Implementation Strategies

Implementation Overview

The success of *Design and Discovery* depends largely on program preparation, organization, and familiarity with the curriculum.

**Planning a Program**
Planning your own *Design and Discovery* program and implementing the curriculum may seem daunting, but these materials will help prepare you. Tips on staffing, suggestions for field trips, a sample budget, ideas for promoting the program, and examples of schedules are some of the items included.

**Instructional Practices**
*Design and Discovery* has proven to be most successful when incorporating certain instructional practices. Learn about the *Design and Discovery* approach and instructional strategies that are beneficial when implementing *Design and Discovery*.

**Participating in Fairs**
Science and engineering fairs provide opportunities for students to showcase their projects and compete in engineering competitions. Learn how *Design and Discovery* students can participate in fairs affiliated with the Intel International Science and Engineering Fair (Intel ISEF).
Implementing a Program

Implementation Strategies

A Design and Discovery program is most effective when implemented in an environment that allows for extended blocks of learning, making available sufficient time to introduce, carry out, and complete design investigations. This section provides information on planning a program that fits your needs.

Staffing
This area provides information on staffing positions and responsibilities needed to carry out a successful program.

Budget
Creating a project budget ensures allocation of money for specific program essentials, including the program facility and supplies. This section includes a detailed sample budget as well as fundraising ideas that can be used to plan a program.

Mentors
Mentors play an important role in the program. This area provides information on the role mentors play, how to recruit mentors, what makes a good mentor, training, and additional mentoring resources.

Field Trips
Field trips offer a real-world connection. This section assists with all logistics in arranging meaningful field trips that integrate with the curriculum.

Publicity
Publicity offers suggestions for ways to promote Design and Discovery for recruitment, sponsorship, and recognition purposes. It includes downloadable documents for promoting the program.

Scheduling
Sample schedules in this section provide examples of how Design and Discovery can be implemented in different settings to match program formats and timeframes.
Staffing

Implementing a Program

The curriculum is best taught by knowledgeable and trained staff—ideally, with a science, engineering, or design background. If it is going to be taught by someone with background in another discipline, it is recommended that the facilitator review the curriculum thoroughly, try each activity, and if necessary bring in experts for the sessions where extra help is needed.

The staff should understand the design process, be fluent with the curriculum goals and the program's overall goals, be good communicators, and support family involvement. Facilitating learning through supportive exchange with students is essential. The goal is to nurture independence, not reliance on adult answers. Empowering each student to solve problems independently is critical behavior for staff. Ideally, there will be two staff members for every 10 students. A typical Design and Discovery program will have 20 students, two facilitators, and several mentors.

If you are planning to implement a Design and Discovery program, you will need to consider the following staffing positions and responsibilities.

Program Organizer
The program organizer is responsible for setting up a Design and Discovery program. This person is responsible for the safety and well-being of the students, administration of the program, and overall organization. This person will probably do the following:

- Hire facilitators
- Find a location for the program
- Establish a budget
- Do any necessary fund-raising
- Recruit students
- Recruit mentors
- Purchase the supplies
- Plan the field trips
- Plan the final event
- Train the facilitators

Facilitators
The ideal facilitator is someone who has had some experience teaching or working with youth. The curriculum is best taught by knowledgeable and trained staff, ideally with a science, engineering, or design background. If it is going to be taught by someone with
background in another discipline, it is recommended that the facilitator review the curriculum thoroughly, try each activity, and if necessary bring in experts for the sessions where extra help is needed.

The staff should understand the design process, be fluent with the curriculum goals and the program's overall goals, be good communicators, and support family involvement. Facilitating learning through supportive exchange with students is essential. The goal is to nurture student independence, not reliance on adult answers. Empowering each student to solve problems independently is critical behavior for staff. A one-day training should be set up for the facilitators.

Expect to have 1-2 staff members for every 10 students. There should be a minimum of two adults with the students at all times. A typical group size is 20 students.

**Where to Find Facilitators**

Look for staff among high school and middle school teachers, undergraduate and graduate university students, and staff of local junior/community colleges, and other colleges and universities. List positions with local professional associations, education associations, and school districts. If necessary, advertise in the employment section of your local newspaper. Many colleges and universities have student chapters of the Society of Women Engineers and other professional engineering organizations.

**Screening Facilitators**

Staff should complete an employment application and provide references. It is recommended that you do a criminal background check on each staff member. Check with your organization's insurance carrier for specific rules for your liability insurance. If staff will be responsible for transportation, a special driver clearance may be required by your organization.

**Training and Orienting Facilitators**

Staff training should be held prior to the beginning of the program and include the following:

- Day-to-day curriculum overview and work plan
- Site orientation including safety issues, room usage, computer systems
- Procedures for field trips
- Training in "facilitation" skills
- Emergency procedures
- Discipline procedures
- Review of the design process
Compensation
Expect to pay staff members $12 to $30 per hour depending on experience and standard wages in your area. Check with the local school district to compare pay rates for summer school teachers. Each facilitator will require approximately 120 hours including the sessions and prep and wrap-up time.
You will need to allocate money for staff salaries, food, program supplies, T-shirts (optional), awards, telephone costs, postage, shipping, facility, printing, transportation, and insurance. Below is a sample budget in U.S. dollars.

## Sample Program Budget

<table>
<thead>
<tr>
<th>Income</th>
<th>Formula</th>
<th>Projected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sponsorship</td>
<td></td>
<td>$10,000</td>
</tr>
<tr>
<td>Participant fees</td>
<td>$250 x 20 participants</td>
<td>$5,000</td>
</tr>
<tr>
<td><strong>Total Income</strong></td>
<td></td>
<td>$15,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expenses</th>
<th>Formula</th>
<th>Projected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff: program coordinator, instructors, assistants</td>
<td></td>
<td>$6,500</td>
</tr>
<tr>
<td><strong>Food</strong></td>
<td></td>
<td>$800</td>
</tr>
<tr>
<td>Program supplies</td>
<td></td>
<td>$1,500</td>
</tr>
<tr>
<td>T-shirts</td>
<td>25 @ $10 ea.</td>
<td>$250</td>
</tr>
<tr>
<td>Training</td>
<td></td>
<td>$50</td>
</tr>
<tr>
<td>Awards/recognitions</td>
<td></td>
<td>$50</td>
</tr>
<tr>
<td>Telephone</td>
<td></td>
<td>$50</td>
</tr>
<tr>
<td>Postage</td>
<td></td>
<td>$250</td>
</tr>
<tr>
<td>Shipping</td>
<td></td>
<td>$100</td>
</tr>
<tr>
<td><strong>Program site rental</strong></td>
<td>Two vans, two weeks</td>
<td>$1,500</td>
</tr>
<tr>
<td>Printing</td>
<td></td>
<td>$500</td>
</tr>
<tr>
<td>Mileage</td>
<td></td>
<td>$300</td>
</tr>
<tr>
<td><strong>Transportation</strong></td>
<td></td>
<td>$2000</td>
</tr>
<tr>
<td>Scholarships</td>
<td></td>
<td>$1,000</td>
</tr>
<tr>
<td>Insurance</td>
<td></td>
<td>$150</td>
</tr>
<tr>
<td><strong>Total Expenses</strong></td>
<td></td>
<td>$15,000</td>
</tr>
</tbody>
</table>

**Starred items may be procured in-kind or provided by participants.**
The Facility
At a minimum, the program requires a classroom space with work tables (not desks) and access to computers with word processing, spreadsheets, and Internet connection. It is preferable to have access to a large computer lab so that you can incorporate technology whenever applicable and relevant to the tasks. An ideal site should include a classroom, a work area with access to tools (like a wood shop or metal shop), and a computer lab. The rooms should be closely located to minimize staff supervision needs. An outdoor work/play area should be available, as well as a place for eating lunch/snacks.

Facility Suggestions
Possible sites include schools, colleges, local companies, science museums, community centers, or youth organization facilities, such as an Intel Computer Clubhouse, www.intel.com/education/icc. Look for a location that is central to your field trip sites and easily accessed by public transportation.

Facility Cost
Site costs will vary. Expect to pay $2,000 to $6,000 to rent a site. However, many of the suggested sites can be obtained for low or no cost. Collaborating with a local school district or organization is a good way to negotiate discounted space.

Supplies
Some supplies can be donated and others will need to be purchased. Be sure to review the supply list and plan ahead. The Supply List provides a detailed inventory of items needed for the program’s hands-on activities.
Sample Fund-Raising Letter

Implementing a Program: Budget

Date

Contact
Company
Address
City, State Zip

Dear Contact:

Engaging students in math, science, and technology is one of the most important factors in creating tomorrow's workforce.

*Design and Discovery* is a program that addresses this issue. Through hands-on activities, mentoring, presentations, and behind-the-scenes field trips, students discover the world of design and engineering. The participants are then challenged to identify a problem or opportunity and design a solution. Students present their designs to their peers and community in a design and engineering fair.

*Design and Discovery* will be offered to (number of) students from (school, club, organization) as an (after-school activity in the spring, summer camp, etc.). Participants are typically students in grades 7-9 that have expressed an interest in the program.

(background paragraph on presenting organization)

We would like to request (Company's) assistance in providing this opportunity to the students of (school, club, organization, area). Your sponsorship of (amount) would be greatly appreciated.

If you have any questions or would like additional information, please contact Sally Someone at 503-555-5555. Send email inquiries to someone@organization.org.

Regards,

Sally Someone
Design and Discovery Coordinator
Non-profit Youth Organization
Mentors
Implementing a Program

Why Include Mentors
Mentors are a vital part of Design and Discovery. Mentors are partners in learning, who can inspire students and participate in Design and Discovery in many ways. They might attend several days of the program and share their experience with students while working on activities. Others may come in for a lunch or an hour to give a talk. And others may devote time to a single student working one-to-one on a design project.

Ideally, some mentors initially work with the whole group as assistants and experts. Once students are focused on a project and have identified their project needs (8D: Mentor Matching), then one mentor works with one or two students for an extended period of time to support each student's project development. Mentors provide guidance and personal attention. Additionally, they provide expertise, and act as role models.

Recruitment
Mentors can be engineers, engineering students, product designers, high-tech professionals, teachers, or any adult who has the necessary skills to assist the students. Mentors can be recruited from a variety of places, such as local design and engineering businesses; professional organizations such as the Society of Women Engineers (www.swe.org*), American Society of Civil Engineers (www.asce.org*), American Society of Mechanical Engineers (www.asme.org*); universities; parents; and friends. They can be recruited by word of mouth, advertising, phone calls, and by holding information sessions. If mentors are not available in your area, consider e-mentoring though universities and businesses elsewhere, or an e-mentoring organization.

Time Commitment
Actual mentor hours will vary. It is important to figure out where mentors will be the most beneficial. It is suggested that you include mentors in as many sessions as possible and schedule them so that their expertise can be used in the sessions that relate to their background. Starting in Session 12 or 13, mentors should work one-on-one with students to assist them with their design projects. Again, they may not be available to be at every session, but should be encouraged to work out a schedule with their assigned student.
Contact with an assigned student may include email, phone calls, individual meetings, and group meetings.

**Roles and Responsibilities for Mentors**

- Act as a resource for an assigned student to help with his or her project
- Provide the assigned student with contact information and parameters for contacting the mentor for help (when and where to call, email address, etc.)
- Act as a role model for their field
- Notify program director of any issues or concerns

Mentors should not give students money or pay for project-related expenses.

**What Makes a Good Mentor?**

- A good mentor provides young people with support, counsel, reinforcement, and constructive feedback.
- Mentors are good listeners, people who care, and people who want to help young people bring out strengths that are already there.
- Mentors are role models who provide students with insight into their chosen profession and encourage students to pursue their interests.
- Mentors help students make connections with people who may be helpful to them.
- Mentors enjoy giving back through community service.

**Training**

Mentors should be briefed in their expectations, the structure of the program, and the curriculum. They should be given specific information about program rules regarding the mentor-student relationship. This should include safety issues and rules related to meeting times, sites, and methods of contact. They should be given a copy of the curriculum in advance so that they can become familiar with it.

**Matching Mentors**

Finding the right student-mentor match can be difficult. Plan to match students with a mentor once the projects are underway and project needs are clear. To match, you may:

- Have students select their mentors. (In this case, include multiple opportunities for interaction with mentors during the program prior to mentor selection.)
- Assign mentors based on areas of expertise.
- Assign mentors geographically.

**Mentor Appreciation**

Be sure that the facilitators and students write thank-you notes to the mentors.
acknowledging their commitment and contributions. Be sure to mention mentors in any publicity.

**Screening Mentors**
Mentors should complete an application and provide references. It is recommended that you do a criminal background check on each mentor. Check with your organization's insurance carrier for specific rules for liability insurance.

**Mentoring Resources**
The Mentoring Center, [www.mentor.org](http://www.mentor.org)*

Friends for Youth Mentoring Institute, [www.mentoringinstitute.org](http://www.mentoringinstitute.org)*

The National Mentoring Partnership, [www.mentoring.org](http://www.mentoring.org)*

National Mentoring Center, [www.nwrel.org/mentoring](http://www.nwrel.org/mentoring)* (Technical assistance packets are available at [www.nwrel.org/mentoring/packets.html](http://www.nwrel.org/mentoring/packets.html)*.)

Big Brothers Big Sisters of America, [www.bbbsa.org](http://www.bbbsa.org)*

International Telementor Program, [www.telementor.org](http://www.telementor.org)*
Mentor Profile

Emily Hackett, Mentor
"You Get to See a Young Person Grow"

When Emily Hackett looks back on her education in engineering, she can think of several people who played an influential role. "There were teachers in elementary and middle school who encouraged me, and good advisers in college and graduate school. But I never had a female mentor. That's got to be helpful for a girl considering this career field."

Hackett has a Ph.D. in materials science and an undergraduate degree in mechanical engineering. She has worked in design automation, improving the design of integrated circuits. She also volunteers her time as a mentor to several girls participating in Design and Discovery camps. She learned about the program through a local chapter of a professional organization, the Society of Women Engineers. At first she was a little reluctant about mentoring. "It sounds ambiguous. What does one do as a mentor? But it's turned out to be a really good experience."

Hackett began meeting weekly with a group of girls who already had taken part in a summer Design and Discovery program. "They were at the point where they had ideas for products and were working on prototypes. I offered them some suggestions for materials they might consider using."

An eighth-grader named Taylor, for example, was working on a jewelry storage idea that would keep necklaces from getting tangled. Hackett describes their process: "I started by helping her with some back-of-the-envelope calculations: If you want so many hooks on that display disk, what does the diameter of the circle need to be? We used basic geometry." Taylor also wanted her display disk to rotate, and that meant adding a stepper motor. "It was important to her that the whole thing be automated. Neither of us knew quite how a stepper motor works. We had to figure out how to wire it with a controller. Taylor also had the idea of using knife switches—she had used them in the Design and Discovery camp. But she wanted to make it more complicated, with four switches. She caught on to the wiring just like that."

Taylor proved herself a skilled problem-solver. "She recognized a bug that I completely
missed. She noticed the battery was getting warm and realized we should look for a short circuit. She's that focused on what she's doing," Hackett says.

The mentor also points out why a project like Taylor's offers good reason to get more women into engineering. "She's addressing a problem that women have, with jewelry getting tangled.

It's complicated enough for a good student project—an interesting challenge, but not too complicated for her to solve. At the same time, she learned a lot from it, both mechanical and electrical."

Hackett says it was easy to find a comfortable way to work together. "I found myself coaching her with questions. I've done a lot of tutoring and teaching before, so the tutor role comes naturally to me. And she is so bright and focused. It's like working with an adult engineer. We'll sit down for a work session, put our heads down, and look up two hours later. There are people I've worked with professionally who can't do that."

Taylor had her prototype ready two days before the deadline for a regional science and engineering fair. What was the reward for Hackett? "The rewards I've always gotten out of this kind of stuff, which is to have fun and, I hope, have some good influence on people in the community. You really get to see a young person grow, and you start to take some pride in their project." Mentors don't need extensive technical experience to be effective, Hackett adds. "People know more than they think they know. You don't have to be an electrical engineer to help somebody with a circuit."
Sample Mentor Application
Planning a Program: Mentors

_Design and Discovery_ is a design and engineering initiative for students entering the seventh through tenth grade in the fall. In a two-week day camp (dates) and regular follow-up activities, students will create a prototype for a design project. Mentors will work closely with one or a few students, advising and helping them with their projects.

Please complete the following application and permission to conduct a background check, and send with a current résumé to (mailing address and email address).

**I. Basic Personal Information**

Name:
Address:
Home Phone: Home Email:
Work Phone: Work Email:

**II. Background and Interests**

Do you speak any foreign language well enough to mentor a student whose native tongue is that language?

No Yes Languages:

Do you have any prior experience working with youth?

No Yes

If yes, please describe:

List any special training, skills, hobbies, etc. that you believe will enhance your ability as a mentor.

Have you volunteered with any service organization?

No Yes

If yes, please describe:

**III. The Mentoring Experience**
Have you ever been a mentor? No Yes
Have you ever been mentored? No Yes
Will you be available to mentor through (date)? No Yes

How many hours per month will you be available?

Please describe your personal goals for participating in Design and Discovery. What do you hope to give? What do you hope to receive?

IV. Design and Discovery-Related Questions

Did you enter a science fair in middle or high school? No Yes
If yes, please describe:

Have you participated in a science fair as an adult? No Yes
If yes, please describe:

Could you host a tour or job shadow at your company? No Yes
If yes, please describe:

Disclosure Statement for Design and Discovery Volunteers

Name:
Address:
Phone: Email:
Social Security No: Date of Birth:
Driver's License No: State, Exp. Date
Occupation:
Employer:
Supervisor's Name:
Supervisor's Telephone:
1. Have you ever been convicted of a crime of violence?  
   No  Yes  
   If yes, please describe:

2. Have you ever been convicted of a crime against a person?  
   No  Yes  
   If yes, please describe:

Have you ever been a witness or accused (respondent) in a case in which a Family Services Agency determined there was substantiated conduct that was determined to be child neglect or abuse?  
   No  Yes  
   If yes, please give details, location, your involvement, and final determination.

Have you ever worked in a setting that involved either children or youth?  
   No  Yes  
   If yes, please give details, location, your involvement, and final determination.

List three persons not related to you who can judge your qualifications for this position.

<table>
<thead>
<tr>
<th>Name</th>
<th>Relationship</th>
<th>Address</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
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<tr>
<td>2.</td>
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<tr>
<td>3.</td>
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</tbody>
</table>

I hereby attest that all information I am submitting is true and complete to the best of knowledge. I understand that:

A. It is the intent of the (name of organization) to deny a volunteer position to any person who has been convicted of a crime of violence or a crime against a person or to any person whom any Family Service Agency has found substantiation of a child abuse allegation.

B. In applying for a volunteer position, the information that I have furnished on this form is subject to verification, which may include a criminal history check. I may be required to provide any necessary or required documentation to obtain said verification.
C. Histories of psychiatric or psychological treatment reflecting impairment of my ability to handle children may result in denial of my volunteer application.
D. If I am accepted as a volunteer, I may be removed from said position, or said position may be eliminated at any time, in the sole discretion of (name of organization) or its agents. I have, and hereby agree, that I have no right to continue in said volunteer position, and said position may be terminated at any time, with or without cause.

Signature                  Printed name                  Date

To be completed by organization
Interviewed by:                      Date:
Field Trips
Implementing a Program

Local field trips are a wonderful way to expose students to the real world of design and engineering and are an important part of the Design and Discovery experience. In some of the sessions, suggested field trips are noted. Field trips should be arranged well in advance.

Try to relate the field trip to components of the design process. Field trips should be designed to give students a unique opportunity to experience engineering in the real world. Field trips need not be expensive. The designed world is all around us, so even something as simple as a structured trip to the supermarket can be an effective field trip. Look for opportunities to show students engineering solutions at work. This can be as complex as an automated packaging plant or as simple as the water slide at the local pool.

Making Contact
To schedule a field trip, start with your personal connections. Most companies will allow behind-the-scenes tours, especially if an employee has an interest in it. Ask parents about their workplaces and jobs. Next, contact local branches of professional engineering organizations, such as the Society of Women Engineers (www.swe.org*), American Society of Civil Engineers (www.asce.org*), and the American Society of Mechanical Engineers (www.asme.org*). Most of these organizations have members that work in the engineering field and may be interested in helping some aspiring engineers.

New Field Trip Location
Be sure to discuss field trip goals ahead of time. Familiarize the host organization with the curriculum and establish a clear plan.

Chaperones
It is important to arrange chaperones for the field trips. These can be parents or mentors. All chaperones should be made aware of safety issues and procedures. When possible, be sure to include extra fun activities, such as a picnic, a trip to the beach, or a meal at a restaurant, etc.

Transportation
Transportation may involve renting vans, having parents drive, or renting a bus. Be sure to plan this into your budget.

Before the Field Trip
To get the most out of a field trip experience, it is important to be prepared. Have goals and expectations clearly discussed up front. Students can come up with questions or can be provided with a scavenger hunt. Students should be prepared to draw sketches, take
pictures, and take notes to record their observations. Before going, pose the following questions: What are we trying to find, discover, or understand today? How will you record what you find?

**During the Field Trip**
Encourage students to look for solutions that they have seen designed. Be sure to debrief during the field trip. Discussion questions might include: What did you find that others should see? How did you figure out how a design solved a problem? Are there additional problems you see that still exist? Keep asking targeting questions that connect to the goals of the field trip. Tell them to look for things like specially placed lighting, signage, ways of containing or displaying materials, items that do one specific job, and features of the place they are visiting that have been designed to solve a problem. Tell them to notice informational displays and interpretive boards. Discuss: How are materials presented? How is important information conveyed? How are pictures used? Drawings? Models?

Allow time for sketches and picture taking, with the goals in mind. Ask that students share these pictures when they return as ways of reminding themselves and others what they saw that was valuable. They should also take advantage of any contacts they meet who can help them with their design projects.

**After the Field Trip**
Debrief the field trip by discussing what students got out of it and how the experience will help them with their projects. Have them share observations, sketches, and photos. Don't forget to send thank-you notes.

**Field Trip Alternatives**
If a field trip is not possible due to time or distance, consider inviting a local engineer, designer, or inventor to present to the group. Ask for an interactive presentation with a hands-on activity for the participants.

Suggested Field Trips and Experts (By Curriculum Section)

**Understanding the Design Process**
- A visit to a store, mall, a walk around the facility to identify problems, needs, and opportunities
- A field trip to a design or engineering firm to learn about the firm's design process
- Expert: product designer

**Engineering Fundamentals**
- A trip to a factory or plant.
- Experts: materials engineer, electrical engineer, mechanical engineer

**Thinking Creatively About Problems and Solutions**
- A visit to a place, such as a mall or store, to conduct interviews and get feedback on their ideas
• Expert: materials engineer

Making, Modeling, and Materializing
• A field trip to a bicycle repair shop
• A visit to the modeling shop of a design firm
• A trip to a hardware or home improvement store to look at parts and components
• Experts: product designer, shop manager, handyperson

Prototyping
• A visit to a design firm to see prototypes
• A place to conduct user testing on prototypes
• Expert: product designer

Final Presentations
• Guest speakers: engineer, product designer

Other Field Trip Ideas
• Manufacturing or packaging plant
• Supermarket
• Train station or rail yard
• Commercial farm with equipment
• Post office
• Water park (slides, tubes, fountains, etc.)
• Auto repair shop
• Machine shop
• Distribution warehouse
• Commercial bakery
• City waterworks or sewage treatment plant
• Power generation dam
• Bridges
• Locks
• Shipyards and docks
• Shopping malls (with escalators, people movers, etc.)
• Light rail, trolley, or transit system
• Construction site
• Rock quarry
• Military base
• Ship (merchant marine, military, cruise)
• Army Corps of Engineers
• City, county, or state engineering departments
Publicity
Implementing a Program

Once you've decided to create your own program using the Design and Discovery curriculum, it's time to promote it. Start by announcing the program to the local media. Send a press release to the local newspapers, magazines, radio, and TV stations. Don't forget the school newspapers and community newsletters. Promotion is important for building both sponsorship and participation.

 Recruiting Participants
Plan to recruit a large pool of applicants to ensure that your program will be full to capacity and represent a diverse group of participants. Place posters and applications in places where potential participants and/or their parents will have access to them. Provide applications to teachers, youth organizations, and clubs. Inform parents about the program and personally invite students to participate. Hold an information session to introduce the program and generate interest.

The Press
Design and Discovery is a unique, innovative curriculum and may be of interest as a feature story. Invite reporters to visit the program and attend the student presentations. Media coverage in your first year will help with recruiting and sponsorship in following years. Target reporters that typically cover business, technology, or education stories. Be sure to get parent permission for students to be photographed or featured in articles. The newspaper, radio station, or television station will typically have prepared releases. After the program, send a press release detailing the successes and experiences of the program. Include quotes from students and parents about the experience. If possible, include a photo of participants working on a hands-on activity. A close-up photo is preferable.
Sample Press Release
Implementing a Program: Publicity

FOR IMMEDIATE RELEASE [Date]:
For additional information contact:
Sally Someone, Design and Discovery Coordinator (503) 555-5555

Design and Discovery Comes to Anytown
Anytown, USA—(Organization) will present Design and Discovery as an after-school program beginning (date) at (location).

Engaging students in math, science, and technology is one of the most important factors in creating tomorrow's workforce. "Science and technology skills have become basic skills—like reading, writing, and arithmetic—necessary to compete in today's economy," said Carlene Ellis, Intel's Vice President of Education.

Design and Discovery is a program that addresses this issue. Through hands-on activities, mentoring, presentations, and behind-the-scenes field trips, students discover the world of engineering. The participants are then challenged to identify a problem or opportunity and design a solution. Students present their designs to their peers and community in a design and engineering fair.

Design and Discovery will be offered to (number of) students from (school, club, organization) as an (after-school activity in the spring, camp in the summer, etc.) Participants are typically students in grades 7-9 that have expressed an interest in the program.

(Background paragraph on presenting organization)
[Date]

Attention Parents:

We are presenting *Design and Discovery* as an after-school program for grades 7-9.

*Design and Discovery* is a program that encourages exploration of product design and engineering careers. Through hands-on activities, mentoring, presentations, and behind-the-scenes field trips, students discover the world of engineering. The participants are then challenged to identify a problem or opportunity and design a solution. Students present their designs to their peers and community in a design and engineering fair.

This is a fabulous opportunity for students to have hands-on experience with high-tech tools, meet professionals working in science and technology, and get an insider view of several local design, engineering, and technology firms.

I have enclosed an application for your child. To be eligible, students should be in grades 7-9 and have an interest in science or technology. Scholarships are available.

If you have any questions or would like additional applications, please contact Sally Someone at 503-555-5555. Send email inquiries to someone@organization.org.

Regards,

Sally Someone  
*Design and Discovery Coordinator*  
Non-profit Youth Organization
Sample Student Application
Implementing a Program: Publicity

Design and Discovery: An engineering and design [summer, after-school, weekend] program

[Sample Program Description: Design and Discovery is a design and engineering initiative for students entering the 8th, 9th, or 10th grade. This program involves students in the exploration of design and engineering concepts during an interactive [length of program] program.

Through hands-on activities, field trips, and projects, students will learn to recognize and explore the designed world around us. They will meet scientists, engineers, product designers, and technology specialists. In addition, they will learn team-building skills and participate in related field trips. Students will develop a project that incorporates the study of design, engineering, and computer applications and will be supported by adult mentors.]
**Design and Discovery**  [dates]

**REQUIREMENTS**
[Sample Requirements: To qualify for the Design and Discovery program, students should be entering the 8th, 9th, or 10th grade.]

To apply, complete the attached application and return to:
[Name of organization, address]

**THE SITE**

[Explain where the program will be held, the address, and the facilities available there.]

**DETAILS**

Dates:  
Times:  
Location:  
Fee:  
Capacity:  
Deadline:  

**TIMELINE**

Applications Due:  
Pre-Program meeting for students and mentors:  
Program Dates:  

**DESIGN AND DISCOVERY VOLUNTEERS**

Adult volunteers are needed to help with the program and chaperone field trips. Volunteers must (include requirements.)

**Design and Discovery**  [dates]

Name_______________________________Age___________________Date of Birth____/____/____

Address___________________________________________________________________

____ (Street) (City) (State) (Zip)

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*Other names and brands may be claimed as the property of others.*
Phone( )_____________________Cell( )_________________Email____________________

Grade in Fall 2002____________ School (Name and Location)__________________________

Parent(s)/Guardian(s)
Name________________________________________________________

T-shirt Size? SM M LG XL XXL

In the event of emergency, please notify the following person (available during program hours):
Name_________________________Relationship to Participant__________________________

Phone( )_____________________Cell Phone or Pager( )__________________________

INTERESTS

☐ Engineering ☐ Medicine ☐ Computer Science ☐ Science
☐ Math ☐ Education ☐ Physics ☐ Social Work
☐ Government ☐ Law ☐ Design ☐ Other_______

Do you plan to attend college? ☐ YES ☐ NO ☐ NOT SURE

Has anyone in your family attended college? ☐ MOTHER ☐ FATHER ☐ SIBLING

ESSAY QUESTIONS

(attach an additional sheet if needed)

1. What is your favorite subject in school and why?

2. Why are you interested in this program?
Design and Discovery [dates]

STUDENT AGREEMENT
I have reviewed the Design and Discovery program description carefully. I understand that admission to this program is done by individual selection based upon interest and essay submission.

_______________________________________  ______________________________________
Applicant's Signature                      Date

PHOTO RELEASE
I, being the Parent/Guardian of:___________________________hereby consent that (student's name)_______________ name, image, and likeness, whether in video-tape, photograph, motion picture film and/or electronic images for which she/he poses, and/or audio recordings made of her/his voice will be the property of and may be used by [name of organization], its assigns or successors, for purposes of promotion and/or recruitment of other students, including television, free and clear of any claim whatsoever on my part.

_______________________________________  ______________________________________
Signature of parent/guardian                Date

PARENT/GUARDIAN PERMISSION
As a legal guardian I give permission for the student named above to participate in all phases of the activities including off-site trips. I understand and agree to cooperate with all regulations. I will not allow her/him to attend if she/he is not in good physical condition. In an emergency, I give permission for the program authorities to take any emergency measure deemed appropriate. The parent/guardian will be notified as soon as possible. THIS FORM CANNOT BE PROCESSED WITHOUT THE SIGNATURE OF A PARENT OR GUARDIAN.

_______________________________________  ______________________________________
Signature of parent/guardian                Date
Scheduling
Implementing a Program

The Design and Discovery curriculum is most appropriate when implemented in a setting that allows for extended learning. Time needs to be provided for the session’s hands-on activities and discussion periods. The curriculum is probably best implemented in informal education settings, such as an after-school, weekend, or summer program. It is an ideal program for implementation by youth organizations such as Girl Scouts, Boys & Girls Clubs of America, Camp Fire USA, Boy Scouts of America, church groups, and science clubs.

Time Structure
Each session is 2.5 hours and is divided into activities. The curriculum can be divided into shorter sessions depending on your needs. Each activity varies in length (some may be 20 minutes, while other are 60 or even 90 minutes). It is important that the sessions and activities be sequential as each session builds on the previous session. The sessions were originally established as 2.5 hours for a two-week, all-day summer program. This structure left room for field trips, and other activities, such as swimming, and a lunch break. More information about scheduling ideas can be found in the Implementation Examples section.

Scheduling Options
The Design and Discovery curriculum covers approximately 45 hours of contact time with students. There are various ways to arrange a Design and Discovery schedule, from an intensive two-week camp immersion to an extended after school program. Each of the 18 sessions takes 2.5 hours to complete, without time set aside for breaks, meals, special field trips, speakers, or a final presentation.

In the first example schedule below, the program runs all day with each session lasting a half-day with breaks and lunch. This program would run two weeks with time for an additional half-day field trip and a half-day for an event to present final projects.
Sample Design and Discovery Camp: Two-Week Program

**Week One**

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00-9:30</td>
<td>Orientation or Ice Breakers</td>
<td>Review Home Improvement</td>
<td>Review Home Improvement</td>
<td>Review Home Improvement</td>
<td>Review Home Improvement</td>
</tr>
<tr>
<td>9:30-12:00</td>
<td>Session 1</td>
<td>Session 3</td>
<td>Session 5</td>
<td>Session 7</td>
<td>Session 9</td>
</tr>
<tr>
<td>12:00-1:00</td>
<td>Lunch and Free Time</td>
<td>Lunch and Free Time</td>
<td>Lunch and Free Time</td>
<td>Lunch and Free Time</td>
<td>Lunch and Free Time</td>
</tr>
<tr>
<td>1:00-3:30</td>
<td>Session 2</td>
<td>Session 4</td>
<td>Session 6</td>
<td>Session 8</td>
<td>Session 10</td>
</tr>
<tr>
<td>3:30</td>
<td>Wrap Up and Notebook Entry</td>
<td>Wrap Up and Notebook Entry</td>
<td>Wrap Up and Notebook Entry</td>
<td>Wrap Up and Notebook Entry</td>
<td>Wrap Up and Notebook Entry</td>
</tr>
<tr>
<td>4:00</td>
<td>End</td>
<td>End</td>
<td>End</td>
<td>End</td>
<td>End</td>
</tr>
</tbody>
</table>

**Week Two**

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00-9:30</td>
<td>Review Home Improvement</td>
<td>Review Home Improvement</td>
<td>Review Home Improvement</td>
<td>Field Trip</td>
<td>Set Up for Fair</td>
</tr>
<tr>
<td>9:30-12:00</td>
<td>Session 11</td>
<td>Session 13</td>
<td>Session 15</td>
<td>Session 16</td>
<td>Session 18</td>
</tr>
<tr>
<td>12:00-1:00</td>
<td>Lunch and Free Time</td>
<td>Lunch and Free Time</td>
<td>Lunch and Free Time</td>
<td>Lunch and Free Time</td>
<td>Lunch and Free Time</td>
</tr>
<tr>
<td>1:00-3:30</td>
<td>Session 12</td>
<td>Session 14</td>
<td>Field Trip to Design Firm</td>
<td>Session 17</td>
<td>Mini-Engineering Fair</td>
</tr>
<tr>
<td>3:30</td>
<td>Wrap Up and Notebook Entry</td>
<td>Wrap Up and Notebook Entry</td>
<td>Wrap Up and Notebook Entry</td>
<td>Wrap Up and Notebook Entry</td>
<td>Wrap Up and Notebook Entry</td>
</tr>
<tr>
<td>4:00</td>
<td>End</td>
<td>End</td>
<td>End</td>
<td>End</td>
<td>End</td>
</tr>
</tbody>
</table>

**Other Scheduling Options**

In an after-school program such as a science club, each 2.5-hour session could be broken up over the course of the program. Devoting two 90-minute time periods per week to *Design and Discovery* sessions, the program could be completed in a semester, just in time for students to enter their projects into local and regional science fairs in late winter and early spring. The example schedule below shows how a science club meeting twice a week for 90-minutes each could implement the program. Additional time can be set up for more work sessions or field trip experiences.
**After-School Schedule**

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guest Speaker</td>
<td>Activities 2A, B, C, D</td>
<td>Activities 3A, B, C and 4A, B</td>
<td>Activities 4C and 5A, B</td>
</tr>
<tr>
<td>Activities 1A, B, C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 5</td>
<td>Week 6</td>
<td>Week 7</td>
<td>Week 8</td>
</tr>
<tr>
<td>Activities 6A, B, C Field Trip</td>
<td>Activities 7A, B, C</td>
<td>Activities 8A, B, C, D and 9A</td>
<td>Activities 9B Field Trip</td>
</tr>
<tr>
<td>Week 9</td>
<td>Week 10</td>
<td>Week 11</td>
<td>Week 12</td>
</tr>
<tr>
<td>Activities 9C and 10A, B</td>
<td>Activities 11A, B, C and 12A</td>
<td>Activities 12A, B, C Field Trip</td>
<td>Activities 13A and 14A</td>
</tr>
<tr>
<td>Week 13</td>
<td>Week 14</td>
<td>Week 15</td>
<td>Week 16</td>
</tr>
<tr>
<td>Activities 14B, C and 15A</td>
<td>Activities 16A, B</td>
<td>Activities 17A, B Field Trip</td>
<td>Activities 18A, B</td>
</tr>
<tr>
<td>Week 17</td>
<td>Week 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organize Fair</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Presentations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Instructional Practices

Implementation Strategies

*Design and Discovery* is most successful when facilitated as an inquiry-based and student-centered program. This section provides suggestions for facilitating *Design and Discovery*.

**Approach**
The *Design and Discovery* curriculum follows the principles of project-based learning. This area provides more information about the educational approach taken in *Design and Discovery*.

**Strategies**
*Design and Discovery* has been implemented in a variety of settings. This section offers suggestions for facilitating the program based on proven successes.

**Logistics**
Project work involves details that need to be thought through. This section provides assistance on managing projects and supplies.

**Student Materials**
Like professional engineers and designers, *Design and Discovery* students use design notebooks to record their ideas, respond to questions, and sketch drawings. This section provides information on using design notebooks, the student handouts, and other student materials.

**Safety and Tool Use**
Students use a variety of hand tools throughout their project work. This section provides tips on how to use these tools safely.
Approach
Instructional Practices

**Applies Principles of Project-Based Learning**
Project-based learning is an instructional model that involves students in investigations of compelling problems that culminate in authentic products. In *Design and Discovery*, students identify a design problem that is relevant to their own lives and come up with an innovative solution. Through hands-on work, they create design briefs, sketches, models, and working prototypes of their design solution. The work is inherently meaningful because it allows students to pursue their interests and engages their curiosity. Much of students' work takes place in the real world, outside the classroom, where they conduct surveys, gather data, talk to professionals, observe users, test their products, and showcase their projects.

**Engages Students in Inquiry-Based Learning**
*Design and Discovery* is an inquiry-based curriculum that encourages higher-order thinking. Inquiry skills evolve throughout the sessions as students explore the world around them, identify a problem that interests them and, through test and trials, develop ideas to solve the problem. Through hands-on activities, they gain an understanding of basic mechanical, electrical, and materials engineering principles that can be applied to their design solutions. As students develop their models and prototypes, they determine—with the help from mentors and experts—what engineering principles they can apply to their own designs.

**Uses Tools of Professionals**
*Design and Discovery* follows a 10-step design process used by professional engineers and designers. The design process guides students through their project development, beginning with the identification of everyday problems and culminating with developing and presenting a working prototype. As students follow the design process, they use other tools of working engineers and designers. They learn how to write a design brief, create conceptual drawings, use creative brainstorming techniques, develop models, and make working prototypes. They develop the lifelong skills of working collaboratively, being problem-solvers, and presenting their ideas. Through this process, *Design and Discovery* students assume the roles of real engineers and designers.

**Follows a Sequential Order**
The *Design and Discovery* curriculum is divided into 18 sequential sessions, each with two to four hands-on activities. The order of the sessions mirrors the design process, and it is
therefore strongly recommended that the order not be rearranged. Engineering fundamentals are included after students are introduced to the design process and before they delve into their own projects. This allows students to refer back to their learning from these engineering sessions and decide what engineering principles they may want to incorporate into their designs. By the end of the Design and Discovery experience, each student will have his or her own working prototype. Many students may wish to further refine their design solution and enter engineering and science fairs.

**Builds Interest in Engineering and Science Careers**
Research has shown that in middle school many students lose interest in science and math and end up taking fewer of these classes in high school, which ultimately closes doors to math and science careers. One of the goals of Design and Discovery is to generate interest in engineering and science for students who may not otherwise be interested in these areas. Students who experience Design and Discovery soon acknowledge that this is not a typical science class. Many students who were not previously interested in engineering careers express interest after the program. Mentors are integral to Design and Discovery and help to further students' exposure to engineering and science careers. Field trips can also serve this purpose by providing students first-hand experience with working professionals. Design and Discovery culminates with a final presentation of students' projects where students have an opportunity to share their expertise and demonstrate their projects to the community.
Facilitation

*Design and Discovery* is a student-centered experience. The facilitator should establish a safe environment where students are encouraged to ask questions, pursue their ideas, conduct tests and trials, and make mistakes. The facilitator should assume the role of consultant throughout the *Design and Discovery* experience and understand that he or she does not need to be the expert with all the answers. The facilitator should encourage students to seek answers to their questions through conducting research, talking to experts, and testing their ideas.

Facilitators may find that some *Design and Discovery* students wish to pursue ideas that may seem very large and probably unrealistic. However, students should never be discouraged. The facilitator can help redirect them or help them to narrow their focus by breaking down an idea into smaller parts. It is important to remember that *Design and Discovery* is about the process of getting from "think" to "thing" and not just about the final product.

Grouping

Session descriptions indicate when it is preferable to have students work in small groups or in pairs. Otherwise, the curriculum is flexible for students to work as the facilitator wishes. In sessions where students are grouped, it is recommended that students rotate through different groups or pairings to encourage students to work with a variety of people.

Ideas for Assigning Groups
- Deal playing cards to each student. Form groups by numbers, suits, or colors.
- Divide students based on common characteristics: clothing, hair color or style; alphabetical by first, middle, or last name.
- Have students draw names.
- Roll dice to choose a random number. Assign groups by numbers or evens/odds.

It is also up to the facilitator to decide how the students will work on their design projects. It is suggested that they work individually or in pairs. If they work in pairs, they should be able to get together outside of class time to work. Students working together should also be in the same grade level, especially if they want to enter an Intel ISEF-affiliated science fair. Check with your local fair for rules on group projects.
Bringing in Experts
Experts may be brought in to support Design and Discovery students at any point. Experts are most useful during the engineering fundamentals sessions if the facilitator does not have an engineering background. Experts may be drawn from parents, community members, universities, and local businesses.

Mentors are integral to Design and Discovery—especially during the phase of individual project work. See Mentors for more information about recruitment and responsibilities of mentors.

Assessment
While assessment is not built into the Design and Discovery curriculum, the curriculum does lend itself well to portfolio assessment. Portfolios allow students to represent the learning that has taken place during the Design and Discovery program. This curriculum involves identifying a need that could be met by redesigning, modifying, or improving an existing product or designing a new product. Students can collect and reflect on examples of their work throughout the program and present them as portfolio entries at the end of the program. Portfolio entries could include evidence that explains the design goal and the planning, implementation, results, and evaluation of the design solution.

Electronic portfolios offer an innovative alternative to more traditional portfolios. A digital portfolio might use multimedia technology, allowing students to collect and organize their portfolio components in a variety of mediums, such as video, audio, text, and graphics. For example, taking digital photos to document the design process, recording reflective video, using narration to describe aspects of the design solution, or creating a 3D simulation of a working prototype can all be highlighted through the creation of an electronic portfolio. An electronic portfolio, if published online, offers students a creative way to present their learning to a larger audience while also increasing their technology skills.

The curriculum also provides many embedded assessment opportunities where observational data can be used as an ongoing record of student understanding. Discussion and student handouts supply another avenue for checking understanding of key concepts.
Logistics
Instructional Practices

Managing Projects
As students create models and prototypes, they will need a safe place to keep them. Keep in mind that some of the projects may be rather large. Also, students may be transporting them between home and the Design and Discovery site and will need to have a safe way to transport their project. Advise students that they should take this into consideration when developing their models and prototypes. Be sure that they use strong materials and create something to hold their project to make it easier to store and transport.

Work Space
It is recommended that a Design and Discovery program be held in a spacious room with tables. Students need space to work on activities and build their models and prototypes. The room should also have a closet to keep supplies and a safe place for students to keep their projects. Students will also be working collaboratively through much of Design and Discovery and will need a room layout that is conducive to this. Since Design and Discovery is not an online curriculum, it is not recommended that it be held in a computer lab, although access to a computer lab is important for Session 9 and access to a presentation station is helpful in Session 4, 12, and 16 to show student videos. Having an internet-ready computer connected to a projector is useful to show web resources and videos to supplement the curriculum.

Managing Supplies
Each Design and Discovery session and activity includes a supply list. The entire supply shopping list is also available. All supplies may be purchased up front or may be bought as needed. Many of the supplies can be donated by students, mentors, and other volunteer organizations. Many vendors may also offer a discount for materials purchased in large quantities and for a youth program.

It is suggested that supplies be kept in a safe closet. A day prior to each session, organize the supplies for that session. Non-consumable supplies may be used over and over so be sure that they remain in good condition.
Supply Resources

Building, Electrical and Lighting, Hardware, Plumbing, Tools
The Home Depot
800-430-3376
www.homedepot.com*

Craft Supplies
Michaels
www.michaels.com*

Electronics
Radio Shack
www.radioshack.com*

Office Supplies
Office Depot
888-463-3768
www.officedepot.com*

Science Supply Houses
Carolina Biological Supply Co.
800-334-5551
www.carolina.com*

Pitsco
800-828-5787
www.pitsco.com*
Student Materials

Instructional Practices

Design Notebooks
A student composition book can be used as a design notebook. These notebooks should be used throughout the curriculum for students to record everything related to Design and Discovery, from responses to answers on the student handouts to design sketches. Students can write the questions from the handout on the pages of the design notebook. It is recommended that each student have a student composition book with grid lines. The gridlines will help students as they begin sketching their ideas.

The design notebook is a diary of progress of an idea. It is a place to record ideas, inspirations, discoveries, sketches, and notes. It is very important for students planning to participate in an Intel ISEF-affiliated science fair or who are interested in applying for a patent.

Design Notebook Guidelines

- Date and sign each page.
- Number each page.
- Never remove pages.
- Do not erase.
- Include explanation notes with any sketches or diagrams.
- Keep accurate and detailed notes.
- Be consistent and thorough.

Student Handouts
Each activity includes a student handout. These can be provided for students all at once in a three-ring binder or may be handed out session by session. Students should not write on these, but should do all of their writing and sketching in their design notebooks.

Video Journals
Video journals are optional. Capturing students' thoughts on video can serve as a powerful tool for reflection. Set up a video camera on a tripod at the end of each session and ask a few students to talk about their experiences and their projects. This can be organized with questions, prompts, or left open for students to just talk. It can be done in pairs or individually, although students will probably feel more comfortable in front of a video...
camera with a friend.

**Suggested Prompts**

- Explain what you worked on today and how it helped further your project.
- Explain how you are feeling about your experience in *Design and Discovery*.
- Explain what your goals are for your project and how you plan to meet them.
- Explain what has been most helpful so far in developing your project.

The video can be shared with the students throughout *Design and Discovery* as a way to discuss and reflect upon the design process. It may be shared with parents so that they can see what their child is thinking and doing in *Design and Discovery*. It can be edited and made into a short video piece to be shown at the final fair or presentation.

**Student Resource Cards**

Throughout the *Design and Discovery* curriculum, students are introduced to design and engineering concepts and brainstorming techniques. A set of six Student Resource Cards (PDF; 1 page) is provided as a student resource. All six cards can be printed on one sheet. The cards can then be cut into individual cards and distributed to students during the activities listed below.

- For Session 1, Activity A, use Discover an Engineer and Design Notebook.
- For Session 1, Activity B, use The Design Process.
- For Session 2, Activity B, use Activity Mapping.
- For Session 2, Activity C, use SCAMPER.
- For Session 8, Activity B, use Design Brief.
Safety and Tool Use
Instructional Practices

Tool Safety
Students use a variety of tools throughout Design and Discovery. Before using tools, be sure to demonstrate proper use of the tool and point out safety precautions.

General safety rules:

- Keep the work area clear of clutter.
- Maintain and keep tools sharpened, oiled and stored in a safe, dry place.
- Wear eye protection when cutting, sawing, drilling, or grinding.
- Inspect tools regularly.
- Use the right tool for the job, for instance, do not use a screwdriver as a hammer.
- Carry a sharp tool pointed downward.
- Protect a sharp blade with a shield.
- Store tools in drawers or chests with cutting edge down.
- Train all mentors in the proper use of hand and power tools.

Tools
The following tools may be used throughout Design and Discovery sessions:

**Needle-nose pliers**: Needle-nose pliers are used to bend and shape wire. Needle-nose pliers are used in Session 1 when students design their own paper clips and in Session 5 when students make a mechanical toy. Students may also need to use pliers during the modeling and prototyping phase of their projects. Be sure that students carry the pliers pointed downward.

**Wire cutter/stripper**: Wire cutters and strippers are often combined in one tool, but may also be purchased separately. Wire cutters and strippers may be used in Sessions 1 and 4, depending on what type of wire is used. Some insulated wire is already partially pre-stripped for use, while other wire may need to be stripped. To use a wire stripper, identify the gauge of the wire and place the wire in the proper hole, and then pull the insulation away and off of the wire. Wire cutters are used when the length of the wire needs to be modified. Some wire comes pre-cut. Check the supply list for each activity to determine the length of the wire needed. To use a wire cutter, place the wire in the sharp part of the blade and cut at a right angle. Never rock the wire cutter from side to side or bend the wire back and forth against the cutting edge. Point tools away from you when stripping or...
cutting wire.

**Screwdriver:** Small Philips* screwdrivers are used in Sessions 4 and 6. In Session 4, they are used to screw the wire to the battery and lamp holders. (Some battery holders may be pre-wired.) This can be done beforehand by the facilitator or during the session by the students. In Session 6, screwdrivers are used to take apart clock radios. When using a screwdriver with electrical equipment, be sure to use an insulated screwdriver. Place object on a table, not in the palm, when using a screwdriver.

**C-clamp:** Clamps are versatile tools that serve to temporarily hold work securely in place. C-clamps are used in Session 3 to hold materials in place when conducting a materials properties test. When using a clamp, ensure that the pressure plate is in full contact with the workspace before tightening. Pads can be used with C-clamps to avoid marking the surface.

The following tools may be used when students are working on their models and prototypes.

**Hand saw:** Saws are made in various shapes and sizes and for many different uses. Be sure to use the correct saw for the job. Choose a saw with a handle opening of at least 5 in. (12 cm) long and 2.5 in. (6 cm) wide and slanted at a 15° angle. Before cutting, check for nails, knots, and other objects that may damage the saw. If material is long, place in a vise. Start the cut by placing your hand beside the cut mark with your thumb upright and pressing against blade. Start the cut carefully and slowly to prevent blade from jumping. Pull upward until blade catches the wood. Start with partial cut, and then set saw at proper angle. Apply pressure on the down stroke only.

**Hammer:** Hammers are made for specific purposes in various types and sizes, and with striking surfaces of varying hardness. Select a hammer that is the proper size and weight for the job. When striking a hammer, strike squarely over the surface. Be sure to have an unobstructed area to swing a hammer. Use the correct type of hammer for the work. Keep your eye on the object you are hitting. Hold the hammer with your wrist straight and your hand firmly wrapped around the handle.

**Hot glue gun:** A hot glue gun is ideal for gluing wood, metal, fabric, ceramics, masonry, leather, cardboard, and PVC. Insert glue sticks when glue gun is in off position. Keep fingers away from hot glue.

**Knives:** Knives may be used to cut thicker materials. Always cut away from the body.
Keep hands and body clear of the knife stroke.

**Tin snips:** Tin snips are useful for cutting sheet metal, plastic, and linoleum. Do not attempt to cut heavier materials than the snips are designed for. Never use tin snips to cut hardened steel wire or other similar objects. Such use will dent or nick the cutting edges of the blades. Be careful of the sharp edges of the materials and tool. Use only hand pressure for cutting. Never hammer or use your foot to get extra pressure on the cutting edges.

**Goggles and Gloves**
Students should always wear goggles and latex gloves when working with tools, wire, and other sharp materials.

**Wire**
Wire is measured in gauge which refers to the size of the wire. The higher the gauge number, the thinner the wire. The lower the gauge number, the thicker the wire and the more amps capacity it has to carry current further from the electrical source. *Design and Discovery* students will be using different gauged wire for different uses. In session one, they use steel or copper wire, 14 or 18 gauge to make paper clips. In session four, electrical engineering, they use 22-gauge wire that is stripped 0.25” and bent 90 degrees. Use a wire stripper to strip insulation from wire and a wire cutter if wire needs to be shortened.
Participating in Fairs
Implementation Strategies

Participating in Fairs provides information on opportunities for students to share their hard work by showcasing their projects and competing in engineering competitions.

Intel ISEF
This section presents information on participating in the Intel International Science and Engineering Fair (Intel ISEF) and the Intel ISEF-affiliated science fairs where students qualify to participate in Intel ISEF.

Hosting a Fair
Hosting a Fair offers suggestions on how to host your own engineering fair. Hosting a fair is explained in detail in Session 17, Fairly There; and Session 18, Dress Rehearsal.

Other Fairs
A selection of engineering fair and competition opportunities for middle school age students is provided here. For middle school students who may not yet be eligible for an Intel ISEF-affiliated science fair, Hosting a Fair and Other Fairs are good practice for future participation in an Intel ISEF-affiliated science fair.
The Intel International Science and Engineering Fair (Intel ISEF) (www.intel.com/education/isef/) is the world's largest pre-college science competition. It provides an opportunity for the world's best young scientists and inventors to come together to share ideas, showcase cutting-edge science projects, and compete for more than $3 million in awards and scholarships. Each year, 10 to 15 percent of finalists file for patents on their projects.

Overview
The Intel ISEF is the world's only international science fair representing all life sciences for students. Every year, more than one million students in grades 9-12 compete in regional science fairs and nearly 500 Intel ISEF-affiliated fairs held around the world. Then, at Intel ISEF, more than 1,200 students from 40-plus countries win the chance to compete for the scholarships and prizes in 14 scientific categories and a team project category.

The Intel ISEF has been coordinated for more than 50 years by Science Service, one of the most respected nonprofit organizations advancing the cause of science. As title sponsor, Intel Corporation has committed millions of dollars to developing and promoting this competition. In addition, each year a volunteer committee representing the host city raises funds to sponsor events throughout the fair.

Intel's Sponsorship
Intel became the first title sponsor for the Intel ISEF in 1997 as a way to recognize and reward excellence in science from the world's best young scientists, and to encourage more young people to explore science and technology in their higher education and career choices.

Since assuming the sponsorship, Intel has focused on increasing international participation and adding new awards such as Young Scientists Scholarships, Achievement Awards, Best of Category, and awards to teachers and fair directors. Intel's sponsorship of the Intel ISEF is part of the Intel® Innovation in Education initiative to prepare today's teachers and students for tomorrow's demands.

Intel ISEF-Affiliated Science Fairs
An Intel ISEF-affiliated science fair is a science competition that is a member of the Intel ISEF network. These competitions exist in every state in the U.S. and 40 countries. All Intel ISEF-affiliated science fairs register with Science Service and must consist of five participating high schools or 50 students in the ninth through twelfth grades. Some fairs may have middle school divisions. Fairs are conducted at local, regional, state, and national levels.
Before participating in the Intel ISEF, a student must compete at an Intel ISEF-affiliated science fair. Each affiliated fair can send two individual project finalists and one team project to compete in the Intel ISEF. Information for becoming an Intel ISEF-affiliated fair and finding an Intel ISEF-affiliated fair near you is available at http://www.societyforscience.org/page.aspx?pid=309*

Below is general information about the fair. For more detailed information, go to Science Service, www.sciserv.org/isef/* and Intel ISEF www.intel.com/education/isef/.

**How to Participate**

1. Any student in grades 9-12 or equivalent is eligible to enter.
2. First, compete in a high school or local science fair. More information at www.sciserv.org/isef/*.
3. Winners at the high school or local level can then compete in a regional or state fair.
4. Winners of the regional or state level may be eligible to compete at the Intel ISEF. Each affiliated fair can send up to two individual finalists and one team consisting of up to three members to represent them at the Intel ISEF.

**The Engineering Category**

Engineering is one of the 14 Intel ISEF categories. According to the Intel ISEF student handbook, an engineering project should "state the engineering goals, the development process, and the evaluation of improvements." Engineering projects may include the following steps:

1. Define a need.
2. Develop design criteria.
3. Search literature to see what has already been done.
4. Prepare preliminary designs.
5. Build and test a prototype.
6. Retest and redesign as necessary.

This mirrors the design process in *Design and Discovery*. It is important that students keep accurate and consistent notes and sketches in their design notebooks for Intel ISEF. It is critical to thoroughly read the Intel ISEF rules since they are very specific.

If judges ask students what their hypothesis is, students could answer, "This project is an engineering project. I defined a need and then developed design criteria to meet that need. This procedure replaces the scientific method for my project."

**Project Submissions**

Project submission criteria are thoroughly explained on the Science Service Web site www.sciserv.org/isef/*. Most of the information is generalized for all the categories and needs adaptations for an engineering project. Successful project submissions include:
1. Project data book (the Design and Discovery design notebook)
2. Abstract: A 250-word, one-page document that includes the purpose of the project, procedures used, data, and conclusions
3. Research paper
4. Visual display (Be sure to read the display rules.)
Hosting a Fair
Participating in Fairs

Many schools or districts already have annual science fairs that Design and Discovery students may be able to participate in. Session 17, Fairly There, describes the suggested engineering fairs for Design and Discovery. This culminating event is held to recognize students' hard work and celebrate their accomplishments; to share engineering expertise with others; to practice presenting projects to an audience; to get feedback on their projects: display boards, prototypes, and presentations. A brief description of each culminating event follows.

A Solutions Showcase
This culminating event is held for parents and community members and is an opportunity for students to share their work and get feedback. Each student explains his or her project with a display board that includes their design brief, sketches, their models, and prototypes. They can also create slide presentations. Invite a guest speaker to open the event. Don’t forget to have snacks on hand as well as programs for the guests.

A Mini-Engineering Fair
This culminating event is held for younger students and peers. In this case, all of the students set up their project displays around the room and the guests visit each project for an explanation by students. These presentations are more informal than a Solutions Showcase. In addition to sharing their projects, Design and Discovery students also plan mini-engineering activities for younger students to give them a taste for engineering and what they've learned.

Organizing a School Science Fair
Many resources are available for organizing a more traditional school science fair. For example, see Science Fair Central, www.school.discovery.com/sciencefaircentral/*. The science fair organizer section provides information for teachers on how to organize a school science fair.
Other Fairs

Participating in Fairs

Many organizations hold science fairs that are geared to middle school. The following is a partial list of resources.

Science Fair Resources

**eCybermission.** eCybermission is a Web-based science, math, and technology competition for seventh- and eighth-grade teams of three or four students and a Team Advisor who have registered on the site. Teams select a problem related to one of four Mission Challenges: Arts and Entertainment; Environment; Health and Safety; and Sports and Recreation. [www.ecybermission.com](http://www.ecybermission.com)*

**Christopher Columbus Awards.** The mission of the Christopher Columbus Awards program is to have middle school students (sixth, seventh, and eighth grade) combine science and technology with community problem-solving in a real-world setting. In teams of three or four, students identify a problem or issue they care about and use science and technology to develop an original solution. With the help of an adult coach, they work with experts, conduct research, and test out their ideas. Ten finalist teams and their coaches receive an all-expense-paid trip to the Walt Disney World Resort to attend National Championship Week and a $200 grant to further develop their ideas. The first-place team wins a $5,000 savings bond per team member; second place, a $3,000 savings bond per team member; and third place, a $1,000 saving bond per team member. One of the 10 finalist teams wins the $25,000 Columbus Foundation Community Grant to develop its idea in the community. [www.nsf.gov/od/lpa/events/bayernsf/intro.htm](http://www.nsf.gov/od/lpa/events/bayernsf/intro.htm)*

**Invent America!** Launched in 1987, Invent America! is a nonprofit K-8 education program that helps students develop problem solving and creative thinking skills through inventing. Teachers can enroll and become an Official Invent America! member. Members can enter their students' inventions in the National Invent America! Student Invention Contest. Entries are judged on the basis of usefulness, creativity, illustration, communication of ideas, and research performed. First-, second-, and third-place winners receive U.S. Savings Bonds. Past winners have received congratulations from the President of the United States, traveled to Japan to receive awards, and had their inventions displayed at the Smithsonian Institution. [www.inventamerica.org](http://www.inventamerica.org)*

**The Discovery Channel Young Scientists Challenge.** The DCYSC is a creation of Discovery Communications, Inc. in partnership with Science Service. Every year, 6,000 out of 60,000 student competitors in grades five through eight are nominated to the DCYSC by
fair directors of Science Service-affiliated fairs. Between June (entrance deadline) and early September, judges choose 400 semifinalists among the entries. Students' work is judged on its scientific merit as well as the students' ability to communicate the science of their project. In October, 40 finalists receive an all-expense-paid trip to Washington, D.C. for the competition finals, which consists of a series of team challenges and oral presentations. The finalists present their original science fair project to the judges and other finalists. The winners receive scholarships and semifinalists receive prizes.

www.school.discovery.com/sciencefaircentral/dysc/*

Toshiba ExploraVision Awards Program. ExploraVision is a competition for students in grades K-12, divided into four categories: grades K-3; grades 4-6; grades 7-9; and grades 10-12. Participants must be U.S. or Canadian citizens or legal residents. The purpose of the competition is to encourage students to look at the tools and technologies we all use every day, identify a problem that a current technology does not solve, and then imagine possible solutions to the problem. Prizes for the student members of the four first-place teams will each receive a U.S. EE Savings Bond worth $10,000 at maturity. Second-place winners will receive U.S. EE series bonds worth $5,000 at maturity. Canadian winners receive Canada savings bonds purchased for the equivalent issue price in Canadian dollars. National finalist team members and their parents/guardians travel to Washington, D.C. for ExploraVision Awards Weekend where they are recognized for their outstanding achievement.

www.toshiba.com/tai/exploravision/index.html*

The National Engineering Design Challenge (NEDC). The National Engineering Design Challenge (NEDC) is an annual engineering-based competition for grades 9-12 that challenges students to apply mathematics, science, and technology to a multidisciplinary problem. Teams of students design, build, and demonstrate a working model of a new product that is a proposed solution to the problem. Past design challenges have included designing and fabricating a temporary shelter that is portable, inexpensive, and easy to set up in a variety of environments; designing an easily transportable fitness system for people of all ages and physical abilities; and developing a solution to enable a person to open and/or close containers that are commonly found in the home or office. The National Engineering Design Challenge can be conducted over four, eight, or ten weeks, or as a one-semester program. www.jets.org/programs/nedcdesc.cfm*

The WWW Virtual Library: Science Fairs. This library is an attempt to provide a single comprehensive list of every science fair accessible on the Internet. These include national, international, state, and regional fairs. http://physics.usc.edu/~gould/ScienceFairs*