to five times before real digital production is even begun.

Meanwhile, the art department generates concept art which determines the mood of the film. The art is then transformed into three-dimensions through the use of world modeling. During this step, the modelers may use either a computer program called Maya or may use clay to physically sculpt a replica. Touch probes then digitize these physical sculptures.

The next step in the production process is articulation. “Articulation is creating the California Fault Lines Mapped; Local Landscape Shows Activity

By K. SZWYJKOWSKA

On Thursday at eight in the evening, Dr. Sue Hugh of the US Geological Survey faced a large audience in Baxter auditorium to give a talk titled “Finding Fault in Los Angeles.” Unlike many of the other lectures seen on the Caltech campus, this one involved little obscure science and did not attempt to explain complicated phenomena at any more than the most basic possible level.

Dr. Hugh kept on the light and humorous side as she explained the location of various faults in Southern California, the area that, in her own words, “we all know and love.”

Many California residents are reasonably concerned with earthquakes and earthquake safety; though construction over active fault zones is now forbidden by law, many buildings, including the JPL campus, are built over and around major faults and thus are quite vulnerable to earthquake damage.

This also means that most major earthquakes also take their toll on human life; the Northridge Earthquake in 1994 killed 51 people and injured over 9000; the 1971 earthquake near San Fernando caused at least 58 deaths and 2000 injuries and the list goes on. This perhaps accounts for the impressive turnout at the lecture, though Dr. Hugh soon made it interesting in its own right.

In a short introduction to the causes of earthquakes in general, Dr. Hugh explained, very basically, the three different kinds of faults which may occur when tectonic plates meet on the earth’s surface: normal, thrust and strike-slip faults. Each results from a different overlap of the plates and earthquakes occur when plates rearrange along these faults.

The entire coast of California is, as Dr. Hugh explained, a very active fault zone; the San Andreas Fault stretches 1200 km, over much of the coast of California, with a large bend in the Los Angeles area, which Dr. Hughes explained, causes stress on the surrounding land. The Los Angeles area is laced with numerous smaller faults, such as the San Gabriel Fault zone, the Sierra Madre fault zone and the Raymond fault, located near to JPL.

The lecture included a picture tour of many of these faults, photographed in familiar locations around the LA area. Dr. Hugh showed, surprisingly many interesting-looking hills and short ridges, which the everyday observer hardly notices, are traces of faults and signs of flourishing earthquake activity to a geologist.

For example, a parking lot elevated slightly from a nearby road, or an unusually steep hill in the
Da Vinci Earthshine Technique Helps Study Climate Changes

By ROBERT TINDOL

PASADENA, Calif.-Scientists who monitor Earth’s reflectance by measuring the moon’s “earthshine” have observed unexpectedly large climate fluctuations during the past two decades. By combining eight years of earthshine data with nearly twenty years of partially overlapping satellite cloud data, they have found a gradual decline in Earth’s re-

flectance that became sharper in the last part of the 1990s, perhaps associated with the accelerated warming in recent years.

Surprisingly, the declining reflectance reversed completely in the past three years. Such changes, which are not understood, seem consistent with increased cloudiness in Earth’s clouds.

The May 28, 2004, issue of the journal Science examines the phenomenon in an article, “Changes in Earth’s Reflectance Over the Past Two Decades,” written by Earle Palle, Philip R. Goode, Pilar Montanes Rodriguez and Steven E. Koonin. Goode is a dis-

tinguished professor of physics at the New Jersey Institute of Technology (NJIT), Palle and Montanes Rodriguez are postdoctoral associates at that institution and Koonin is professor of theoretical physics at the California Institute of Technology.

The observations were con-

ducted at the Big Bear Solar Ob-

servatory (BBSO) in California, which NJIT has operated since 1997 with Goode as its director. The National Aeronautics Space Administration funded these ob-

servations.

The team has revived and mod-

erized an old method of deter-

mining Earth’s reflectance, or albedo, by observing earthshine, sunlight reflected by the Earth, using a telescope and a relatively simple electronic detector.

By using a combination of earthshine and satellite data on cloud cover, the earth-

shine team has determined the following:

Earth’s albedo is not constant from one year to the next; it also changes over decadal timescales. The computer models currently used to study the cli-

mate system do not show such large-decadal-scale variability of the albedo.

The annual albedo decreased very gradually from 1985 to 1995 and then declined sharply in 1995 and 1996. These observed declines are broadly consistent with previously known satellite measures of cloud amount.

The low albedo during 1997-2001 increased solar heating of the Earth, the brighter the earth’s infrared (heat) radiation observed in the tropics by satellite, comprise a large influence on Earth’s radiation budget.

Our results are only part of the story, since the Earth’s surface temperature is determined by a balance between sunlight that warms the planet and heat radi-

ated back into space, which cools the planet,” said Palle. “This de-

pends upon many factors in addi-

tion to albedo, such as the amount of greenhouse gases (water vapor, carbon dioxide, methane) present in the atmosphere. But these new data emphasize that clouds must be properly accounted for and illustrate that we still lack the detailed understanding of our cli-

mate system necessary to model future changes with confidence.”

Goode says the earthshine ob-

servations will continue for the next decade. “These will be im-

portant for monitoring ongoing changes in Earth’s climate sys-

tem. It will also be essential to correlate our results with satellite
data as they become available, particularly for the most recent years, to form a consistent de-

scription of the changing albedo,” he said.

Earthshine observations through an 11-year solar cycle will also be important to assessing hypoth-

etically influenced solar activity on climate.”

Montanes Rodriguez says that to carry forward future observations, the team is working to establish a global network of observing sta-

tions. “These would allow con-

tinuous monitoring of the albedo during much of each lunar month and would also compensate for local weather conditions that sometimes prevent observations from a given site,” he said.

Nicholls has been associated with JPL and the Jet Progri-

laboratory for 46 years and has worked at Caltech for more than 20 years. He is chair-

man of the Industrial Rela-

tions Committee, which brings business leaders to campus to attend classes and events and to have classes presented to 3,600 additional people at their companies or off site every year.

The Industrial Relations Committee fulfills some of the needs of course offerings and has raised Caltech’s profile among major corporations. Nicholls was instrumental in fostering the MIT/Caltech Enterprise Forum in which technology-based companies and issues are presented to the campus community, the financial community and the entrepreneurial com-

munity.

Nicholls also opens up his In-

dustry Relations programs to students free of charge and several times this past quarter the courses in stepping-stones to internships, jobs and other endeavors.

Circulation
Natalia Deligne

Tombrello initiated a course many years ago to provide under-

graduate research opportunities for top first-year physics students. He subsequently expanded the program to include high school students who applied for admission to Caltech and through this effort was able to attract some outstanding students to Caltech.

He received the Feynman Teaching Award as well as two Associated Students of Caltech Teaching Awards. Along with Nichols, Tombrello has been an instrumental figure in setting up the annual Climate Change Workshop which all Caltech hosts with Loyola Law School.
Caltech Grants Upper Class Merit Awards to Outstanding Scholars

BY ROSEMARY LARRANAGA

The Faculty Scholarships and Financial Aid Committee is pleased to announce the recipients of the 2004-2005 Caltech Upper Class Merit Awards. Upper Class Merit Awards are based on outstanding scholastic achievement, research and related endeavors. These awards are made possible through contributions from generous donors who have endowed the competition. Scholarships for the 2004-05 academic year will be provided by the Stuart Foundation (Carnation Merit Scholarships), Lew and Edie Wasserman (Caltech Upper Class Merit Awards), the John Stauffer Scholarship, earmarked for Chemistry/Chemical Engineering majors, and the Rosalind W. Alcott Scholarship.

The Committee awarded more than one million dollars to this year’s recipients. The following students will receive awards ranging from three-quarters tuition to full tuition plus room and board for the next academic year:

Carnation Merit Award
Vincent Auyeung
Arjun Bansal
Adam D’Angelo
Wei Lien Dang
Mithun Dwakar
Christopher Franco
Yiyang Gong
Viviana Gradinaru
Chongqin Gao
Judith Hubbard
Patrick Hummel
Matthew Johnston
Daniel Koslover
Tony Lee
Jeremy Leibs
Jennifer Li
Binghui Ling
Marin Markov
Clare Moynihan
Timothy Nguyen
Karlin Oberg
Yangkai Ouyang
Weronika Patena
Yin Qi
Joan Karen Sun Ping
Tom Sze
Neil Tivari
Jing Xiong
Mehmet Yenmez

Caltech Upper Class Merit Award
Pavel Batrachenko
Brant Carlson
Elena Fabrikant
Jenna Fisher
Lisa Fukui
Joseph Gonzalez
Lea Hildebrandt
Dorota Korta
EstherMae "Vicki" Loewer
Po-Ru Loh
Galen Loram
Ryan Off
Laura Pratt
Brian Underwood
Joe Wasm
Trevor Wilson
Phillip Zakia

John Stauffer Merit Scholarship
Xiao Peng

Rosalind W. Alcott Merit Scholarship
Christina Dwyer
Christopher McClendon
Bin Wu

Congratulations to this Year’s ASCIT Teaching Award Recipients!

Professors/Lecturers:

Colin Camerer
Economics
K. Mani Chandy
Computer Science
Alan Hajek
Philosophy

Not Pictured:
Kayoko Hirata, Japanese
Feng-Ying Ming, Chinese

Teaching Assistants:

Not Pictured:
Dave Goulet, Applied and
Computational Math

Mihai Stoiciu, Math

Victor Tsai
Planetary Science

Thank you for your dedication to teaching!
A Heretic, if not Victorious Effort

By HARRISON STEIN

The glory of Asian cinema has been largely ignored since the heyday of director extraordinare Akira Kurosawa, as the average American couldn’t tell Zhang Ziyi (famous Chinese actress) apart from Wang Zhihi (Chinese NBA player). However, everything changed with the release of 2000’s earth shattering Crouching Tiger, Hidden Dragon as Western audiences finally began to appreciate the beauty of Chinese and Japanese art, leading to a cinematic revolution.

In recent years, American audiences have been treated to a glut of recent Asian masterpieces such as Rings, Spirited Away, and Princess Mononoké that would have been neglected ten years ago. Thanks to samurai aficionados Quentin Tarantino and his enormous wallet, American audiences will be fortunate enough to see Yimou Zhang’s 2002 epic Hero (or Hero in theaters later this year). Luckily, I was able to view a sneak preview of this Chinese classic this past Friday at a special screening provided by the Caltech Chinese Student Association. The film is targeted at the three Zhao assassins Broken Sword and Flying Snow, and the most powerful warlord in pre-unified China.

Director Yimou Zhang’s inaugural kung fu movie, Hero, is a cleverly told story about how one man defeats three assassins who sought to murder the most powerful warlord in China.

The love story of Broken Sword and Flying Snow is very endearing, albeit a little tacky, and the dilemmas facing the two assassins are infinitely intriguing. The tension between the emperor and the nameless warrior slowly builds until a striking climax wraps the movie into a nice little package. The different tales are cleverly distinguished by colors, as the assassins Broken Sword and Flying Snow wear different colored clothing in the three or four different stories. The beautiful imagery allows the viewer to recognize when the stories change without disturbing the cinematic mood. Unfortunately, the action scenes are a little underwhelming because of the style of fighting. Flying warriors made so famous in Crouching Tiger, Hidden Dragon is now rather stale. Crouching Tiger’s fighting sequences were unrealistic, but because they were so beautifully filmed the audience was able to suspend its disbelief and enjoy the spectacle. However, the action scenes in Hero are laughable and the film’s blatant disregard for period piece and stunning performances, important details, and interesting fights. Hero is not one of the best Chinese films ever made, but it’s far superior to brainless American blockbusters, and hopefully, the film will find a wide audience when it’s released in August. It’s definitely worth a look!

** Out of ****

By HARRISON STEIN

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is its most memorable and unparalleled aspect, but the film is also a compelling action/drama. The love story of Broken Sword and Flying Snow is very endearing, albeit a little tacky, and the dilemmas facing the two assassins are infinitely intriguing. The tension between the emperor and the nameless warrior slowly builds until a striking climax wraps the movie into a nice little package. The different tales are cleverly distinguished by colors, as the assassins Broken Sword and Flying Snow wear different colored clothing in the three or four different stories. The beautiful imagery allows the viewer to recognize when the stories change without disturbing the cinematic mood. Unfortunately, the action scenes are a little underwhelming because of the style of fighting. Flying warriors made so famous in Crouching Tiger, Hidden Dragon is now rather stale. Crouching Tiger’s fighting sequences were unrealistic, but because they were so beautifully filmed the audience was able to suspend its disbelief and enjoy the spectacle. However, the action scenes in Hero are laughable and the film’s blatant disregard for period piece and stunning performances, important details, and interesting fights. Hero is not one of the best Chinese films ever made, but it’s far superior to brainless American blockbusters, and hopefully, the film will find a wide audience when it’s released in August. It’s definitely worth a look!

** Out of ****

Caltech Ballroom Dance Club Party: Our end of term party will be held this Saturday, June 5 in Winnemute Lounge. We will begin with a 15 minute dance lesson on Merengue at 8:30, followed by general dancing from 9 pm until you can’t dance anymore. The price is FREE, and refreshments will be provided. As with all our parties and classes, no partner or previous dance experience is necessary, just bring yourself and join us for the good times!

Also summer ballroom classes are coming up: Salsa dance classes: Offered jointly by the Caltech Ballroom Dance and Salsa Clubs. Beginning salsa lessons will be taught Wednesdays from June 2nd through August 2nd, from 8:30 - 10 pm and the cost is $5 per class or $40 for the entire 8 week series. No partner or previous experience is necessary.

Lindy Hop (Swing) Class: Classes in beginning Lindy Hop will be taught for eight Mondays beginning June 14th through August 2nd, from 6:30 - 8 pm in Winnemute Lounge. The cost for Caltech students and SURFers is $6 per class or $40 for the entire series; non-students pricing is $8 per class, $56 for the series. No partner is necessary and refreshments will be served.

Caltech Grad Students...

Stuck here doing research on your dissertations? Then take a break from the typical “all nighter”... on Thursday, June 17, join us for the FREE! LACMA Overnight Tiki Tiki Tiki Dance Party which will open the museum to party-goers beginning at 7 pm and continuing till 7 am the following morning.

In addition to free admission to exhibitions including Beyond Geometric and Inventing Race, the party will include music by DJ Diabetic, a custom-painted mo­tor scooter created by artist Shepard Fairy, and a silent auction. Proceeds of which will benefit LACMA education programs for at-risk youth.

We wanted to send our friends at CalTech a special, advance invitation to our latest event given the recent success of LACMA’s first “all­nighter” - Cabaret LACMA, which drew nearly 9,000 party insiders!

Caltech’s 2nd annual “Travel Fair” will take place on Wednesday June 16th from 11:00 am to 2 pm in the foreground Chandler Dining Hall. Come to our annual travel fair and see what great travel packages and deals your favorite travel vendors. There will be a music and a barbecue meal will be available to purchase. The event will be the final of the Caltech sponsored silent auction, proceeds of which will benefit LACMA education programs for at-risk youth.

Summer Work Study: Information and applications for 2004 Summer Work Study are available in the Financial Aid Office. If you are interested in Summer Work Study, please submit the required application as soon as possible, but no later than June 1, 2004. Your entire financial aid application must be complete by June 1, 2004 in order to be considered for Summer Work Study. If awarded, the work study funding will begin July 1, 2004.

Racquetball Challenge Court, Wednesdays, 5:30 - 8:30 PM, Braun Gym. Show up to the Racquetball club’s challenge court and take on anyone here. We usually have two reserved courts, and we play winner stays on. Challenge yourself and a worthy opponent! Everyone is welcome and we normally have all skill levels show up (including beginners). And if you’re still not sure, know that the club pays for all the equipment. You can borrow the necessary equipment from the front desk. See you there.

Submit to the Totem! The Totem is now accepting submissions for the 2004 edition the literary magazine. Anyone in the Caltech community can submit their poetry, short stories, artwork and/or photography to the Totem. Please send your work by email to totem@itis.caltech.edu, or by campus mail (MSC 922).

Scholarships

The American Association of Japanese University Women is currently accepting applications for their 2004 scholarship program. Female students enrolled in accredited California colleges and universities, who will be junior, senior or graduate student by Fall 2004 are eligible to apply. You may pick up an application by contacting the Financial Aid Office or e-mail them for more information. E-Mail Address: augur@worldnet. aol.com The deadline for this scholarship is September 30, 2004.

The Ayer Rand Institute presents the 6th Annual Essay Contest on Ayu Rand’s 1918 Novel “Atlas Shrugged.” There is one $5,000 and two second prizes of $1,000. There are also third, finalist, and semifinalist prizes.

Continued on Page 6, Column 1

2004 McNally Competition Winners

The McNally-Fleming Community Literacy Foundation is pleased to announce the winners of the 2004 contest for excellence in writing. In the category of non-fiction essay, the prize is $5,000 and goes to Wendell Bird, for the essay “The Alabama Cotton Project.” The award in prose fiction goes to Elliott Karpi­¬

Honorable mention is given to Eva Murdock, Jeremy Gillula, John Sadowski, Michael Villet, and Samuel Thomason.

2004 Hallett Smith Prize

The prize in the Hallett Smith Competition (for the finest es­say submitted to Shakespeare) was won jointly by Nicholas Rep­precht and Chris Meagher.

For more of this issue, visit www.caltech.edu
Spitzer Space Telescope Sets Infrared Eyes on Dark Matter

By WHITNEY CLAVIN

Ten years ago, a group of astronomers set out to find invisible, or dark, matter in the outer fringes of our galaxy. Long postulated to make up a significant chunk of the universe, dark matter may be purely made up of massive, celestially hidden objects. A new study, published in the May 2004 issue of The Astrophysical Journal, is the first to rigorously test the hypothesis that the majority of dark matter is made up of low-mass objects known as "machos." These objects, thought to be a bit larger than stars but more massive than the galaxies they are a part of, are thought to make up a significant fraction of the dark matter in the Milky Way galaxy.

"We were ecstatic," said Dr. Brian M. Patten of the Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass., a project scientist at NASA's Jet Propulsion Laboratory, Pasadena, Calif., and an investigator for the Spitzer Space Telescope project. "The team looked for the objects' gravitational effects on more than 100,000 stars in our galaxy, and the Spitzer Space Telescope data provided us with a unique opportunity to test the existence of machos.

The team of astronomers recently collected data for four additional macho events and plans to study nine more. For more information about the Spitzer Space Telescope, visit http://www.spitzer.caltech.edu.

The Spitzer Space Telescope is managed by JPL for NASA's Office of Space Science, Washington. Science operations are conducted at the Spitzer Space Telescope Center at the California Institute of Technology in Pasadena. JPL is a division of Caltech.
Sallie Mae has a number of scholarships available: The Sallie Mae Fund First in My Family Scholarship Program. The Sallie Mae Fund Unmet Need Scholarship Program, The Sallie Mae First in American Dream Scholarship Program, and The Sallie Mae 911 Education Fund. In addition The Sallie Mae Fund awards a $1,000 scholarship to a future college student at each of its nationwide “Payring for College” workshops. For a complete list of 2004 scholarships applications, criteria and deadlines, please visit: http://www.thedsalliemaefund.org/ Educaid is offering its “Double-Take” Sweepstakes. Win two $2,500 scholarships - One for you and one for your school. Applications are available in the Financial Aid Office, or on Educaid’s website: https://www.educaid.com/doubletake Project 287 is a free job referral network for students 16 & older. The goal is to employ dependable students to work in their science/medical field of interest during the summer of 2004 in colleges all over the country. For more information contact: Dr. Joe W. Conner, P.I. Pasadena City College 1570 E. Colorado Blvd., Pasadena, CA 91106 (626) 585-7163 QuestBridge promotes meritocracy in America by uncovering exceptionally talented, self-motivated students from low-income and/or minority communities and linking them with the nation’s premier colleges, prep-schools, graduate programs, professional schools, enrichment programs, scholarships, and internships. For more information see the website: http://wwwquestbridge.org/index.htm The John Gyles Education Awards of $3000 are available to full Canadian or American citizens who are studying all areas of post-secondary study. A minimum GPA of 2.7 is required. Criteria other than strictly academic ability and financial need are considered in the selective process. Filing dates for mailing applications in 2004 are April 1, June 1 and November 15, 2004. To receive an application, send only a stamped (US 37c) self-addressed envelope to: John Gyles Education Awards Attn: The Awards P.O. Box 4808 712 Riverside Drive Fredericton, New Brunswick Canada E3B 5G3 If you are a college student who is interested in becoming a naval officer when you graduate, you could apply for the Baccalaureate Degree Completion Program (BDCP). This program pays future naval officers a monthly salary while they are still attending college. Qualified technical majors can receive a salary of approximately $1,500 per month up to 3 years prior to graduation and qualified non-technical majors can receive this salary for up to 2 years prior to graduation. Additional information is available at: www.navy.com/ The National Council of Jewish Women/Los Angeles provides a variety of scholarships year around for women, regardless of religious belief or ethnic background, who reside in Los Angeles County. The organization focuses on each applicant’s dedication to her chosen path and her financial need. Applications are available in the Financial Aid Office. For more information visit: www.ncjwla.org/ Columbia University’s Postbaccalaureate Premedical Program is America’s oldest and best. Discover why our graduates have an 85% placement rate in American medical schools. Call (800) 890-4127 gspremed@columbia.edu www.columbia.edu/premed Columbia University’s Prebaccalaureate Premedical Program is America’s oldest and best. Discover why our graduates have an 85% placement rate in American medical schools. Call (800) 890-4127 gspremed@columbia.edu www.columbia.edu/premed Columbia University's Postbaccalaureate Premedical Program is America's oldest and best. Discover why our graduates have an 85% placement rate in American medical schools. 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Movement Study to Separate Space, Time During Learning

BY MARK WHEELER

PASADENA, Calif. - We give little thought to reaching for an object. Should something be in the way, we simply use our arm to go over or around whatever it is to grab whatever we want.

If you think about it, says Elizabeth Torres, a postdoctoral scholar in biology at the California Institute of Technology, it's a remarkable talent. The simple act of reaching and grasping involves a cascade of rapid-fire events.

First, one of our senses, vision, eyeballs the object's location and distance. Next, the brain determines what "degrees of freedom" of the limb are needed to grab it - what angle of the elbow, what rotation of the shoulder, how far to turn the wrist and bend the fingers. Finally comes the determination of the appropriate speed for extending the arm, then stopping precisely at the object's location.

But what's long puzzled neuroscientists like Torres is how the brain translates two different "languages" into action: the sensory cues that come from our vision system - which feeds the brain information about the location, orientation and shape of the object of desire - and the motor execution of the movement of bone and tissue that actually grabs it.

The answer? Geometry, suggests Torres. A transitional, geometric stage between sensory perception and motor actions, in which the brain simulates a task such as grasping an object without actually moving the arm. Her research, which provides further insights into the marvelously complicated workings of the brain, has been published in the May issue of the Journal of Applied Physiology and was selected as a "Highlighted Topic" by the journal.

Torres's approach ignores timing, posing that during learning, the spatial and the temporal components of the motion can be separated. In her view, the brain first determines a path that, in the case of arm movements, leads the hand along the most optimal direction to solve the task geometrically in a given context.

This means the brain takes into consideration the relationships of other objects to the goal (the telephone in front of the water glass) and the amount of physical space the arm will have to work in. This geometric path is special in that it can be traversed with different timing and still be the same path.

For instance, the straight line between two points in space creates a path that is the shortest distance joining them. This path is unique in that no other path qualifies as the shortest one between these two points.

Thus, no matter how one travels along it, fast, slow, or slowing down and speeding up, it is still the shortest path. Only later, says Torres, does the brain learn how to adjust the timing to best traverse the path. This is analogous to the way in which a dancer learns the choreography of a particular dance, or a musician learns to perform a piece. First, they master the motion that gives the desired outcome and then they adjust the timing of this motion to bring the movement to perfection. Eventually, they become so proficient at it that they can put emotion into it, thus reaching a new level of performance.

More recently, behavioral data collected in the lab of Caltech's Richard Andersen, the James G. Boswell Professor of Neuroscience, lends support to Torres's theory. The data shows how nonhuman primates learn to avoid obstacles. Indeed there is a clear separation between learning or forming a geometric solution to a particular object and that solution becoming automatic. Learning consists of forming a geometric strategy, the best path to use in space with respect to a particular set of goals. It becomes an automatic movement only later, when the best time profile is uncovered that best traverses that particular path.

Torres says that without the electro-physiological data from the brain, it's hard to confirm whether this theoretical idea makes sense as a brain solution for learning goal-oriented behaviors. Thus her current research in Andersen's lab focuses on the monitoring of learning and adaptation as they evolve in the non-human primate, in a part of the brain known as the posterior parietal area.

"Dr. Torres is a truly remarkable scientist," says Andersen. "As a graduate student at UCSB she developed a completely novel geometric theory of motor control. She is now testing her theory with experiments here at Caltech and already has results that support her ideas."

"As in a game of chess, through action simulation one can anticipate various outcomes before making a definite move," adds Torres. "Finding evidence in support of this geometric stage, where actions are simulated before actually being executed, would be a first step toward understanding how new motor skills may be acquired all the time."

Research in Richard Anderson's lab will study learning and adaptation in the brains of non-human primates.

Dr. Elizabeth Torres developed a theory of motor control as a graduate student and continues her study of movement and the brain here at Caltech.

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US Geological Survey Intent On Increasing Earthquake Education

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Though not a geologist by training, she proposed the project herself and was granted the funds to do it; she spent a year traveling the California coast, tracing fault lines and mapping them out for benefit of California residents.

Hugh says she was inspired to carry out the project at her first public lecture about earthquakes. When someone asked her where exactly in California the faults she was discussing were located, she realized that, though she knew the general layout of fault lines near the California coast and knew the area quite well, she was not able to see exactly how the two maps of California—that showing its cities and streets—overlapped.

The project was therefore an attempt to reconcile the views of California into one coherent map, on which fault lines would be shown, relative to their location near features (like roads and buildings) more recognizable to the non-scientific audience. Hugh showed pictures of sites she visited as part of her survey and even showed pictures of the San Andreas fault taken from a commercial airline jet and mentioned that, if one knows what to look for, one can get quite a kick out of tracing the line of the fault when flying along the California coast.

Dr. Hugh ended her talk with a quotation about the power of earthquakes to create, as well as destroy; the movements of tectonic plates over the earth's surface cause mountain ranges to rise in some regions while the earth is pushed together and create "sink" lakes in places where land is pulled apart. New features are shaped with the destruction of old ones; so that, though earthquakes are a very present danger for residents of California, their power cannot necessarily be considered uniformly bad.

Simulators, Lighting Lead to 'Hyperreality'

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strings the animators will pull to create the story," said DeRose. This determines the ways in which a character walks, talks and moves. During this step, much is mathematics and computer science comes into play.

In particular, a method called subdivision surfaces is utilized in order to smooth out rough facets which appear in the model. This method uses linear interpolation to split a facet and then calculates split averages in order to determine where the rest of the points should go. Square matrices then determine how the surfaces will interact. If this subdivision is taken to a limit, the surface would eventually appear smooth.

After articulation, shading further refines the characters by painting their physical images. Set Dressing also creates details for the background locations of the film. Then comes layout, when the film really starts to come together," DeRose said. During this step, the shots are put together and the film is handed off to the animators. The animators, who DeRose calls "the actors of the process" determine the time evolution of the virtual strings which control the characters, determining their primary motion, such as their stride and face expressions.

Secondary motion, such as that of cloth or fur, is left for the simulators. In order to create such graphics as fur, simulators often define vector fields on the surface. Effects then handle the animation which does not appear in every shot, such as a snowstorm which may only occur in one scene and lighting generate the light effects.

"There is a lot of cheating in this step. Many of the light effects, such as shadows, are not physically in the place where they should be. We're not after reality; we're after hyperreality," said DeRose.

In the future, Pixar is planning to release the feature film "The Incredibles" in 2004 and "Cars" in 2005. Utilizing mathematics and computer programming in innovative and exciting ways, Pixar looks ahead to a bright, successful future in the entertainment industry.

Pixar was established as an independent company in 1986 when it was bought from Lucasfilm by Steve Jobs. It released its first short, Luxo, Jr. in that year. Luxo went on to win an Academy Award.

Toy Story, Pixar's first full length film, was released in 1995. It was also the first film animated completely by computer and became the highest grossing film of the year. Pixar also had its IPO in 1995.

In total, Pixar employees have been awarded sixteen Academy Awards®. Pixar has also won two Gold Chos for Computer Animation for the Gummi Savers commercial titled "Conga," in 1993 and in 1994 for the Listerine commercial titled "Arrows."