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Instructional Design: *Coast Alive!* (Southern California)

I. EXECUTIVE SUMMARY:

We propose a ***bold new program*** to bring students and their teachers into the southern coastal State Parks and Coastal Conservancy sites to study and investigate California's marine ecology and their role in preserving the coast's rich natural and cultural history. *Coast Alive!* is based on the highly successful Cal Alive! program, which uses interactive, multi-media technology to capture students' imaginations and involve them in learning about their local environment. What makes *Coast Alive!* so special is that it takes the students, and their teachers, from highly motivating activities in the classroom out to the coast so that they can directly experience the beauty and fragility of our coastal environment, the threats it faces, and the importance of restoring and preserving it.

David Orr writes in *Earth in Mind*, "Even in this time of ecological concern, schools, colleges and universities continue to turn out a large percentage of graduates who have no idea how their personal prospects are intertwined with the vital signs of the earth. How can this be?"

Following his argument, we agree that there is an irreducible body of knowledge that all students should know:

a) How the earth works as a physical system (for *Coast Alive!*, the physical processes underlying marine and coastal systems);
b) Basic ecological and physical processes and how they interact;
c) The basics of human ecology;
d) The natural history of the students' own region (so they can "read" their own coastal habitats);
e) And the background knowledge necessary for students to understand why native ecosystems are naturally resilient and locally adapted, and to participate in their restoration .

Through education and outreach, we hope to, prepare a large, diverse and on-going generation of citizens who are scientifically literate and experientially aware to thoughtfully analyze public problems. This next generation will support long-term solutions based on a solid understanding of how the planet works as a series of physical and ecological systems.

Because *Coast Alive!* is a project that specifically targets the actual environment of the kids of Los Angeles, San Diego, Long Beach, Santa Barbara, and Ventura—the Pacific Coast—, it has immediate relevance to students in the region, and to the teachers who will guide them in this study.

Coast Alive! will train close to 3,000 teachers, bring 50,000 school children to the coast, and will (over the life of the project) educate 180,000 southern California students about coastal processes and conservation. Students and educators will participate in direct, relevant, and exciting learning experiences, aided by park interpreters and scientists. By so doing, we hope to inform, and create in the next generation, natural advocates for our coast and parklands.

Form A Network

The *Coast Alive!* Project team will coordinate an extensive, multi-county network of students, teachers, scientists, park and resource specialists, and community groups as they plan and implement coastal watershed/marine studies and stewardship projects. To thoroughly prepare them for coastal watershed studies, ecological monitoring investigations, and actions that protect and restore the coast, the project will give teachers and students a deep scientific understanding, educational motivation, and social and technical resources. The project will be aligned with the California State Science and Social Science standards (Appendix 2), with the Coast as the integrating concept.

***Deliverables (if fully funded)*:**

Phase I: Planning (Fall 2003-Winter 2004) Implementation (Winter-Summer 2004; Production (Winter 2005); Full Program (Fall 2005)

To this end we will:

1. Plan and produce *Coast Alive!* , a five-part educational program, (classroom component that includes the multimedia technology piece, teacher guide, teacher workshops, student site visits, projects);

2. Distribute at least 2,250 teacher packages (multimedia software plus guides) to teachers in the target region;

3. Plan and offer up to 22 two-day teacher workshops, for 20 teachers each, throughout the region;

4. Help coordinate school visits to coastal sites;

5. Help coordinate and/or link student groups to coastal projects such as stewardship and service-learning projects and/or on-site student investigations;

6. Coordinate and offer 50 mini-grants of $200 each to provide transportation for underrepresented school groups to and from coastal sites.

II. INTRODUCTION: What is the theme of this study?

Coast Alive! will combine interactive educational software, professional development opportunities, and park-based field investigations to increase student understanding of southern California's coastal ecology and issues related to the health of coastal environments and watersheds.

Major theme: How ecological and physical processes act and interact
What we are trying to stress with the program is the interconnectedness of living and nonliving processes, *and,* at the coast, the land-sea interface. We know that:

- these interactions are ongoing;
- they are pervasive;
- these interactions have evolved over time, and are in equilibrium (balanced);
- and they are system wide;
- there is a human interface as well;
- but the balance of these interactions may be dramatically altered by major disruptions such as firestorms, oil spills, aberrant winds, and earthquakes.

Geographic focus: The coast of Southern California (Santa Barbara to San Diego)
This section will be covered in the software, and in the field.

An overview: In order to fully explore the more complex ecological and physical processes that underlie the natural world of the southern coast, it is very important to give students an overview of that coast.

What does the coast really look like? Is the coastline a uniform band of white sand beaches stretching from Point Conception to Cabrillo Point? And how far inland does it reach?

Are there cliffs, coastal bluffs with prairie, coastal scrublands, dunes, rocky intertidal areas, islands, kelp forests, salt marshes, mudflats, bays, lagoons, sandbars, sandflats, canyons, rivers, creeks, streams, ponds, lakes?

What kinds of animals are found near the coast? Birds? Upstream? In the Uplands? Are there woodlands and forests? Along the creeks? Salamanders? Lizards? Are there miles and miles of wildflowers? Where do you see the marine mammals? What kind of fishes are here? Mollusks (clams, oysters, or mussels)? Crabs? Jellyfish?

How does the coast change as you go south from Santa Barbara? Why does it change? How does the climate change? What caused the topography? Where did Native Californians live before Europeans arrived? How did they live here? What do people do here now? What effect has the arrival of Europeans had over the last 200 years?

What parks are here? Is there anything that looks the same as it did 200 years ago? What natural disasters have affected this area? How do Santa Anas, fires, earthquakes, floods, and oil spills influence the natural world? How do they influence the built world of people? How do people influence the natural world?

The Computer Program:
Subtitle: Coast Alive!: Earth, Wind, Fire, Water (Southern California).
When our planning group was considering the focus area of the coast of southern California, the phrase "Land of Earth, Wind, Fire, Water" came to the fore. Surely, at least superficially, recent earthquakes, Santa Anas, firestorms, and the ever-present threat of offshore oil spills help characterize

one's sense of the place. And so, after much deliberation and scientific insight, these idiosyncrasies came to describe our southern California program.

The four "elements", earth, wind, fire and water, are also the cornerstone of Aristotelian science, and so in a broader sense, form the basis of the scientific content for this educational program. For *Coast Alive!,* "Earth" means the lithosphere, or rock-based solid material that forms the outer crust of the planet. "Wind" represents the atmospheric sciences that focus on weather and climate, i.e., meteorology. "Fire" for Aristotle was the spirit that infused living things, and for *Coast Alive!* it represents the biosphere, the collection of living organisms that interact in populations and ecosystems throughout the area. And "Water" means the hydrosphere, and includes the ocean, freshwater rivers, lagoons, lakes, and creeks.

Meeting the needs of students: the software piece
Coast Alive!—Earth ,Wind ,Fire, Water is a theme broad enough to:

1. ***Include four subprograms***
   Earth: 6th grade, 9th grade Plate tectonics; Dynamic systems
   Wind: 5th grade, 8th grade Convection patterns of air currents
   Fire: 7th grade 9-10th grades Ecosystems; Adaptation; Genetics
   Water: 6th grade 9th grade Energy exchange; Vector analysis

2. ***Be relevant to students' lives and interests:***
   • Includes topical activities: hang-gliding, skateboard parks, surfing, cell phones
   • Visits: beaches, migratory animals (grunion, gray whales)
   • Explores: firestorms, earthquakes, and mudslides
   • Uses local sites, local maps, freeways
   • Generates a sense of fun!

3. ***Be suitable to students' ages and abilities and interests*:**
   • Tailors text, online activities, and scope to be age appropriate
   • Includes appropriate language,skills and experiences.
   • Has a "hook" for each section, and that hook is a puzzle or conundrum (Students in the middle grades are especially engaged by puzzles, mysteries, complex problems and their own prowess at solving them,)

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4. ***(If funded) Offer Spanish/English language version***

5. ***Be sensitive to racial and cultural biases***
   • The *Coast Alive!* Resource Board (a group of teachers that periodically reviews material) is drawn from a diverse population of teachers in southern California.

III. IDENTIFY GOALS: What are the scientific and educational goals of this project?

Compliance

The content of the program will meet not only the needs of the target group, and the requirements of the funder, and the current educational environment of California.

***Standards**:* Teachers who attended our focus groups last fall loudly proclaimed their need to use materials that met at least a few of the California Science Content Standards. We are committed to addressing content standards in each segment of the *Coast Alive!* program. We will embed those standards in storylines that are engaging to students.

Standardized Tests: Currently, the No Child Left Behind Act of 2001 specifies that all states must measure student progress in science at least once each year, testing in three grade spans. Test scores on these exams will determine whether sanctions will be levied against low-performing schools. While monitoring of student performance is commendable, in some cases teachers may be forced to use the exams as the central organizer for their curriculum, which may be very troubling:

> A study by the Rand Corporation recently found that high-stakes tests primarily focus on lower-order thinking skills (memorization and factual recall), and read like a middle school version of *Trivial Pursuit.* Is this the future of science education to which we are commending our nation's children?

The planning team has concluded that while factual material will be included, this *Coast Alive!* program will favor higher-order thinking skills, and focus on *understanding* of the concepts on which content standards are based, rather than on mere memorization of facts, definitions and formulas (see part IIIB, for more on this decision.)

A. SCIENTIFIC CONTENT GOALS

Major theme: How ecological and physical processes act and interact

What we are trying to stress in this program is the interconnectedness of living and nonliving processes, *and,* at the coast, the land-sea interface. We know that:

- These interactions are ongoing;
- They are pervasive;
- These interactions more or less balance one another;
- And they are system wide;
- There is a human interface as well;
- This balance may be dramatically altered by major disruptions (such as firestorms, oil spills, aberrant winds, and earthquakes.)

Interconnectedness The recent blackout that hit the Eastern United States provides a striking analogy for our major theme: the huge power grid that keeps the Northeast illuminated at night may be complex, but it also is a vivid visual demonstration of the interconnectedness of cities upstate, towns downstate, rural areas across borders, and so on. And, when disrupted, huge, widespread regions that people may not even realize are linked, may lose their power.

By analogy, there is a vast "grid" of ecological and physical interconnections across the Southern California coast. This analogy works on many levels:

- The land is connected to the sea by watercourses that drain the upland watersheds; what happens upstream affects the downstream;
- Beneath the surface, there are two major tectonic plates, one moving northwest; (so, the mainland sits on both plates!);
- The topographic shape of the local coastline is linked to the cutting action of winds and waves;
- The marine food web is intimately linked to the terrestrial food web;
- Climatically, the ocean is connected to terrestrial patterns of wind and drought
- The cyclicity of Santa Ana winds is connected to ocean temperatures off the coast of lower California and the rain-shadow effect of the Sierra Nevada;
- The inversion layer (smog development) is directly connected to the east-west topography of the San Gabriel and San Bernardino mountains;
- Migratory animals are connected to the coast by way of food webs and/or the topography of the near-shore sea floor;
- Ocean currents are influenced by the near-shore sea-floor topography;
- The seasonal fire regime is linked to the annual drought, to the Santa Anas and to adaptations of terrestrial plant communities;
- Landslides and dry creep are linked to plant adaptations as well as soils;
- Marine fish kills, destruction of freshwater spawning areas, and loss of freshwater invertebrate fauna (e.g., crayfish) may be connected with fire-initiated erosion and mudslides inland.

Core topics for this program, drawn from the Science Standards and Framework, include:

Earth (Lithosphere): **Plate tectonics**;
1. earth as a dynamic system;
2. geological events; mountain building
3. seismic events and earthquakes;
4. seafloor spreading; hotspots; submarine canyons
5. the rock cycle; soils; erosion; deposition
6. beaches and rivers as dynamic systems;
7. sediment flows; landslides

Wind (Atmosphere): Convection currents in air;
1. sun's energy;
2. wind patterns along coast;
3. water vapor, fog, clouds;
4. heat and thermal energy;
5. effects of climatic factors on migration and on seed dispersal;
6. motion and forces; vector analysis; linear graphs.

Fire (Biosphere): Evolution of fire-adapted landscapes
1. ecosystems and disturbance;
2. adaptation to fire;
3. seed germination and effect of fire;
4. plant genetics
5. classification schemes; cladograms
6. causes and effects of periodic fire;
7. chemistry of carbon (and of burning);
8. firestorms and mud/landslides;

9. effects of fire-caused erosion;

Water (Hydrosphere): Convection; ocean food webs, resources and ecosystems;
1. energy and materials exchange;
2. biodiversity and alteration of habitat;
3. upwelling; thermal and chemical aspects of convection;
4. ocean as moderating force on land;
5. land-shaping force of water, waves;
6. ocean currents; tidal cycles.

In the computer program, these core concepts will be fleshed out and explored through a central "cy-brary" students can access at any time and from any screen.

Doing science**:** The most interesting questions from a scientific perspective are those in which a problem is discovered, the problem is a compelling one, and the "answer" (solution) is not known. For a scientist, the willingness to test, to question, to reevaluate and revise ideas, is the *essence of science*. The same questioning attitude defines both the nature of the science experiences that students have with *Coast Alive!*, and CIB's process of creating and improving those experiences for students.

So, in operational terms, let's define science simply as a way of asking questions about the natural physical world, and of gathering and evaluating evidence— physical and quantitative—through investigations, experience, simulations, and the work of others—that should help answer those questions.

And so, it is best if investigation is the center of what students do; investigatory experiences *are* science. Investigations and experiments are the means by which scientists collect information, discover meaning and weave it into hypotheses, and, perhaps even theories. (see part IIIB, for more on this decision.) And, they are interesting to students because they give students a chance to *do* science.

To see how *Coast Alive!* envisions incorporating problems or puzzles into the *computer* software, please see Part VA, Activities for the Software Component.

To learn how *Coast Alive!* envisions incorporating problems and puzzles into the *field investigations*, please see Part VB, Activities for the Field Component.

Scientific Goals of the Field Component**:** The computer program leads up to a full-fledged set of field experiences that will tie in with each of the above segments.

***** Unfortunatel,y we are unable to flesh this out at this time, due to lack of funding for this portion of the planning phase.***

Critical skills students will acquire or improve:
Science Process Skills

• observing	• data collection	• classifying
• analyzing	• researching	• hypothesizing
• testing	• inferring	• communicating
• evaluating	• synthesizing	• providing compelling evidence for statements

Specific Tools
Familiarity with gel electrophoresis; vector analysis; force calculation; pedigree diagrams; energy pyramids; Hardy Weinberg equation; cladograms; food webs;

[more later]

Specific Field Skills

***** Unfortunately, we are unable to flesh this out at this time, due to lack of funding for this portion of the planning phase.***

Key Modalities of learning
The program taken as a whole will offer a broad diversity of experiences, in a wide array of "sensory modalities" (visual to auditory to kinesthetic to verbal to dramatic, etc.) In this way, *Coast Alive!* will fill the needs of a student population with diverse learning styles.

Other Discipline Areas: Content
Social science, math and language arts concepts will be incorporated into these scenarios, and the appropriate content standards will be addressed.

B. FUNDER/SUPPORTER GOALS:

By creating regional partnerships with the State Parks and the California Coastal Conservancy, the *Coast Alive!* team will not only provide real-world opportunities for students to help them understand important science and history concepts in the familiar context of their local environments, but also encourage coastal park visitation and stewardship.

Awareness Students will be motivated to understand the geological, ecological, and social processes that form and alter the coastal landscape. By making our approach problem based, we engage students in their own education. Using exciting, technology-based, resources such as video and animations focused on *their region,* students will extend their knowledge of academic subjects as they explore the ecology of their watershed (e.g., *local* tidal lands, marine/coastal systems, estuarine wetlands, uplands and riparian habitat.)

Students will also learn about humans and the environment, including how people have impacted the coastal environment during various times in our history.

Understanding By challenging students to make links to real-life situations, —first, in the classroom and schoolyard through simulations, games, virtual experiments—they will deepen their understanding of the myriad processes and interconnections that affect their environment.

Action By enabling students to actively participate at actual coastal sites in investigations, their experience will be powerfully altered and enhanced.

Teacher Insight Educators will benefit by acquiring understanding of required content, and through the workshops, by becoming more successful teachers;

California-Specific Resources Educators will also benefit by acquiring regionally appropriate resources (most resources are generic, often East-Coast oriented) and by developing their own in-depth field programs for given parks or sites;

A New Generation of Supporters The park and conservancy sites will benefit from increased visitation and a new generation of supporters, while acquiring a new means to serve their constituents.

Ecoliteracy The state will benefit in having a more ecologically literate citizenry.

C. EDUCATIONAL GOALS

Introduction

For this program to enjoy broad use in the schools of Southern California, we will need to have complete buy-in from the teaching community. For this reason, we will be in almost constant communication with that community, and be in tune with the general tenor of the field. Our planning team has met repeatedly, to consider the needs of the community of educators. We have created a "Resource Board", which consists of middle grade and high school teachers as well as independent educators and university professors, to discuss the elements of the program, how it can best be constructed and how to meet specific needs.

In addition to meeting with classroom teachers, it is important to be aware of current school reform issues, especially those issues that relate to the production of high quality and useful science educational materials. Specifically, we find it essential to keep up with matters that relate to *how to teach science* and *how to construct appropriate assessment tools* (to find out if students are learning, and truly understanding, concepts.

The sections below summarize our explorations to date.. Where the earlier section on Scientific Goals focused on *what* to teach, this section centers on *how* to teach.

Focus Groups

More than 60 teachers in southern California schools joined Jennifer Rigby (facilitator), Carol Baird (representing *Coast Alive!*), and Lorrae Fuentes (Logistics) in Fall 2003 to explore issues related to the development and implementation of *Coast Alive!*. The group was self selected, and therefore does not represent a completely random sampling; nevertheless, the focus groups provided critical information. Below please find some of the more relevant outcomes:

Standards: California Content Standards are extremely important to the role of the classroom teacher and in the process of selecting classroom materials. Standards drive the curriculum. Teachers appreciate materials that have a matrix that shows alignment of supplementary material to specific content standards.

Software: Participants seek software that is grade-level appropriate, with adequate search functions, interesting links, and visual and voice clarity. Such material needs to be user-friendly with built-in assessment so that teachers can monitor student progress. Layered information is preferred to accommodate different abilities.

General: Teachers seek material that is easy to use, inquiry-based, and designed to provide real-life applications. They are very interested in locally based, environment-centered material, and will be sure to use such supplemental material if it is easy to acquire and to use.

Field Trips, Investigations: Teachers are willing to travel anywhere from 40-120 minutes to reach a field trip site, although they are concerned about taking too much time to travel. The major constraints to organizing field outings are financial considerations and bus availability. Classes that are allowed to raise funds can overcome the financial barrier.

Field trips must be validated as a site for active learning tied to specific standards or conducted on a weekend with an enticing incentive attached. Participants see the value of field outings as: "a place to do science," "a place to see science done professionally," "to validate what is done in the classroom," "to open up our senses," and "to provide real-life connections."

There was overall enthusiasm for visits to coastal sites, and to coastal (as well as inland) parks. With the provisos regarding academic activity above, all participants would welcome the opportunity, especially if buses were paid for, to take students to the coast—more than once! Despite this lack of awareness and understanding of service-learning, participants were extremely interested in learning about establishing and sustaining service-learning opportunities.

Professional Development: It was clear that professional development is an ongoing process undertaken for its intrinsic value to educators. Some of the focus group participants were beyond the need for salary credit and viewed professional development as an opportunity for personal enrichment.

When asked about additional incentives, the majority of participants suggest a menu of options, including university academic credit, district salary credit, and stipends (ranging from $100.00 - $150.00 per six-hour day).

Participants did express interest in a five-day summer *Coast Alive!* workshop that combined field investigations with lectures/lab work and that merges content with pedagogy. Having material ready for use in the classroom is important, as is content that merges science, culture, and history.

A NEW APPROACH

How People Learn Cognitive research over the last 50-60 years, and particularly, in the most recent 15 years, has yielded an overwhelming body of scientific work that is quite revolutionary, considering the way most Westerners have thought about "learning". Here are some of the results, from a variety of disciplines that study the human mind:

1. Genuine learning is subjective, and intensely active;
2. Starting at a very young age, each child constructs a personal understanding of the world, woven out of all of her experiences, and continues creating this ever-widening fabric of integrated concepts with each new experience;
3. In this way, every person fashions, out of personal experience, a uniquely structured, personal web of knowledge about how things work;

4. People retain less than 20% of the information they hear in lectures, less than 25% of what they read (textbooks), as compared to 90% of what they learn by doing.
5. People learn when they attach *meaning* to the experience.

Changes in the Economy, in the Society At the same time, the demands of today's workplace and our 21st century society and democracy require that people use their minds, not their hands. Traditional schooling has been tied to the past, to preparing students for the industrial workplace, in which most work was manual and repetitive, and in which decision-making was not prized except among a very small elite group of professionals and managers. But, in the 1990s, the U.S. Department of Education surveyed a large number of government and industry studies, and found that all of them identified the need for higher-order thinking skills among members of the American workforce, and they also found that our schools have not been up to the task.

Implications for teaching: The implications for education are fundamental and far-reaching. Unlike students of the past, who were raised in traditional school environments, today's students need opportunities to *apply* knowledge to generate and construct *meaning*. Teaching science therefore becomes an active, even social, process of creating experiences, helping students make sense of experiences.

Most of us who were taught in the 20th century were considered passive learners, in that the teacher's job was to fill the empty vessel of a student's mind with pieces of knowledge. The newer cognitive science has shown that while that approach may "work" for facts that can be learned with brute force (memorization, drill), the *higher-order thinking skills* related to problem-solving cannot be mastered that way. How, then, can we prepare students for this "new approach"?

The Five E's:

Engagement: Fortunately, we can identify one ingredient that will provide the missing link, and that is "engagement." Surveys show that students crave "engagement," the commitment of the educational community to providing meaning and relevance to students. And, there is overwhelming evidence that students so engaged will perform, grow, and reach their own potential (and with it, the opportunity to become thoughtful problem-solvers in the complex world of this new information-oriented economy.)

Exploration: We can encourage students to work without direction from the teacher. Asking students to openly explore gives them a common base of experiences, within which concepts, processes, skills, and problems skills can be identified!

Explanation: By asking students for explanation, we focus their attention on a particular aspect of the previous experiences; they are invited to demonstrate their conceptual understanding, skills, or behaviors. The student explains possible solutions or answers, giving evidence for his assertion; he listens to other students' ideas; questions their explanations; and he answers critiques. The student is learning how to create a hypothesis, and defend it.

Extension: Instructor (or instructional materials developer, in our case) expects students to use knowledge, concepts + terms + skills, in new situations (e.g., the scenarios for *Coast Alive!)*.

Evaluation: Encourages students to assess their understanding, abilities: e.g. "Why do you think. freshwater clams are more affected by upstream mud than are shrimp? Evaluations provide an opportunity for open-ended questions, too (How do you know? What evidence do you have.…?.

The Role of Technology

How to use technology to our advantage:
Interactive multimedia in the classroom can help teachers meet the goals of the five "E's":

Engagement
1. High quality electronic media is—through its exploitation of full color visuals, rich sound and voice-over, three-dimensionality and user control— thoroughly engaging, exciting, interactive;
2. Unlike textbooks (whose long production time tends to render them out of date), technology media which can have a rapid turn-around time can focus on current real-world problems and scale topics to the user.

Exploration
1. Because of the branching capability embedded in good programs, technology media can provide "scaffolding" (building on what the student knows) along with tools to enhance learning;
2. And because the student is in control, these media approximate guided inquiry, using default data.

Explanation:
1. Scenarios can be constructed in the tech environment to help the student become completely self-directed (inquiry) and develop online hypotheses that then are tested;
2. Due to the use of voice-over and other social enhancements, small groups of students can work at a tech station together. This arrangement facilitates group interaction: discussion of possible paths or solutions, providing evidence for their assertions, and so on.

Extension:
1. Interactive multimedia can readily provide *real-time real-world* data; and we will use our web site to keep our students and teachers up to date); technology creates opportunities for students to apply what they have learned in new situations;
2. Tech media can also offer the opportunity to *do* science.

Evaluation:
1. It is now possible for instructional technology to offer assessment tools online; once the student completes the assessment, it can be forwarded to the teacher;
2. CIB has used open-ended questions in its previous programs; many teachers encourage these questions in the resource materials.

Coast Alive!
Will use technology where it is best applied

IV. FORMULATE KEY QUESTIONS *What key issues guide the project?*

***Internally Devised Parameters and Criteria for the Software Piece*:** Early on in the planning for the project, the *Coast Alive!* Team met several times specifically to devise a list of parameters to guide the pedagogical development of the project. Here are the top priority educational criteria in developing this resource for schools:

- As much as is possible, focus on presenting phenomena that students can (1) manipulate, (2) alter (factors or variables), (3) assess, and (4) develop hypotheses to test (= inquiry).

- Develop assessment tools for teachers:
  (1) formative assessment for each student, online for the computer material;
  (2) summative assessment for each unit, based on the "Big Problem."

- Create non-linear modules that will be provide material to be completed in 20-minute chunks

- Address the science standards.

- Make problem-solving activities interactive.

- Decide on one of two choices for delivery: (1) all four scenarios—*Earth, Wind, Fire, Water—on one disc, addressing fifth, sixth, seventh, eighth, ninth+ grades; (2) (less desirable) one scenario per disc;* at least these both limit the scope

- Use State Parks and other coastal sites as focus for the project overview, and as the settings for the activities: include new video and photographic images; history; natural history; maps;

- Make the project teacher friendly, possibly using some of the following ideas:
  - Ability to track student progress on disc material;
  - Clear pathways to go through materials;
  - Summary questions after each module (that can be electronically sent to teacher)

Externally Devised Parameters for Designing Science Materials (from *Developing Inquiry-based Science Materials*)

In designing for students, the science experiences should be:

- ***Conceptually structured;*** In essence, this means that the students will confront the knowledge or understandings we wish them to understand, not the mechanical aspects of the activity itself.

- ***Evidence-based:*** Science is defined operationally as a process of gathering and evaluating evidence; increasingly, being able to gather and evaluate scientific evidence is a survival skill as essential as reading. Citizens and voters are being asked to make more and more decisions related to science (e.g, local water and air quality; fire control; medical care.)

- ***Materials-centered:*** Scientific investigations gather and interpret quantifiable information about the material world. Students must develop skills in using equipment and materials.

- ***Inquiry-oriented:*** Students engage in scientifically oriented questions; give priority to compelling evidence; formulate explanations from that evidence; connect explanations to the given body of scientific knowledge; and communicate and justify their explanations.

V. CREATE LEARNING ACTIVITIES: What experiences, activities, investigations will help students learn skills and discover understandings?

A. Computer-based Activities: The joy of using a computer in doing these investigations is due to the fact that the virtual world allows one to control variables that might be very obstinate in the real world, or even impossible due to logistical constraints.

Some educational software programs are exquisitely suited for this kind of science: they allow the user, in a virtual world informed by the expertise of the software developer, to manipulate any aspect of the environment. So, in *Interactive Physics*, for instance, the student encounters the "inclined plane" set of experiments and can change variables such as stickiness of the surface, friction, gravity level, angle of the plane, and "discover" the relationships among these variables, test his idea over and over, and confirm or alter the hypothesis.

These sorts of programs allow learners to create an infinite number of problems and test the effects. Students engage in active and interactive learning manipulating any aspect of the environment. We call such environments "microworlds" and they are very powerful. Of course, all of the Sim projects (SimCity, etc.) create microworlds, and are in fact simple simulations of real-life situations. The degree of discovery is potentially very high.

Modified Microworlds: The *Coast Alive!* group envisions a series of *simpified* microworlds (we are of course not able to produce SimCity style simulations on the current budget).

Scenarios:
a. Earth: Students design an outdoor concrete skateboard park with all the undulations and twists and three-dimensional curves associated with these new gathering spots for adolescents. In trying to locate an appropriate site and construct an appropriately sized park, one of the concerns is, of course, the seismic environment. Not only is there the issue of major or minor earthquake, but also the problem of landslide activity and dry creep, all of which might cause miniscule shifts in the soil underlying the park, and lead to cracking and dislodging. The student will be given five choices of sites, and will collect data to find an appropriate site for the park. (Topics include rock strata; geologic history; P & S wave activity.)

b. Wind: Student groups plan when to to hang glide from a coast side peak the following year and locate an appropriate take-off peak, time of year, time of day, as well as landing destination. They must factor in projected wind speeds and wind direction, taking into account such seasonal phenomena as Santa Ana winds, coastal fog and smog, as well as tides (beach landing) and seasonal crowding at the landing site.

c. Fire: Student groups vie with each other in the following scenario: a devastating firestorm during the Santa Ana windy season hits the upland scrub area near the coast, stripping it of most of its vegetation. Over the course of the following months, five plant species pop up in the burnt canyons—all of them new to science! The task for each of five student groups is to identify one of the new species, classify it using both traditional and new DNA/protein sequencing methods, give it a name, map it, dig soil cores to see its history, and then germinate it and develop a management plan (if native, for protection; if invasive, to keep under control; if noninvasive, decide what to do).

d. Water: Student has the option to put new oil rigs out in the Pacific, offshore from one of the five counties. Student must consider economic factors (shipping lanes, costs), political factors (recreational beaches, viewscapes, historical sites), ecological factors (oil spills affecting benthic marine fauna and migratory wildlife), currents, and they cannot place the rig before securing an oil rigger course certificate of completion.

We envision each of these electronic scenarios becoming both the driving force to engage students, as well as the culminating assessment piece. Each of them involves “guided inquiry” (see previous section) where the student determines the approach he/she takes (the overall experience is guided by the choices provided to the students by the *Coast Alive!* team, and limited only by the lmitations of interactive media. been). We envision rigging each scenario so students are sooner or later compelled to refer back to the “cy-brary”, source of background material to fully equip them to solve the puzzle/problem.

Background Material & Activities: This is the “Cy-brary”

B. Field-based Activities: The joy of using a computer program like *Coast Alive!* is only exceeded by the thrill of working in the field with ***real phenomena.*** The team will create a few sample experiments and activities to do in your default coastal site, park or even slightly inland location. As noted earlier, variables become very obstinate in the real world, so we hope to create a few sample investigations that eliminate most variables and settle on a few.

*****   Unfortunately we are unable to flesh this out at this time, due to lack of funding for this portion of the planning phase.***

VI. REVIEW FOR CONNECTIONS TO COMPLIANCE:

To which standards and disciplines do the activities relate?

CA CONTENT STANDARDS IN SCIENCE

EARTH SCIENCE

	5th	*6th*	*7th*	*8th*	*9th*
Water					**CA Geology**
Cycle	**				**Hazard map**
Ocean salt	**				*Ocean curr*
Vapor	**				*Atm gases*
Fog, cloud	**				*Atm chemht*
Recycling	**				*Greenhouse*
Local origin	**				*Solar E*
Convection					***
Distribute ht	** *ocean*				*Circ pattern*
Weather chg	* *maps*				*Temp invers*
H2O resource					*ENSO*
Water chem.				****freeze**	*RF, deserts*
Density,					*Climate*
buoyancy				**	*Compmodels*
Waves					**Global patt**
Plate tect.					***
Evidence		**			**Prin 3 plate**
Layers		**			*Rock props*
Plates		**	*		*Plate bound*
Quakes, volcano		**			*2 kinds volcs*
Geol events		**	*		*Why quakes*
Features		**	*		*Hotspots*
Epicenter		**			*Seafloor*
Topography					**Biogeochem**
H2O weathers		**			*Carbon cyc*
River dyna sys		**			*Nitrog cyc*
Beach dyn sys		**			**Driven by E**
Geo shapeshabs		**			*C flow times*
Rock cycle			*		*C reservoirs*

LIFE SCIENCE

	5th	6th EARTH	7th LIFE	8th PHYS	9th
Physiology					***
Special structs	**		**Levels org**		**Homeostasis**
Blood, O2	**		**Bone, muscl**		*NS commun*
Digestion	**		**Repro organ**		*Feedbk loop*
Kidney	**		**Plant repro**		*N waste,liver*
Plant circ	**				*Immune resp*
Photosyn	**				*Hormones*
Respiration					
Ecology					***
E exchange		**			**Stability**
Matls transfer		**			**H,C,N cycles**
Pops & fxn		**			**Pop size chg**
Diff orgs roles		**			*E pyramid*
Limiting factors		**			**B,I,E,D**
Stability					**Chg in ecosy**
Resources					
E conversion		**			**Heat loss**
Renewable,non		**			**Prod, cons**
Natl origin res		**			
Cell, molecular					***
Chem of life			**	**	
Parts of cell			**		
Central dogma					
ATP production					
Enzymes					
Genetics, sex					***
Sex, meiosis			**		*Genet map*
Traits, genes			**		*Phenotype*
Alleles, mitosis			**		*Mendel*
DNA, chromo			**		*Dom rec*
Evolution					***
Gen+env			**		**Allele frequ**
Nat'l selection			**		*Heterozygote*
Hardy Weinberg					*Equilibrium*
Gene drift, isol					*Pop,specia*
Evidence evol.			**		**Mutations**
Cladograms			**		**Evol rels**
Extinction			**		**Biodiversity**

Physical Science

	5th	*6th*	*7th*	*8th*	*9th*
Structure mtr					
Elements	*			*	*
Atoms	*			*	*
Molecules	*			*	*
Chem props	*			*	**
Atomic struc				*	**
Reactions					
Simple				*	
Chem Bond					*Chem Bond*
Rxn Rates					*Rxn Rates*
Chem Equil					*Chem Equi.*
Density				**Density**	
Density, buoy.					*Density*
Motion, forces				**	
Conservation E				**	
Momentum				**	
Waves					**Forces**
Chemistry					***
Gases					**Gases**
Stoichiom.					*Stoichiometry*
Acids			*		*Acids Bases*
Organic					*Organic*
Biochem			*		*Biochem*
Nuclear Rxn			*		*Nuclear Rxns*
Periodic Table				*	
Heat, Thermo.				*	*
Electrical E					
Electricity					**
Magnetism					**
Chem. Liv.Sys.	*			*	
Elements	*			**Molecules**	*biochem*
Light			**		

INVESTIGATION AND EXPERIMENTATION STANDARDS

VII. ASSESS STUDENT LEARNING:

What tasks, products will demonstrate student learning? 0.5 page How will you assess progress along the way? 1 page What culminating experience will students do to assess the degree to which they have achieved the goals of the study? 2 pages Rubrics? Criteria? Benchmarks?
Total 2-3 pages

A. What tasks demonstrate student learning?
   (in general?)

B. How will we assess progress along the way?
   1. Computer program
   2. Classroom exercises
   3. Field investigations
   4. (Service: restoration project, etc.)

C. What culminating experience will students do to assess their understanding?
   1. Computer program
   2. Classroom exercises
   3. Field investigations
   4. (Service: restoration project, etc.)