

# Student & Teacher Computer Science Handbook



*A Guide for Researching, Documenting, and Displaying Projects at the  
Greater Kansas City Science & Engineering Fair*

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# A Word to the Teacher

## Why study Computer Science and Telecommunications Networking?

Organizations and people need Information for managing their day-to-day activities. Telecommunication is an information highway on which information travels from the source to the destination. However, before information enters the highway, it must be created and validated. For example, the school where you want to apply for admission needs your resume. This involves two basic steps (a) composition of your resume and (b) dispatching it to the school through e-mail. Computer science is responsible for the first task and telecommunication is responsible for the second. These two are highly complementary and one cannot function without the other. In the last 20 years significant progress is made in these two areas which provided you some of the most important tools such as e-mail, internet, web, database, etc., to manage your activities. They have become so ingrained in our behavior that we cannot live happily without it. You cannot play your video games or cannot watch movie or cannot even go to out without the support from telecommunication and computer science.

It is, therefore, important to know and learn about computer science and telecommunication, and contribute to their growth to make them more efficient. They are highly interesting and entertaining disciplines and studying and researching these technologies can prepare students for future careers in any discipline: everything from art to science. Knowing, learning, and researching in these disciplines can also enable students to think logically which is essential for problem solving and inventing new things.

## Why should students participate in the Greater Kansas City Science & Engineering Fair?

### 1. To Raise Self-Esteem

Too often, children, i.e., young researchers, are not given opportunities to get involved in projects that recognize their own personal achievement. When they innovate, not only their self-esteem but also logical thinking is enhanced through recognition as creative and productive individuals.

### 2. To Increase Parent Involvement

Parents are the most effective guide and innovative programs successfully involve them. As children attempt to innovate and problem solve, they enthusiastically interact with family members at home to relate their project ideas. Parental involvement helps students learn more effectively.

### 3. To Assist Students With the Application & Synthesis of Knowledge and Skills

When applying the innovation process students use hands-on experience to apply and synthesize the knowledge they acquired through textbooks and lectures.

### 4. To Experience the Scientific Process

Scientific research must be experienced to make it useful to the community. This fair creates an environment for students to get hands-on experience of the scientific process as they innovate by observing, collecting data, organizing, generalizing, predicting, revising and applying scientific facts.

### 5. To Encourage Creative Thinking

Research stimulates hidden creativity. It provides the opportunity for students to channel their creative skills. Encouragement from parents and teachers enforces this interest.

### 6. To Motivate Students to Learn

Motivation to think, read, write and illustrate becomes more fun when students have an exciting project to anticipate. Innovative projects allow them to choose topics based on their individual interests or need to explore new ideas.

### 7. To Integrate the Curriculum

Teachers and students can naturally integrate the curriculum, which saves time and gives purpose and meaning to learning. Students combine science, language arts, social studies, library skills, art, math and more—depending on the type of problem they are trying to solve.

### 8. To Develop Higher Order Thinking Skills

When students innovate, they move quickly through the Bloom's taxonomy by using previous knowledge, comprehension skills, application, analysis, synthesis and evaluation.

## 9. To Enhance Library and Research Skills

Students must use both primary sources (people) and secondary sources of information, such as libraries, reference works, or online resources.

## 10. To Contribute to the Advancement of Technology

The quality of life depends on providing effective solutions to real-life problems. Any innovation and deployment of effective solutions takes the quality of life a step further in the right direction. Students through their research experience and findings contribute to society.

# Instructor Insights and Ideas

Research in computer science needs very few resources, many of which are available to nearly every family. A desktop or a laptop, a wireless router, a printer, and a scanner are sufficient to effective research. More advanced research may need a few other items but they are readily available cheaply. However, with such limited resources a student can produce a research miracle with proper supervision and mentoring.

A few points worth remembering:

### 1. Research and Development in Computer Science

Computer science projects can be straightforward with as few resources as a single computer. Solutions range from using school-based resources during off-hours to creating a team-based project where students can share computing resources. Student versions and safe free software are available, usually at significantly reduced cost and sometimes at no cost to qualifying participants. The free availability of open-source operating systems such as Linux, Unix, etc., has resulted in applications becoming available at no cost over the Internet, or included with commercial distributions of Linux. These programs range from well-regarded image manipulation tools to full-featured software development environments and tools.

Both telecommunication and computer science are well documented. Books and manuals are available at stores, libraries and even online. Additionally, trade journals and magazines can provide many ideas and research resources for projects. There are a number of browsers such as Google, Yahoo, etc. are very useful in identifying research problems and for doing literature survey for the research. Some highly useful commercial web sites for new of ideas are:

<a href="http://www.zdnet.com">http://www.zdnet.com</a>	<i>Ziff-Davis' main web site for eWeek, PC Magazine</i>
<a href="http://www.infoworld.com">http://www.infoworld.com</a>	<i>Infoworld Magazine web site</i>
<a href="http://www.computerworld.com">http://www.computerworld.com</a>	<i>Computerworld Magazine web site</i>
<a href="http://www.nwfusion.com">http://www.nwfusion.com</a>	<i>Network World Magazine web site</i>
<a href="http://www.pcworld.com">http://www.pcworld.com</a>	<i>PC World Magazine web site</i>
<a href="http://www.slashdot.org">http://www.slashdot.org</a>	<i>A favorite web site for information about Linux</i>

### 2. Computer Science Research Project Categories

Computer science research project can be categorized as (a) application research and (b) system research. In application research system components are not altered or modified rather the research deals with user and middleware. For example, developing efficient sorting schemes, measuring range of wireless communication, measuring the effect of wireless devices such as cell phone, PDA, etc., on their functionality, and so on. There are a large number of highly useful application research projects and students are encouraged to find projects which are useful to the society and teach logical thinking. Application research is easier than system research because this needs very little system architecture knowledge and very few resources.

System research, on other hand, is difficult, needs specific resources, and assumes that the researcher has a good knowledge of computer architecture. However, students who have such knowledge are encouraged to select a system research project. For example, investigating computer operating systems, dealing with data input/output, dealing with drivers, etc., are subject matter for system research projects.

### 3. **You Do Not Have to Reinvent the Wheel**

Science projects are judged on (a) innovation, (b) originality, (c) solution approach, (d) usefulness to the society, (e) presentation, (f) accuracy of the outcome, and (g) experimental design. While there is extreme value in innovation around novel ideas, developing new ways to analyze a problem using a rigorous scientific approach may be more valuable. Challenge students to think about real-life problems, efficient solution approaches, and method of deployment.

### 4. **Ideas for Projects**

A highly useful list of computer science research areas (system and application) has been created by the University of Illinois at Urbana-Champaign, which is one of the top rated universities with an excellent computer science department. Note that this list does not give any research project and a student has to identify it with the help of his or her mentor. An effective way is to identify the area of interest and use internet search engine to find a useful project or the student and mentor together can design a project. A combination of these approaches for problem identification is the best way to go about it. The list goes as follows:

#### **A. Architecture and Embedded Devices**

**Focus:** Hardware designs for next-generation computers and computing components.

**Research Topics:** Heterogeneous systems, memory hierarchies, microprocessors, microprocessor organization and trade-offs for integrated implementations, modeling and analysis, multi-computers, multiprocessor analysis and design, performance analysis, and scalable shared-memory multiprocessors.

#### **B. Artificial Intelligence, Robotics and Computer Vision**

**Focus:** Research in this area endeavors to create programs and devices that perceive, react, understand, communicate, plan, learn and reason.

**Research Topics:** Machine learning, reinforcement learning, computational learning theory, explanation-based learning, data mining, cognitive modeling, neural computation, knowledge acquisition, knowledge representation and reasoning, planning, natural language processing, intelligent human-computer interface, computer vision and robotics, vision-based mobile robot navigation, and object recognition.

#### **C. Biological Computing**

**Focus:** The group works with other biological researchers to build simulations and data models, conducts simulation experiments, and designs software.

**Research Topics:** Genetic modeling; image-based modeling and rendering; predictions.

#### **D. Computer Graphics**

**Focus:** The problem of communicating the visual attributes of real or conceptual objects and scenes by simulating their shape, appearance and motion.

**Research Topics:** Geometric modeling, image-based modeling and rendering, implicit surfaces, polygonal mesh simplification and partitioning, real-time shading, computational topology, and appearance modeling and rendering.

#### **E. Human Computer Interface and Multimedia**

**Focus:** The interactions between information systems and users, including image syntheses (computer graphics), virtual and augmented reality, speech synthesis and recognition, and human motion tracking and capture.

**Research Topics:** Collaborative interfaces; dynamic interfaces; interface and application builders; multimedia; visual interfaces; geometric modeling; object-oriented distributed graphics and animation; visualization and virtual reality.

#### **F. Information Systems and Data Management**

**Focus:** Studies the problems involved in building large, complex information systems and database management systems.

**Research Topics:** Digital libraries; distributed knowledge bases; modeling and analysis; text retrieval and multimedia databases.

## **G. Networking and Data Communications**

**Focus:** Researches a variety of networking technologies ranging from high-bandwidth, optical fiber-based communication through wireless and mobile communication and home networking.

**Research Topics:** Asynchronous transfer mode; broadband communications; digital video; fault tolerance; routing; network design; switch design; system software; wireless transport protocols; location management and connectivity.

## **H. Parallel Computing**

**Focus:** Investigates the software aspects of computation on computers composed of multiple processors.

**Research Topics:** Algorithms, compilers, computer systems, fine-grained systems, impact on architectural issues, languages, memory hierarchies and scalable shared-memory multiprocessors, and operating systems.

## **I. Programming Languages**

**Focus:** The design and implementation of computer languages with the goal of improving both programmer productivity and program quality.

**Research Topics:** Actors, compilers, formal semantics, functional logic, and run-time support.

## **J. Real-Time Systems**

**Focus:** Industrial or embedded computer systems that take inputs from environmental or other sensors and respond according to programming rules without the intervention of a human operator.

**Research Topics:** Constraint modeling and analysis, databases, fault tolerance, operating systems, partial computations, scheduling and resource management, tools and prototyping environments, validation, testing and measurement.

## **K. Security**

**Focus:** Information assurance and system security is an important issue today. Information assurance research requires skills in theory, practice, programming and design.

**Research Topics:** Cryptography, watermarking, authentication, security negotiation, and application to networks, systems and software.

## **L. Software Engineering and Computer-Supported Cooperative Work**

**Focus:** Methods and techniques for rigorous software design and the sociology of and tools for computer supported distributed collaboration (email, videoconferencing and discussion groups).

**Research Topics:** Design tools and environments, documentation and software reuse, process modeling and enactment, program verification, program transformation, reengineering, domain-specific architectures and systems, theories of collaboration, and user modeling.

## **M. Systems Software**

**Focus:** Concepts for resource management and the construction of innovative system software.

**Research Topics:** Distributed, generic, object-oriented impact on architectural issues. Distributed databases and computations fault tolerance, microprocessors, modeling and analysis.

## **O. Theory**

**Focus:** The theoretical foundations of computer science using mathematical techniques for modeling and solving computational problems.

**Research Topics:** Analysis of algorithms and data structures, combinatorics, computational geometry, computational learning theory, complexity theory, discrete topology, and theorem of proving.

# Nine Steps for Successful Projects

Research and innovation takes time on the students' part. Teachers should motivate their students to identify a research area in which they can think logically and naturally. Some students, for example, feel excited about the wireless area, some go for data broadcast, some like programming, etc., and generate lots of research ideas and insight. Teachers should encourage these students to further investigate and identify the research project in their selected areas. Students should not be forced to do research in an area which does not appeal to them. However, sometime students copy others and select an area for which they do not have natural inclination. Teachers should mend this kind of situation by identifying students' inclination and suggesting interesting research projects which match their interest and capability. There is not a set amount of time required, but a minimum of eight weeks should be anticipated. During this time encourage your students to work on their projects on a daily basis both in and out of the classroom. It is very important to log every activity (literature search, discussion with your parents, friends, mentor, etc.) to monitor work progress. Included in the journal are ideas for what they want to do, their approach to problem solving, thoughts they generate, and proof of dates for actions taken.

## Step 1: Project selection

The student, with the help parents and the mentor, should Identify and select a research area of his/her choice. A research project which is related to day-to-day activity and useful to the society should be selected.

## Step 2: Brainstorm a Problem

Innovation starts with a question about a problem or an idea for something that may make a job or activity easier, faster, safer or even more enjoyable. Ask them, "What would make some part of your life easier, more fun or more efficient? What problem exists that you would enjoy researching and solving?" Encourage them to think about school, work, leisure time, etc.

## Step 3: Literature Survey

This is a highly useful step. There are many sources to learn about the selected problem and research approaches. Internet, libraries, mentor, parents, and so on are some of important sources. From these sources students should identify useful references, value of the research project, and its applicability in real-life. Often times these responses can take students in interesting directions they would not otherwise have chosen.

## Step 4: Understanding of Problem and Composing Hypothesis

Teachers should help students to understand clearly the research problem and make the objectives clear. For example, if a student wants to investigate efficiency of a GPS device then (a) students should identify what aspect of efficiency they are interested in (voice clarity, navigation clarity, sufficient thinking time, etc.), and (b) they should define objectives, for example, units of navigational capability.

## Step 5: Design

The student needs to plan and document what they believe their project will look like. They should label all of the different parts of the project. The drawing does not have to be perfect, but it does have to be good enough to guide them during their research development.

## Step 6: Development

Students should define (a) solution approach, (b) identify necessary parameters (input and output) under the constraints defined by the school, (c) get a feel of the experimental method, and (d) identify expected outcome. Development reduces theory to practice or involves creating a system that is suitable for validating the concept or hypothesis. Development usually does not result in success after the first attempt, but rather involves trial and error. Reinforce the student that this is common and should be expected.

## Step 7: Validation

Once the experiment is successfully completed, the validation phase begins. In this step, the student should go back and verify that the experiment did implement correctly the solution approach. The student should go back to the hypothesis and compare it with the results of the experiment. There are two possibilities; (a) the final conclusion is the opposite of the hypothesis or (b) the results support the hypothesis. Both outcomes define success. In some cases (a) has a greater impact than (b). This should be noted and a convincing explanation should be provided in the

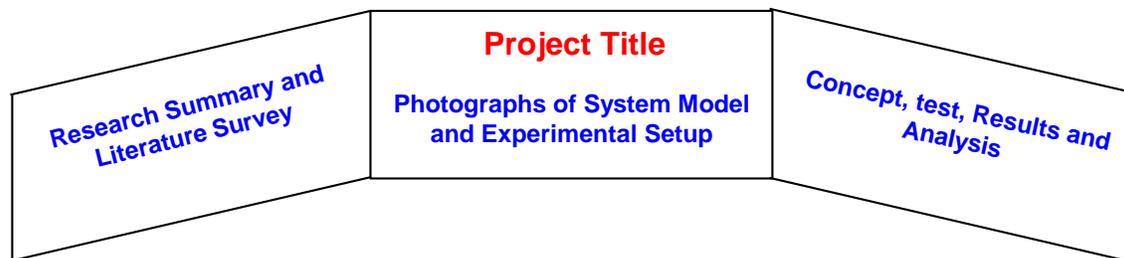
report. The project may not work the first time. If so, ask the student to analyze why the project design failed. Allow the student to redesign and construct a new model. The new model should be tested just as thoroughly.

## Step 8: Prepare Report

This is the hardest part but it becomes simple and exciting if the student has maintained a detailed journal. The final report is a refined form of the student journal. The student must document their project in a formal report. This is the primary method for which they will be judged at the Greater Kansas City Science & Engineering Fair. Appendix A - F of this handbook includes pages that can be copied and used by each student to prepare their report.

## Step 9: Display

Each student should prepare a display to showcase his or her project as illustrated in the following figure. The display can be no larger than *76cm (30 in) deep, 81cm (32 in) wide, in grades 4-6. Grades 7-12 may be 122 cm (48") wide.*



## Fair Rules and Regulations

### GENERAL RULES

1. Any project that has been previously entered in the Greater Kansas City Science & Engineering Fair may not be reentered in the competition.
2. A project may be done by an **individual** student or a **team** of no more than **three (3) students**.
3. A copy of the forms in **Appendix A** at the back of the student section, or a similar version completed by the student, should be completed and included in the notebook accompanying the project at the fair.
5. You may not enter more than one project in the fair.
6. Your exhibit dimensions are not to exceed a maximum size of 76cm (30") deep x 81cm (32") wide in grades 4-6. Grades 7-12 may be 122 cm (48") wide.
7. Your exhibit must be completely self-contained and self-supporting. Note that the display board should be sturdy enough to withstand wind currents present in the exhibit hall.
8. **Do not place valuables or sensitive equipment as part of a display.** Union Station and Science City are not responsible for stolen or damaged equipment or other valuables.

### SAFETY RULES

1. All electrical equipment must be constructed according to standard electrical safety laws. Exhibits requiring electrical current for operation, or illumination, must be designed for operation on alternating current at 110 volts. If batteries are used, they should be storage batteries to ensure continuity of operation.
2. Ordinary doorbell push buttons and open knife switches may not be used to control 110-volt apparatus. Only suitably rated UL 110 volt toggle or push button type switches, mounted on panels or switch boxes are allowed.
3. All wiring, switches and metal parts carrying 110 volt current must be grounded properly and out of reach of visitors
4. All electrical points must be soldered and taped properly (following UL regulations.)
5. Nails, tacks and un-insulated staples may not be used for fastening wires. Use porcelain or other approved types of insulators.
6. All wiring must be **properly insulated** for voltage used.

7. Dangerous chemicals in open containers, open flames, flammable liquids and explosives are strictly prohibited.
8. If bacteria are displayed, they must be in sealed containers.
9. No live animals, vertebrate or invertebrate, are to be displayed at the Fair.

***NOTE: THE FAIR SAFETY COMMITTEE RESERVES THE RIGHT TO INSPECT AND DISQUALIFY ANY EXHIBIT THAT DOES NOT CONFORM TO THE RULES AND REGULATIONS IN THIS BOOKLET.***

## Entering the Fair

**NUMBER OF ENTRIES PER SCHOOL:** Each school is allotted a maximum number of 20 entries. The total number of entries may be in any combination of categories.

### APPLICATIONS

1. Registration is now online at <https://sciencecitygkcsef.stemwizard.com/>
2. Registrations should be completed and received online **no later than the Entry Form due date at 5:00 pm.**
3. All registrations should be accompanied by the **registration fee and a copy of any and all required forms.**
4. Be sure to have all certification forms filled out and signed by the appropriate people (e.g., teacher/sponsor, parent, etc.) **before** you begin experimentation.
5. **Registrations received without the proper forms attached will be rejected.**
6. GKCSEF Team will review all registration within two weeks of the final deadline. Any applications not complying with the rules and regulations set forth in this booklet will be returned to the school with a written explanation.

***Teachers: If there are any registration questions, please advise your students as soon as possible.***

## Setting Up At the Fair

1. For detailed information regarding dates and times of this year's fair, please refer to the Science Fair Schedule on the Greater KC Science & Engineering Fair website at <https://sciencecitygkcsef.stemwizard.com/>
2. The student, parent or teacher can set up the project between 8am and 3pm on set up day.

***(Note – project set-up requires approximately 15-20 minutes. Parking is available in the Parking Garage located just west of Union Station).***

3. When setting up your project, you must bring:
  - Your paper
  - Any required forms
  - Display board and any accessories or models
  - The project number sent to your teacher by Science City. This number identifies the placement of your project. Maps will be at the hall's entrance for your assistance. **Please ensure that your project number matches your table location in the exhibit hall exactly.**

## Judging and Awards

Each project is reviewed by two sets of judges:

**Academic Judges** evaluate each project based on how well experimental, computer science, engineering or invention processes and principles were followed. See the scoring guides for a complete description of how your project will be judged. Each project will be given a **gold, silver or bronze rating** based on the marks received on the scoring guide, and the appropriate ribbon will be awarded. In addition, the top projects in each grade level and category will be selected for **Academic Awards**. Students winning Academic Awards will receive a blue rosette on their project and will be asked to attend the Charles N. Kimball Awards Ceremony to receive recognition for their accomplishments.

**Students Interview** will be for students **ONLY** in grades 7-12. Students are asked to participate in the interview timeframe of the judging night to explain your project. (**Attendance is requested, but not mandatory.**) Students will be released to their project at 7:30pm the night of judging and asked to stand by their project until 8:30pm. During this time, judges will be coming around asking questions and details about your project. The interview process will help all students start preparing for the International Science & Engineering Fair, if their project is one of the top 3.

The **Pioneers in Science Awards** are given to the top five senior level projects. This award is to recognize outstanding examples of student research, innovation and design.

The **Grand Award** is given to the three best ISEF eligible projects in the Senior Level. Students winning the Grand Award will receive an all-expense paid trip to the International Science & Engineering Fair (ISEF).

Over 60 organizations present Special Awards at the Fair. **Special Award Judges** evaluate the projects based upon their organization's interests and priorities. Each organization determines its own awards including plaques, prizes and cash. Students winning Special Awards are asked to attend the Charles N. Kimball Awards Ceremony to receive their award from the sponsoring organization. A list and description of Special Awards organizations may be found on the website at [www.sciencecity.com/education](http://www.sciencecity.com/education)

## Computer & Telecommunications Projects Student Guide

Each project is to include a **paper**, **display** and **working model** where appropriate.

- The **paper** is to explain the project in detail to the judges.
- The **display** allows you to present your project visually in a concise manner, allowing a judge to easily determine its merits.
- The **working model** is where you put your ideas, planning, development and implementation abilities into action to demonstrate your work.

**The following are ten steps to guide you through the requirements of Computer Science or Telecommunications Projects at the Greater Kansas City Science & Engineering Fair.**

### **Step 1 - Project Journal**

Researchers must maintain a journal to document what they created, the ideas they generated, and proof of dates for these actions. The journal provides evidence that a researcher came up with an idea first. Don't worry about grammar or spelling when you make your notes, but do make sure that the notes are legible.

The following information should be included in your journal:

- The dates, times and places where you worked on your project.
- Any problems, solutions, tests and results.
- A drawing or conceptualization of your first idea, changes and final design. These drawings must have all parts/concepts labeled.
- A list of materials used.
- The initials of an adult who saw you working. This can be a teacher or parent. This witness can prove the work and ideas are yours.

### **Step 2 - Brainstorming Ideas for Projects**

A project can begin with a question about why something works or exists in a certain manner, or an idea for something that may make a job easier, faster, safer or even more enjoyable. The process involves transforming that initial idea from your brain into a framework for stating the problem concept and methods for proving or disproving its validity. For this project you may have to brainstorm an idea. Start by asking the following questions:

- What bugs you?
- Is there something you are especially interested in learning about or understanding more fully?

- Is there a better way to do something you normally do?
- What problems occur in your daily life that you could solve?
- Do your parents, brothers/sisters, grandparents, friends or neighbors know of anything that they would like to see understood or improved?

Write down in your journal all of the ideas you come up with. Select one of them to pursue for this project. It is important to have a witness initial the entry for documentation purposes.

### **Step 3 - Researching the Idea**

Before you start working on your project, you need to see if it already exists and what researchers have pursued in the same category. This may include visiting libraries, looking in books and magazines, checking the Internet, asking friends and relatives or even contacting other researchers. Write down in your journal the places you have checked, the dates you checked them and the results.

### **Step 4 - Survey**

Ask friends, relatives and teachers what they think of your proposed idea. This will help determine if it is worth the effort of development. Write down in your journal who you asked and what their comments were.

### **Step 5 - Project Design**

Sketch (if applicable) what you think the project might look like, or the approach you will take in answering the hypothesis. Label all of the various parts of the diagram. At this point, the drawing doesn't have to be perfect, but does have to be good enough to help you conceptualize the work to be done. It is acceptable to ask for advice from your family and friends as long as they are acknowledged in the final report. This sketch should be dated and go into your journal. Have the entry initialed by someone who understands it.

### **Step 6 - Project Development**

Now you can actually build a working model (if applicable), based on the sketch in your journal. Remember that very few projects work the first time and problems are common. For researchers, this is the challenging (and sometimes frustrating) part of the innovation process. When a problem does arise:

- Think about ways to overcome it.
- Ask for advice and ideas from friends, family, neighbors or other researchers.
- Modify the working model until you're satisfied with the results.

Write down in your journal what problems were encountered and how they were overcome. Have the entry initialed by an adult.

### **Step 7 - Concept Testing**

This is the fun part. Determine an appropriate way to verify the hypothesis or concept. The best way to test is by actually using it for the intended purpose. However, in some cases, you may have to devise a special test using artificial conditions.

It is important to test your project more than once and have other people test it more than once. Write the test results in your journal. The project may not work the first time you try it out. If it does not, analyze why it failed. Verify that the test procedure is not at fault. Think how to improve the design of either the project or the test.

After you've decided what modifications to make, repeat step 6 and test again. This may take several attempts.

### **Step 8 - Prepare Report**

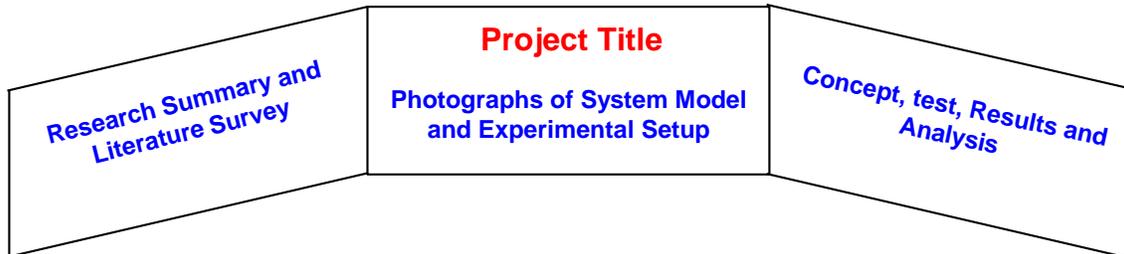
It is important to document your project in a formal Report for those people who will be judging your work at the Greater Kansas City Science & Engineering Fair.

Organize the information for the report as shown in **Appendix A**. You will find that much of the information required has already been written down in your journal and it is simply a matter of copying it neatly into the appropriate section of the

final report. As a matter of fact, the organizational style found in **Appendix A** is based on a technical report style used by most scientists and engineers.

### **Step 9 - Display**

Last but not least, prepare a display to showcase your project. The display needs to be neat, concise, and visually appealing to attract the attention of judges and other interested people. The display must convey the concept of your project in a matter of seconds. For readability, it is best to use large font sizes on signs and labels. A sample project display is given below.



## **Appendix A – Final Report Format**

### **Title Page**

Title of Project & Date

### **Table of Contents Page**

List the sections of your report and the corresponding page numbers.

### **Summary Page**

Briefly describe what you researched and why you think it was important to do so.

### **Documentation of Originality Search**

Copy the information gathered in **Step 3**, including whom you talked to, what libraries or online resources you used, books and magazines you reviewed, and other sources of research or information you used.

### **Documentation of Survey**

Copy the information gathered in **Step 4**, listing the persons you talked to and their comments.

### **Project Description**

In one or two paragraphs, describe the problem researched, if the problem, hypothesis, or concept was solved, the benefits of the results, and the advantages over existing technology, methods, processes, or products.

### **Drawings and/or Schematics**

Redraw the sketch from **Step 5**. It may be hand or computer drawn into a clear, detailed drawing of the project, with all sections clearly labeled.

### **Testing of the Project**

Organize the test results gathered from **Step 7** in this section. Describe how the project was tested and the results. Include all test results on the project that other people had done, and what comments they had. Include graphs to clearly show the test results.

### **Journal Notes**

This section should contain all the notes exactly as written in your journal so the judges can follow the progress of your project. Do not retype them.

### **Acknowledgments**

Give credit to those who helped you and mention how they helped.

### **Bibliography**

Cite your sources used in background research.