IPRO It takes a team!
INTERPROFESSIONAL PROJECTS PROGRAM

ILLINOIS INSTITUTE OF TECHNOLOGY

IPRO 348:
Techno-Business Study of Water Pump Motor Technologies

Sponsored by:

Pentair

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INTERPROFESSIONAL PROJECTS PROGRAM

PUMP
Pentair Utilities Motor Project

"PUMP it Green"

Team member	Specialties	Goals	Expectations
Cachero, Eunice ecachero@iit.edu [redacted] Electrical Engineering 4th Year	-Circuits and power electronics -Works well with teams	-To be able to finish the IPRO task successfully -To learn how to work with people from other fields of study	-To improve my knowledge regarding motors and how they work -To accomplish my Goals
Colmenares, Andre acolmena@iit.edu [redacted] Chemical Engineering 4th year	-Thinking Logically -Fluid dynamics knowledge -Physics knowledge	-To learn about motor and pump technologies, and the efficiency and reliability factors -To perform well on IPRO day -To develop my research skills	-To successfully complete the goals of this IPRO. -To learn about the various motor types.
Dias, Diego Ddias1@iit.edu [redacted] Business Administration 4th Year	-Entrepreneurship	-Get more experience working with a real organization - Learn more about motors in general	-At the end of the semester end up with the best solution for Pentair -gain knowledge with motors
Hannink, Veronica vhannink@iit.edu [redacted] Mechanical Engineering 3rd year	-Strong Research - Skills -Strong leadership and organizational skills.	-To learn more about motor technology -To learn about engineering in the workplace.	-To develop my teamwork skills -To gain knowledge about electric motors.
Jackson, Lisa ljackso2@iit.edu122 [redacted] Psychology 4th Year	-Research and theorist -Proficient writing skills	-To acquire new knowledge of the Pentair technology, and what we can do together for the environment.	-To gain a better understanding of my fellow teammates' ideas that flow from their own fields of study.
Lee, Sunho slee8@iit.edu [redacted] Mechanical Engineering 3rd Year	-Good Research Skills	-Develop an understanding of motors and team building skills	-To learn motor technologies
Matariyeh, Khalid kmatariy@iit.edu [redacted] Mechanical Engineering 3rd Year	-General motor knowledge	-Learn more about motor technologies, and "green" application	-Gain better understanding of motors, and practical engineering
Oberg, Jarrett joberg@iit.edu [redacted] Electrical Engineering 4th Year	-Power electronics -Electrical motors	-Learn more about motor technologies and consultant work.	-To document the efficiency of motors.
Patel, Tejash tpatel43@iit.edu [redacted] Applied Math 4th Year	-Numerical data analysis -Differential equations	-To learn more about motors	-To find an eco-friendly motor.

Faculty Advisor: Phi Lewis, lewisp262@aol.com, 630.715.6954

Team Purpose:

IPRO 348 is a team of students working together for the goal of assisting Pentair with selecting a new motor to use in their water pumps that is more economically and environmentally friendly through research and testing of potential new motor technologies.

Team Objectives:

- Determine the best alternative motor technology for use in water pumps that will both effectively perform its task as well as reduce its energy waste.
- Report to Pentair our findings and our recommendation for which motor they should select to use in their water pumps.
- Effectively work together as a team to ensure that we provide the best recommendation possible.

Background:

Since its initial public offering (IPO) in 1966, Pentair has grown exponentially to the multi-billion dollar corporation it is today. The Minnesota based corporation attributes most of its success to its code of conduct, which holds all employees to the highest level of business, moral, and ethical standards. They describe their drive for success and ethical standards in two words with their slogan, "Win Right."

Supporting its "green" initiative, Pentair's Water Residential Flow Technologies division is consulting IIT IPRO348 to improve the efficiency of the motors used in their sump pumps.

As seen in figure 1, showing the United States Energy Consumption from 1949-2009, it can be noted that energy consumption is trending upwards as the years progress. This fact, as well as the world events, such as the 1970 Arab oil embargo, showed people that the earth's limited resources must be rationed wisely. This is the reason for the "green" movement.

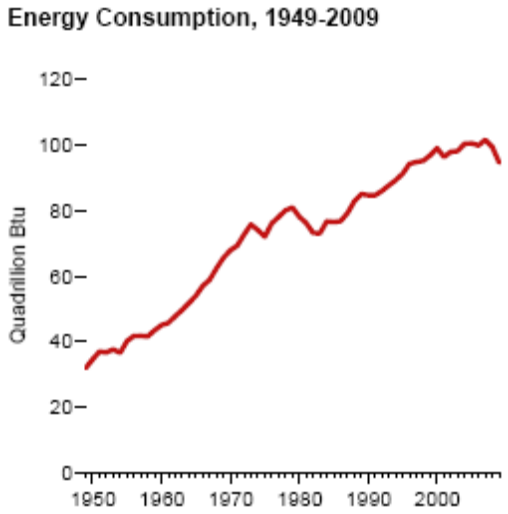

Figure 1 – Provided by http://www.eia.doe.gov/emeu/aer/pdf/pages/sec1_12.pdf

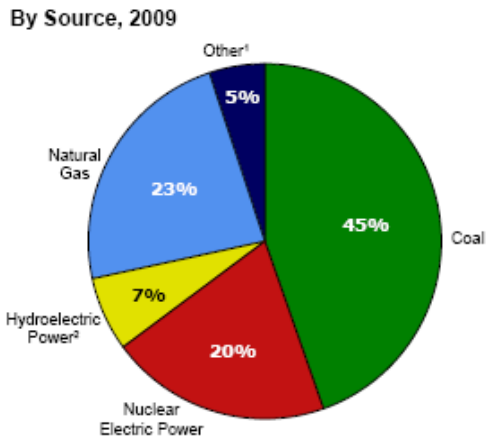

Figure 2 – Provided by http://www.eia.doe.gov/emeu/aer/pdf/pages/sec8_6.pdf

Also seen in figure 2, representing the conversion to electric power and the major sources, coal is still the most prevalent form in which electric power is produced. This fact has been at the forefront of the many, as only about 12% of electric power has been produced by renewable resources. In spite of this, looking at ways to power systems in renewable ways is a noble and necessary need to preserve the earth's resources. In addition it can be seen that financial benefits occur in production of

"green" systems. The U.S. Energy Information Agency provides data, on delivered energy consumption in the electricity sector, showing that 27% of electric power is lost in "electricity related losses". Using 10 cents per kilowatthour, and 27.81 quadrillion BTUs, we find an approximate 81.5 billion dollar market in lost electric power loss prevention. Although it is impossible to eliminate electrical losses reducing losses creates less need and less need is money saved. This Idea has swept household with CFL bulbs in replacement of traditional light bulbs. It is in the consumer's best interest to buy high efficiency bulb, as they may pay more for the bulb, but they save money on electric bills. This allows both consumer and manufacture to make or save money whilst preserving electric energy and reduces use of the earth's limited resources.

The technology Pentair is requesting we improve, to be made "green", is a sump pump motor. The basic sump pump technology is as follows. A sump pump is used to pump rain water out of the basement to prevent flooding due to leakage in the foundation. The parts to a sump pump are standardized and consist of a canister, pump (motor impeller system), pipes, and a check valve.

The part being directly studied is the motor, commonly a DC brushless induction motor, ranging from 1/3 HP to several HP, pending application. The parts of an induction motor have been mostly unchanged since creation. Standard, not energy efficient, motors have the same parts as energy efficient motors. The energy efficient motors are built to reduce electrical losses. An example of such loss is ohmic loss of heat, such that the winding around the stator experience I^2R losses as current passes through the wire. Changing the wire material and gauge or cross-sectional area is a way that energy efficient motors reduce this loss.

In this IPRO, testing of efficiency vs. cost and the analysis of such is what will be done. When tests are performed, the ethics and procedure of these tests needs to be addressed. This is an inter-professional project and that getting an accredited lab, for motor efficiency testing, is out of the scope of this course. That being stated, we see that the NVLAP (National Volunteer Laboratory Accreditation Program) for motor efficiency testing gives ethical and procedural guidance. IEEE 112 method B gives a test standard for such testing as we plan to carry out and it will provide as another useful guide in making sure that testing is done safely and ethically correct.

Electrical efficiency of a motor is beneficial to a business, if they can charge a similar, profitable, price while provide the customer with a better product. This provides a possible economical, as well as ecological benefit, providing a better public image of the company. Providing all those who have a stake in the companies well being, a benefit.

Our group plans on addressing the 5 components of motor loss in the motors we are set to test. We will try to determine the loss due to them and improvements possible as well as a corresponding cost for the improvement. When looking at motors to buy for the original testing these will be of greatest concern. The 5 components are listed below and can be found in *Energy-efficient electric motors and their applications* by Howard E. Jordan, as well as many other publications on the matter.
The 5 components usually associated with motor losses

1. Stator winding
    i. Primary I^2R losses
2. Iron loss in the stator
    i. Hysteresis losses
    ii. Eddy current losses
3. Rotor winding
    i. Secondary I^2R losses
4. Friction and windage
    i. External & Internal f an losses
5. Stray Load
    i. Illusive losses

Team Values Statement:

Desired Behaviors:

- regular attendance and participation
- willingness to work in a team
- effective communication with the group
- showing initiative in doing tasks and research
- good time-management skills
- being respectful of the ideas and concerns of other team members
- completing tasks in a timely fashion
- behaving appropriately in different situations such as when in the laboratory or when talking to clients.

Problem resolutions:

In order to avoid problems within the group, communication with each other is encouraged. If a group member is unable to attend a meeting, it should be communicated to the other members through email or phone. If a problem regarding the project arises, the problem must be clearly identified and possible solutions discussed by the team members. If there is a conflict between team members, it should first be addressed on a one-on-one basis between the conflicting parties. Since the team has about ten people, the problem could also be brought up in meetings so group input can be provided. If this does not resolve the conflict, it should then be brought to the attention of the IPRO team advisor, Mr. Phil Lewis.

Work Breakdown:

Months	August	September				October				November					Dec.
week **Tasks**	08/23 to 08/30	08/30 to 09/06	09/06 to 09/13	09/13 to 09/20	09/20 to 09/27	09/27 to 10/04	10/04 to 10/11	10/11 to 10/18	10/18 to 10/25	10/25 to 11/01	11/01 to 11/08	11/08 to 11/15	11/15 to 11/22	11/22 to 11/29	11/29 to 12/06
1st Visit with Pentair															
Initial Project Plan															
2nd Visit with Pentair															
Testing															
Mid Term															
IPRO Final Project Report															
Poster Creation															
Project Presentation with Pentair (3rd visit)															
Practice															
IPRO Day															
Research															

Expected Result:

Finding the most appropriate motor for Pentair is the purpose and the expected result. We will choose the most proper motor for Pentair as their pumps' motor, considering many factors. The affective factors are these things; power efficiency, cost efficiency, complexity, reliability, life expectancy, voltage, motor speed, lifespan, and more. Several motors will be selected as potential products, but they will be compared through some experiments. `There are some potential risks. An

example of obstacles we might have to face is the acquisition of the motors to test. The motors that we chose to test must be ordered by Pentair and that means that the team has no control over when we get the motors. Another obstacle may be the testing process itself, which could be troublesome due to our lack of equipment to run most tests on the motors outside of Pentair. Research will be crucial to our ability to reach our expected result.

Project Budget:

Expenses	Cost
Travel to Pentair, (200 miles * 2 cars * 3 trips * 50 cents/mile)	$600.00
Prototype, Hardware, and Software	$200.00
Printing (brochures and other documents)	$50.00
Meals during Pentair trips, (3 meals x 8 people x $7 a person)	$168.00
TOTAL:	$1018.00

Designation of Roles:

- Team Leader: Jarrett Oberg
  Lead the team
- Minute Taker: Veronica Hannink
  Record changes under consideration.
- Agenda Maker: Lisa Jackson
  Create the meetings and offers
- Time Keeper: Sunho Lee
  Make sure meetings go according to plan
- iGroups Moderator: Andre Colmenares
  Help to make a final decision and organize the team's iGroups account
- Experiment Coordinator: Khalid Matariyeh
  Make a plan of experiments
- Contactor: Eunice Cachero
  Contact with Pentair
- Business: Deigo Dias
  Deals with business end problems

SOURCES:

U.S. Energy Information Administration, *Independent statistics and analysis*
http://www.eia.doe.gov/emeu/aer/pdf/pages/sec1_12.pdf,
http://www.eia.doe.gov/emeu/aer/pdf/pages/sec8_6.pdf,
http://www.eia.doe.gov/oiaf/aeo/pdf/appendixes.pdf, referenced from Pg. 6, 46

Pentair's public webpage, *Pentair Inc.*
http://www.pentair.com,
http://www.pentair.com/Resources/Images/76862220-55c1-4d6c-9b67-cbd596f5fa6d.pdf

IIT's official IPro webpage*, Interprofessional Projects Program*
http://ipro.iit.edu

MLA Citation

Emadi, Ali.Andreas, John C.,*Energy-efficient Electric Motors*. New York : Marcel Dekker, 2005. Print.

Galowin, Lawrence S., Rossiter, Walter J.Hall, Wiley.*National Voluntary Laboratory Accreditation Program: Efficiency Of Electric Motors*. Gaithersburg, MD : U.S. Dept. Of Commerce, Technology Administration, National Institute Of Standards And Technology ; 1995. Print.

Jordan, Howard E. *Energy-efficient Electric Motors And Their Applications*. New York : Plenum Press, 1994. Print.