A Proposal to Implement a Monitoring and Control System into Virginia Tech's 2005 Solar House

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October 10, 2003

Submitted to—
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Contents

Summary

Every three years the Department of Energy sponsors an event called the Solar Decathlon. The competition challenges teams to design and construct a house that will support its energy needs with Solar Energy. Virginia Tech's performance in 2002 revealed the need for a new monitoring and control system. The previous unit was limited in scope, difficult to use, and lacked presentation capability. This document proposes a new design for this unit that will provide a means for user interaction and diagnostics. Through the use of an interactive website, the team plans to expand public awareness of solar energy. This website will contain real-time statistics of the house and an educational package.

Statement of Problem

The sun is our ultimate source of energy. Ancient sunlight is energy from the sun stored long ago in plant matter, used today in the form of oil and coal. Humans must end their dependency on this ancient sunlight and live sustainably off the sunlight that reaches Earth every day [Hartmann, 1988]. The Department of Energy (DOE) has created a competition called the Solar Decathlon that encourages this idea. Because of its outstanding success in 2002, DOE will be holding the next Solar Decathlon in September of 2005. Similar to its athletic counterpart, the Solar Decathlon challenges schools to design a house that will compete in the following ten categories: architecture, curb appeal, project development, communications, comfort zone, appliances, hot water, lighting, energy balance, and getting around. To evaluate team performance, the National Renewable Energy Lab (NREL) will install monitoring equipment in each house. The competition will demonstrate many thought provoking ideas as well as a means to increase public awareness of solar energy.

The 2002 Virginia Tech Solar House took fifth place overall. The house and team performed extremely well, excelling in a number of areas. Virginia Tech won the categories of Design Presentation & Simulation and Getting Around, and placed second in the category of Lighting. In addition, the team received a special award for innovation. As the first Solar Decathlon and the first Virginia Tech solar house, the performance was a resounding success. In looking to the next competition, however, there are areas where the house can be greatly improved upon. The team did not perform well in several categories. The five lowest scores were in the categories of Refrigeration, Home Business, Energy Balance, Comfort Zone, and Graphics and Communication. Virginia Tech's scores for the 2002 Solar Decathlon are shown in Table 1.

The low score in the category of Refrigeration resulted from the lack of testing of the refrigerator before the competition. The team was still attempting to resolve fundamental problems with the refrigerator during the competition. As a result, this category was the lowest score for the Virginia Tech team. A monitoring system with warning capability would potentially solve this issue by providing the team immediate notification of inoperable systems and appliances.

Table 1: Virginia Tech's Scores for the 2002 Solar Decathlon*

Contest	Final Points	Final Standing
Design & Livability	153.85	4
Design Presentation & Simulation	83.66	1
Graphics and Communication	60.77	4
The Comfort Zone	54.81	7
Refrigeration	47.69	10
Hot Water	80.39	4
Energy Balance	33.33	7
Lighting	92.00	2
Home Business	71.41	8
Getting Around	100.00	1

*http://www.eere.energy.gov/solar_decathlon/team_rankings.html

The Energy Balance category evaluates the team's net energy production, comparing initial to final energy. Virginia Tech's poor rating in Energy Balance stems from the team starting the week with a full charge on the batteries. For example, if Virginia Tech started with a half charge, it would have been possible to end with a positive net gain. Aside from altering the team's strategy in the Energy Balance category, close monitoring of energy transfer through the house would ensure power production and usage are always in check.

The third category in which Virginia Tech received a poor score was the Comfort Zone. This category evaluates the house's ability to maintain a provided temperature and consume a minimal amount of energy. Virginia Tech did not score well in this area because of an inability to construct an efficient system, and the use of a prefabricated condenser unit. The team also had trouble calibrating their instruments to agree with the judge's instruments. The 2003–2004 heat pump team will be working to redesign a state of the art high efficiency multi-mode unit. This unit will also work towards improving the hot water category, which is one of the three categories that tied for their fifth lowest score. A way to evaluate the redesigned heat pump unit would allow for its optimization. Evaluation could be accomplished with a number of monitor points that would allow analysis of the unit's performance. In addition, through monitoring of temperature within the house and power consumed by the heat pump unit, real-time status of the team's performance in the Comfort Zone category will be provided. This parallel system will enable comparison with the metric that actually determines points awarded: the judge's readings.

The fourth category in which Virginia Tech performed poorly was Home Business. The poor rating likely came from an inability to synchronize the computer clock with the judge's clock, leading to late submissions of reports. The results in this category could have easily been improved by making a conscience effort to synchronize the computer clock with the judge's clock.

One of the fifth lowest scores received in the competition was in the category of Graphics and Communication. Virginia Tech did not have a unique way of displaying the heat pump mode of operation and condition of the house. The system in place made use of Automated Logic Software. The 2002–2003 team appreciated the value of the system, but lacked the time and ability to master the software, and was unable to obtain help from the supplier. The first place team, the University of Colorado at Boulder, capitalized on this contest by integrating a projector into the design of their house. The projector served to display the statistics of the house to everyone walking through. The second place team, the University of Virginia, had an original way of displaying their house's condition. They built a color-changing wall out of LED's sensitive to the condition of the house. Virginia Tech needs a fresh idea in order to be competitive in the Graphics and Communication contest. A graphical display of energy transfer through the house would be an excellent way to communicate the ideas of sustainable living and efficiency.

The 2003–2004 monitoring and control system team's goal is to provide a solution to the problems of the house as outlined above. It is clear that monitoring all aspects of the house will put the team in touch with the performance of systems and energy use, as well as provide a way for others to learn from the house. The upcoming section discusses objectives for developing a system that will accomplish this.

Objectives

This document proposes a redesign of the monitoring and control for the 2005 Solar Decathlon house. Our team identifies three major objectives that must be met in the development of this system:

1) provide an interface between the user and critical information about the house
2) monitor conditions, diagnose problems, and evaluate performance of the house
3) create an interactive website to expand public awareness and educate future generations

These objectives define the general direction, or vision, of the project. A more detailed synopsis of the goals, markets, and constraints of our project is outlined in the mission statement as shown in Table 2. The mission statement is broken down into product description, key business goals, primary and secondary markets, assumptions and constraints, and stakeholders.

The mission statement begins with our product description. In brief, our aspiration is to create a product that will provide access to information about the house and control various systems within it. This information includes thermal, electrical and weather conditions, mechanical and electrical performance, and a warning system for potential problems. This information is critical to both the Solar Decathlon competition, as seen in the shortcomings of the previous house, and to the end user who wishes to keep track of energy usage and the functioning of a complex house. Along with monitoring ability, the proposed system will control the operating mode of the heat pump unit, lighting, and power allotment.

There are several business goals we desire to achieve. Our first goal is to increase overall building efficiency. The system will act as a feedback loop when adjusting and optimizing the multi-mode heating ventilating and air conditioning (HVAC) system of the house. Optimal flow rates, line pressures, and other factors of the HVAC system from last year's house were never established. A system optimization will greatly improve its performance. A second business goal is to design the system to be adaptable to any platform. The 2002 house may be used to build and test the system, but it will ultimately reside in the 2005 house, so it must be flexible enough to be integrated into both houses. Furthermore, with consumers as a secondary market, the system must be adaptable to virtually any building. A final business goal is to increase public awareness of solar issues. Through the use of a website, information about the house can be uploaded in graphical format and be available for the public to view. In addition, through an outreach program, we hope to provide lessons and activities to grade school students to educate them on topics such as solar energy and sustainability. This young generation will be facing a much different situation in 30 to 40 years; a positive image of a sustainable future will benefit them greatly.

Table 2: Mission statement for the proposed project.

Product Description	User, evaluation and diagnostics, monitoring & control system
Key Business Goals	Increase overall building efficiency Increase awareness and educate public on solar issues Serve as a platform for future systems
Primary Market	Department of Energy Solar Decathlon
Secondary Markets	Virginia Tech research institution Consumers
Assumptions & Constraints	Complete planning, construction, and evaluation in 9 months Use LabView to develop user interface and data logging system Use National Instruments data acquisition products Rely on donations
Stakeholders	Sponsors Virginia Tech Dr. Ellis Environment

The primary market of our system is the 2005 Solar Decathlon. The impetus for this project would not exist without the competition, and our ultimate goal is to win while showcasing how solar energy can be made practical. However, there are secondary markets that exist and must be considered. The first is the Virginia Tech research institution. The collection and use of solar energy provides a host of research opportunities. By making our data from the house readily available, we hope to facilitate solar energy research within the university. Another secondary market includes the end users of solar energy systems. The Solar Decathlon would have little purpose if it generated concepts and systems that could not ultimately end up in homes and commercial buildings across America. Therefore, the end user will be one of the secondary driving factors of the design.

There are several assumptions and constraints we have identified. Because of Virginia Tech's relationship with National Instruments (NI), LabView software will be used exclusively to design the user interface and data acquisition (DAQ) routines. LabView is an excellent program that will greatly assist in realizing our vision and meeting our goals. Another advantage of LabView is its ability to provide a link between present and future students. The current trend among engineers at Virginia Tech is LabView literacy, so this common ground will help future teams learn the system we create. The Automated Logix system of the 2002 did not have this advantage. In addition to software, we will use NI hardware for acquiring data. A LabView DAQ system will integrate seamlessly with NI software, eliminating hardware communication issues that can be very time consuming to solve. Because of limited monetary funding, our team will rely on donations for equipment. This is reasonable considering the 2002 team's success. Given sufficient time, planning, and research, we feel confident will be able to solicit donations of equipment that will meet our needs.

There are several parties who hold stake in the project's success. One of these groups is the sponsors who donate equipment and allow us to use it in our system. They risk having their name tarnished in a poor showing of their product and risk wasting money in a failed project. Another stakeholder is Virginia Tech. Our team will be representing the university in the nation's capital and showcasing Virginia Tech's capabilities. The success or failure of the project may speak to individuals and other institutions about the quality of work at Virginia Tech. Dr. Ellis is also a stakeholder in this project. He is investing a large amount of time and energy in this project and is depending on our performance. Lastly, the environment stands to gain from our endeavor. What we accomplish may impact the ecological future of Earth. Although an involuntary stakeholder, it is clear that Earth can benefit from progress made by the Solar Decathlon.

Plan of Action

This section addresses our plan for obtaining the previously described objectives. We will predominantly follow the design process as outlined in *Product Design and Development* [Ulrich and Eppinger, 2000]. The steps include identification of customer needs, establishment of target specifications, a search of intellectual properties literature, concept generation, concept testing, product architecture, industrial design, prototyping, and a presentation of final results.

Identifying Customer Needs

With a clear idea of the project objectives, the first step is to communicate with the people we are working for to establish *customer needs*. A few of our customers include past, present, and future solar decathletes, the engineering, architecture, and education departments of Virginia Tech. In order to elicit information from these parties, a survey has been created (see Figure A-1). When possible, interviews have been conducted as well. Results from the surveys can be found in Table B-1. The 2002 solar decathletes, having competed previously, are truly in touch with the capabilities that a monitoring and control system must provide. Identifying customer needs will guide the team in establishing target specifications.

Identifying Target Specifications

Target specifications are a qualitative adaptation of customer needs. They describe specifically how the monitoring and control system must perform to be successful. Based on customer needs and our original assessment we will specify optimistic target specifications. These may include the accuracy of measurements, power consumed by the equipment, and the number of people influenced. Preliminary specifications concerning instrument quality and accuracy have already been determined. Establishing target specifications is the final critical step cementing the details of our objectives.

Inventions, literary and artistic works, names, images, and designs used in commerce are intellectual property. A *search of literature concerning intellectual properties* is being conducted early in the project timeline so that we can avoid infringement and receive proper credit. Original LabView Virtual Instruments (VI) will be conceived and written. In order to increase awareness and educate the public on solar issues, a website will be created. Both of these are intellectual property.

The mentioned website will be designed to accommodate real time statistics of the house and an educational section. Current updates of the house's condition can used by the resident to mange the home when away from home. It will demonstrate to the public the success of the solar house. It will appeal to their ethical and economical senses and convince them of its virtue.

Generating Design Concepts

With detailed planning as a foundation, the design team will *create concepts* of detailed form and function. These concepts will be concerned with the "how" of operation and establish aspects of program architecture, routines, and methods of relaying data. A search of modern solar house power monitoring methods as well as related products, such as existing control systems in on-grid houses, will be useful in generating concepts. Ultimately, *concept testing* will determine whether concepts are retained, discarded, or combined with other ideas. Others will be combined into a design concept that will then be evaluated. It is inevitable that holes in communication between engineers and customers develop. With our design in some discernable form, it will be clear how ideas have been manifested and needs met. Customers will be able to relay their satisfaction or lack thereof and give feedback so that the concept can be refined.

Selecting Design Concept

Product architecture is a plan in which the physical building blocks of the monitoring and control system will be arranged into several major elements: each a collection of components that perform one or more function(s) of the monitoring and control system. During this step, the extent to which the system is modular will be specified by the number of functional elements associated with each major physical element. This specification opens up many possibilities for other products and markets. For example, it may be possible that our data display element can be integrated into another system with distinct objectives, such as other houses or control systems. It is our expectation that someday houses everywhere will emulate the spirit of the Solar Decathlon. To bring about this goal, systems with modular possibilities will be considered and implemented whenever possible without compromising our primary goal.

The proposed monitoring and control system is the critical link between home and inhabitant. Aesthetics and ergonomics are key factors determining ease of communication between the two. As a result, *industrial design* will be involved throughout the development process. Presently, our planned interface incorporates a touch screen monitor. Contact between our team and the Industrial Design department at Virginia Tech has been initiated and will be maintained to ensure that aesthetic and crucial user requirements are allocated the attention they deserve.

So, will the design work and how well does it meet the customer's needs? Definitively answering these questions is the purpose of our *prototype*. After a rigorous journey through the points described above, the monitoring and controls system will be "built" based on the finalized design concept. Code will be written, transducers positioned, and wires installed into the existing 2002 Solar house or a test location not yet determined. The first task of the prototype will be to optimize the performance of the HVAC system. Our prototype will work in tandem with the 2003-2004 Heat Pump Group's prototype to increase overall building efficiency. This is an engineering test of our prototype with qualitative, measurable results.

Management Plan

Organization is a key part of accomplishing goals. Each monitoring and control group member's strengths and specialized skills will determine which areas they will excel in. Attached résumés provide background information on each of the team members (see Appendix C). The control project will be broken into 3 main categories: LabView programming, web development, and installation of sensors and other components into the 2002 house or a test environment. The responsibilities of each team member will cover a wide range; however, there are primary goals for each team member to accomplish. The respective skills of each team member will be matched to their task, producing the most effective path for completion of the project. Due to the tremendous amount of time required to code LabView VI's, Dan Mennitt and Michael Christopher will work on the program development. Ken Henderson will accomplish the web development. Josh McConnell will perform installation and integration of sensors into the solar house and work with the heat pump team.

A Gantt chart, shown in Figure 1, displays the project steps and their respective dates of completion. This chart covers many important topics to be accomplished. Items A, B, and C are well underway at this point in our research. Surveys shown in Figure A-1 have been distributed and analyzed (see Table B-1) as part of the customer needs process. Research was conducted in the areas of intellectual property and concept generation. Sections of the project such as such as product architecture and industrial design will require the utilization of other personnel and university resources. Our workforce is a combination of engineering, architecture, and industrial design students and faculty. We would like to incorporate people with business and education backgrounds as well. Success of this large group will require collaborative meetings to discuss direction and move forward with ideas.

The budget for our project is slim so we will rely on donations for the majority of our resources. Some of the items that will need to be acquired are shunt resistors, thermocouples, flow meters, a data acquisition system, a display device, and a computer. Ideally, these components would be donated. However, a budget of approximately 1,000 dollars has been allotted for acquiring a few items.

The time required to complete this project is limited, and Figure 2 outlines most of the important time constraints. Writing programs, getting components to communicate with each other and implementation into the Solar House are specific time consuming processes not outlined above. The component gathering and planning will be completed by the end of December. The construction and implementation portion of the project will begin prior to January. The project will progress with the combined efforts of many to be completed before the last day of class in May 2004.

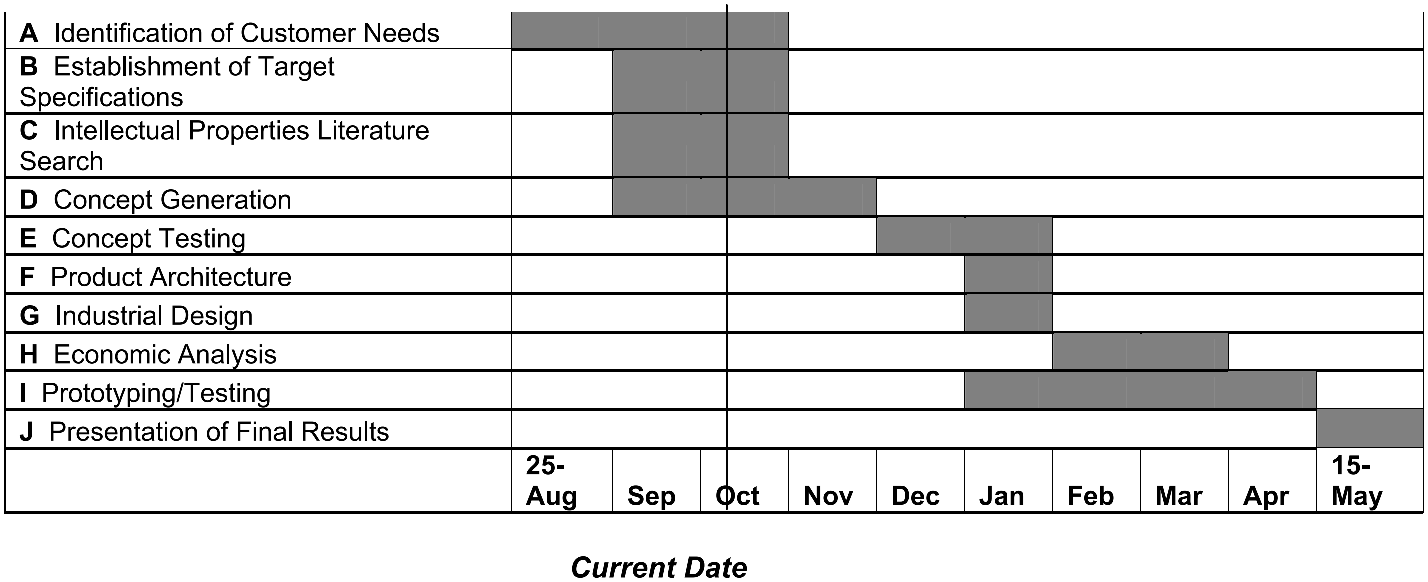

Figure 1. Gantt chart for the proposed project.

Conclusion

The 2002 Solar House had its strong points, but was plagued by a number of problems that resulted in poor scores. We have illustrated how a well-functioning monitoring and control system can prevent these problems in the upcoming 2005 Solar Decathlon. Our proposed design will build on the spirit and innovation of the previous house while seeking to overcome its weaknesses. Specifically, the monitoring and control system will monitor conditions, diagnose problems, and evaluate performance of the house. It will provide an interface between the user and this critical information. Along with an in-house graphical display, the team will create an interactive website to expand public awareness and educate future generations on solar energy. Our team has invested much into the preliminary design. This vested interest comes with the confidence that as a team we have the experience and know-how to design, construct, and evaluate such a system within the given timeframe of nine months.

References

Hartmann, Thom. *The Last Hours of Ancient Sunlight: Waking up to Personal & Global Transformation* (New York: Harmony Books, 1998).

Ulrich, Karl T. and Eppinger, Steven D. *Product Design and Development*, 2nd ed., (New York: McGraw Hill, 2000).

Appendix A: Sample Survey

Monitoring/Controls Systems Survey

Help us decide which systems are most important for monitoring and control in the 2005 Solar Decathlon house. Please rank on the following scale:

1 = Important; 2 = Neutral; 3 = Not Important.

Please let us know from what perspective you will be filling out this from:
(Researcher/Consumer)___________________________

Variables to Monitor

I. Climate/Temperature

Inside the House
___ Ambient Room Temperatures
___ Humidity
___ Barometric Pressure
___ Wall Temperatures
___ Air Movement
___ Radiant Temperatures

Outside the House
___ Roof Top - Temperature Behind the Panels
___ Roof Top - Outside Ambient Temperatures
___ Roof Top - Wind Speed
___ Roof Top - Solar Radiation (Pyranometer)
___ Roof Top - Barometric Pressure
___ Wall Temperatures
___ Under House Shaded Area Temperature

II. Power/Electrical

___ Energy from PV Array
___ Battery Bank Status/Time to Discharge
___ Inverter Status
___ Total Household Consumption
___ Light Level Sensors

Consumption of Individual Energy Intensive Appliances
___ Car
___ Dishwasher/Stove/Washer/Dryer
___ HVAC System Components

III. HVAC Systems

___ Inlet and Outlet Temperatures of Solar Thermal Collectors
___ Inlet and Outlet Temperatures of Water
___ Inlet and Outlet Temperatures of Air
___ Mode of Operation
___ Refrigerant Pressure
___ Compressor Pressure
___ Line Pressures
___ Flow Rates

1

IV. Other Components:

___ Car Status

V. Public Education:

Inside House

___ Display Screen

Website

___ Real-time Vital Statistics

___ Weather Forecast

___ House Web Cam

___ Savings Compared to Comparable On-Grid House (Daily ar

Running Average)

Control Options

I. Power/Electrical

___ Automatically Route Extra Power to Car

___ Shut down systems as necessary (e.g. Kill power to washer

keep house warm)

Questions/Suggestions:

What is your favorite element of the current house that is supported by Mechanical Engineering?

What is your least favorite element of the current house that is supported by Mechanical Engineering?

Suggestions:

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Figure A-1. Survey that was distributed in order to obtain customer / researcher feedback on the various monitoring and controls elements.

Appendix B: Survey Results

Table B-1. Survey Results

Monitor Options

I. Climate/Temperature	Averaged Results
Inside the house	
Ambient room temps	1.00
Humidity	1.25
Barometric pressure	2.38
Wall temperatures	2.13
Air movement	1.81
Radiant temperatures	1.88
Outside the House	
Roof top - Temperature behind panels	1.94
Roof top - Outside ambient temperatures	1.25
Roof top - Wind speed	1.75
Roof top - Pyranometer	1.50
Roof top - Pressure	2.50
Wall temperatures	2.00
Under house temperature	2.00
II. Power/Electrical	
Energy from PV array	1.00
Battery status/time to discharge	1.00
Inverter status	1.25
Total household consumption	1.00
Light level	1.31
Consumption of appliances	
Car	1.38
Dishwasher/stove/washer/dryer	1.13
HVAC components	1.19
III. HVAC System	
Inlet/outlet temperatures of solar thermal collectors	1.25
Inlet/outlet temperatures of water	1.13
Inlet/outlet temperatures of air	1.50
Mode of operation	1.50
Refrigerant pressure	2.13
Compressor pressure	2.00
Line pressure	2.00
Flow rate	1.63
IV. Other	
Car status	1.38

Table B-1 (continued)

V. Public Education

Inside the house	
Display screen	1.50
Website	
Real-time vitals	1.25
Weather forecast	1.63
Web cam	2.00
Savings	1.63

Control Options

I. Power/Electrical

Automatically route extra power to car	1.29
Shut down systems as necessary	1.21

1.0	= Important
2.0	= Neutral
3.0	= Not Important
Blue = 1.5 or greater	

Appendix C: Team Resumes[*]

Team Member 1: Dan Mennitt
Team Member 2: Josh McConnell
Team Member 3: Ken Henderson
Team Member 4: Mike Christopher

[*] Editor's note: The GPAs of these resumes have been removed to protect the privacy of the authors.

Daniel Mennitt

Current Address:
3418 Yellow Sulphur Road
Blacksburg, VA 24060
(540) 552-2415

Permanent Address:
31 Sheffield Road
East Windsor, NJ 08520
(609) 443-8926
dmennitt@vt.edu

Objective

Cooperative Education position in mechanical engineering during the summer of 2003.

Education

Virginia Polytechnic Institute and State University, Blacksburg, VA. 2000 to present.

The College of New Jersey, Ewing, NJ. 1999 to 2000.

Rutgers University, New Brunswick, NJ. 1998 to 1998.

Experience

Research Assistant, **Vibrations and Acoustics Laboratory at Virginia Tech**, Blacksburg VA. Designed experiments, built test setups, recorded and analyzed data. 2003 to present.

ME Co-op, **VPT Inc**., Blacksburg VA. Involved in all aspects of product development including design analysis, mechanical layout, test programs, and engineering support for documentation and logistics of DC-DC converters. 2002.

Student Trainiee, **US ARMY CECOM RDEC**, Ft. Monmouth, NJ. Technician in the ground systems installation design branch system prototyping division in a shelters/vehicle installation facility. 2001.

Supervisor, **Candlewood Management Services Inc**., Howell, NJ. Managed staff and multiple pools including maintenance, finances, and public relations. Summer of 1999.

Production Assistant, **F. Schumacher and Co.**, Cranbury, NJ. Arranged material and digital sales portfolios. Warehouse work, database entry, and cataloguing. 1999.

Computer Skills

Microsoft Office, Matlab, CoolEdit Pro, Adobe Photoshop

Honors

The National Society of Collegiate Scholars

Other Interests

Electric bass, art (acrylics/oils/ink), mountain biking, American muscle restoration, electronics

Local Address
1608 Patrick Henry Drive, Apt 116
Blacksburg, VA 24060
(540) 553-3295
jomcconn@vt.edu

Permanent Address
13561 Casablanca
Court. Manassas,
VA 20112
(703)-791-6625

Joshua M. McConnell

Objective

I am seeking a position of employment in which I intend to use my skills and develop new skills that will benefit my surroundings and myself to its full potential. I am an extremely determined individual who works well with other as well as on my own. I believe there is nothing that I can not do given the chance.

Relevant Experience

2000–2001 ***Extreme Diagnostics and Customs*** Manassas, VA

Design, Fabrication, and Automotive Technician

- Designed and fabricated many new parts for various applications. Main projects were Motorcycle and automotive.
- Acquired automotive diagnostic and repair skills.
- Gained knowledge of engine performance and theory (mainly forced induction).

1998–2000 ***New Sound*** Manassas, VA

Mobile Electronics Technician / Bay Manager

- Gained proficient knowledge of automotive electronic systems.
- Installation of electronic components and fabrication of fiberglass moldings.
- Sales, and managerial assistant skills were also acquired during employment

Skills

MIG Welding	Microsoft Windows	Matlab
Metal Working	Microsoft Visual C++	CNC Programming
Fiberglass Molding	Microsoft Excel	FEPC
Lathe Work	AutoCAD	PSPICE
Engine Performance		

Education

2000 – present *Virginia Polytechnic Institute & State University*, Blacksburg, Virginia

B.S., Mechanical Engineering

- Year: Junior
- Current In Major QCA: 3.5 / 4.0
- Current QCA: 2.96 / 4.0

Graduated High School (Cum Laude) GPA (4.0 scale): 3.8

Kenneth R. Henderson Jr.

Current Address: Permanent
Address:
1306 L Henry Lane 12225 Heathcliff Ct.
Blacksburg, Va. 24060 Ellicott City, Md.21042
(443) 629 - 4257 (410) 531 - 2647
kejr2@vt.edu

Objective

To obtain a position in the field of mechanical engineering. Specific interests include advanced technology, product development/improvement, and advanced energy systems

Education

B.S. Mechanical Engineering: May 2004
Virginia Polytechnic Institute & State University (Virginia Tech), Blacksburg, VA

Computer Skills

Software:	Languages:
AutoCAD	Visual Basic
Turbo-CAD	Mat-Lab
Microsoft Office	LabView

Experience

National Institute of Standards and Technology (NIST), Gaithersburg, Md.
Engineering Cooperative Education Student, Summer-Fall 2002 & Summer 2003

- Assisted in the construction, instrumentation and evaluation of a state of the art residential fuel cell test facility
- Assisted in the data analysis of a photovoltaic system that was installed on the rooftop of the administration building at NIST
- Co-Authored a paper that was presented during the International Solar Energy Conference that took place in Hawaii during March of 2003 entitled "Measured Performance of a 35 kilowatt Roof Top Photovoltaic System"
- Assisted in the development and implementation of a program to test certain electrical characteristics of photovoltaic panels

Horizon Services Inc., Columbia, Md.
Officer / Technician, Summer Breaks Since 1999

- Performed a large variety of tasks including project supervision, office management and many other critical roles necessary for a small business to operate successfully
- Actively involved in the day-to-day installation of electrical, satellite and integrated voice and data networking systems.
- Performed a variety of executive and administrative functions to support the successful operation of the corporation.
- Directly responsible for the supervision of small work crews.

Mt. Airy Bicycle and Fitness, Mt. Airy, Md.
Salesman / Technician, 1993-1999

- Performed hands on technical repairs to a variety of bikes and products
- Performed a variety of other tasks such as sales and customer service functions to help support the day-to-day activities of the shop.

Activities/ Honors

Eagle Scout Rank, 1999
National Society of Collegiate Scholars (NSCS), 2001- Present
Academic Scholarship from the department of engineering (Virginia Tech), 2001- Present
Academic Scholarship from Alfa Laval Thermal, Inc., 2003-2004
National Honor Society, 1999-2000
"Deans List with Distinction" standing, 2000 – Present
Member of American Society of Mechanical Engineers (ASME) as of Spring 2002

Michael D. Christopher

100 Southampton Ct.
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(540) 951-7688
mchristo@vt.edu

Education **B.S. Mechanical Engineering**, expected graduation: May 2004
Virginia Tech, Blacksburg, VA

Experience

Summer Undergraduate Research Program, Adhesion Science Laboratory, Virginia Tech, Blacksburg, VA; May-August 2003

- Performed research to characterize an automotive adhesive.
- Specialized in double cantilever beam (DCB) tests.
- Performed static and fatigue testing of DCB specimens.
- Coded LabVIEW programs to run DCB tests on an MTS load frame.
- Gave a professional presentation at a research symposium.
- Authored a research paper.

Student Engineer, Norfolk Southern Research & Test Lab
Roanoke, VA; January-July 2002 (2 consecutive co-op terms)

- Analyzed metallurgical failures of railroad components.
- Prepared and tested samples for chemical, hardness and strength tests.
- Evaluated prospective parts to replace existing parts in service.
- Submitted technical memos.
- Managed and analyzed MS Access databases for car damage and rail tests.
- Drafted CAD drawings for in-house projects.

Student Engineer, Ballinger Architecture & Engineering
Philadelphia, PA; June-August 2001

- Assisted HVAC Engineers in project development.
- Used AutoCAD to edit and create HVAC drawings for engineering projects..
- Developed 3D drawings to detect collisions of pipes, ducts, walls, and beams.
- Used Trace Load to determine thermodynamic properties of rooms to design HVAC systems.

Student Engineer, National Institute of Standards and Technology
Gaithersburg, MD; May-August 2000 (1st Term), January-May 2001 (2nd Term)

- Participated in solar panel research and evaluation.
- Ran tests using a computer-controlled solar tracker.
- Developed a shading model to determine effects of shadows on a future solar panel array.
- Automated the data collection and reduction process from a test bed of building-mounted solar panels with MS Excel macros.

Computer Skills

Experience with:

- National Instruments LabVIEW; Matlab (w/Simulink); MS Excel, Access, Word, PowerPoint, Outlook Express; Norton Anti-Virus; Minitab
- Building and maintaining personal computers

Honors **Awards and Scholarships:**

- Adhesive Manufacturers Association Award for research presentation, 2003
- Marshall Hahn Engineering Scholarship, 1999-2000
- Dr. Jacobs scholarship, 1999-2000