IPRO 337 Project Plan

Spring 2007

Energy Efficient Lighting Design Using LEDs and Other Technologies

Advisor: Nancy Governale-Hamill

1.0 Objectives

- Incorporation of energy efficient lighting technologies into an existing 6,000 sq ft space, thereby adding to the transformation of the space into a new useful zero-energy lab.

- Testing and measurement of energy consuming Devices that are scaled for renewable energy systems such as photovoltaic, battery storage, and fuel cells.

- Demonstration of the use of day lighting for ambient light. Demonstration of use of low energy consuming systems for task lighting and night time lighting.

- Development of low energy consuming lighting systems including fixture mock ups, lamp mock ups, day lighting harvesting systems, fiber optic day light utilization systems, fixtures utilizing LED, low wattage fluorescent and direct and indirect lighting fixture design.

2.0. Background

A. The project will be sponsored by IIT & donors to turn the 4th floor of Machinery Hall into a research and teaching lab that demonstrates zero-energy usage.

B. The problem includes design and implement the most energy-efficient lighting scheme available, either LED solid-state technology or conventional lighting to be powered through renewable photovoltaic energy

C. Two branches of lighting technology are involved in the designing process. The first branch is conventional lighting including fluorescent and incandescent lights. These are the “traditional” or “old” types of lighting scheme that are widely used. The second branch utilizes Light-Emitting Diode (LEDs) instead of conventional light bulbs. The process also study patterns of light distribution, optics, fixture design to optimize the overall utilization of watt/ft^2.

D. Fluorescent and incandescent lights had been used for so long that they became the norm in residential and commercial lighting. The effectiveness of a light medium is measured loosely by the light it produces (measured in lumens) versus the power it consumes (measure in W). Typical incandescent light bulb has an efficiency of ~5% [1] with a light output around 15lm/W for a 60W bulb. Fluorescent light can last twice as long as incandescent and has twice the efficiency of an incandescent.

[1] Consumer Utilities Services, http://www.cus.net/electricity/subcats/eleclighting.html

LED uses less electricity to produce roughly the same amount of illumination. In 2002, Philips Lumileds introduces a 5W power LED with a range of 18-22lm/W. Higher efficacy LED lighting are also available on the market. The downside of LEDs is that they are often more expensive than conventional lighting, mostly because they are fairly new on the market and the prices are used to cover research and development. It is assumed that the increased use of LED lighting applications will bring the cost down.

E. The issue in establishing a LED lighting scheme is initial cost. It takes longer for the energy-efficiency to balance out the initial cost, and even longer for users to benefit from savings on the utility bill. The second issue is that almost all building structures were built to accommodate the fluorescent and incandescent light, so introducing LED might pose potential problems such as re-wiring, relocating light source, etc. Energy saving is an important benefit from this project because wide uses of energy-efficient application will reduce the dependence on fossil fuel and therefore eliminate pollutions and create a safer environment for future generations. An ethical/habitual issue will be to achieve wide uses of LED through residential homes. As mentioned earlier, incandescent lights are still the norm of general illumination therefore LED lighting applications need to break the norm and demonstrate that they can do just as well as incandescent and better in a sense that they can save money off utility bill. Another area the team is exploring is using day light sensor and motion sensor. Day light sensors serve to utilize sun light to further save energy while motion sensors might be use to light up the space only if needed at night to prevent all-night illumination.

F. As mentioned in part E, the initial cost of buying and installing a LED light system that can replace an existing conventional lighting system can be expensive and the return rate will take longer than fluorescent. The team will calculate payback of our design vs. conventional light.

G. In order to produce an energy-efficient lighting system, it is decided that LED and fluorescent light will be use together. Incandescent light will not be used due to their extreme inefficiency. Our target is an office space with an area of 6000 ft^2. Because there are many windows on the side wall and ceiling, we will utilize sun light in our design to further maximize energy-saving. Ambient light sensors will also be used to maintain a certain lighting level in the room at all time.

H. A relevant topic with this project is the "Zero-energy homes" or ZEH that currently gaining popularity in California.[2]

[2] Newsweek *No more electric bills 'Zero Enery Home'* http://www.msnbc.msn.com/id/8852127/site/newsweek
Department of Energy *Energy Efficiency and Renewable Energy*
http://www.eere.energy.gov/buildings/building_america/pdfs/29915_zeb_path.pdf

I. Rendering of the space

3.0. Methodology/Brainstorm/Work Breakdown Structure

A. Design and implement an energy-efficient lighting system for an office space using power supplied by a photovoltaic system.

B. In order to accomplish the problem set forth in part A. The team conducted a site visit to get a feel for the space. During the subsequence sessions, we listed all the tasks needed to accomplish the goal from beginning to end. Then the tasks were grouped into phases. There are 3 phases: Analysis, Design and Implementation.

In the Analysis phase, we created two sub-teams and named them Design/Rendering and Product Research. The D/R team is responsible for providing the group with visual aid including: demonstrating the capacity of the rendering software, actual rendering of the space and illumination analysis. The data they provided are part of the determining factors in product selection at a later stage. The PR team's responsibility is to search for LED light, fluorescent light, ambient light sensors, and motion sensors. They also contact the manufactures and industry engineers as needed.

In the Design Phase, products selection will be made according to the illumination guideline in the rendering result. The group will also decide on any other aspects to maximize lighting effects (paint, floor, etc…). Sample products will be ordered for mock up and evaluating purposes.

In the Implementation phase, the group will contact Facilities to do general clean up and trash removal from the site. Final products will be ordered and an electrician will install the lights, fixtures, and sensors.

C. The mock up will be set up, sample products will be ordered, and an evaluation will follow. The possible criterion include: how bright the light is, how it looks with the site, the material, ect.

D. All results of research and testing will be documented By the sub-groups and team members then uploaded to igroups so that everyone will have access to all of the findings.

E. The group will evaluate the product and analyze the result together. Advice will be sought from the instructor, who has an extensive knowledge in industrial lighting.

F. A sub-team responsible for the report will divide the task of writing the report among themselves. A rough draft will be presented to the group for adjustment and the final report will be a polished version including everybody's work.

G. Not applicable.

4.0 Expected Results

A. IPRO 337's expected activities of our results is to have a virtual 3D study model and images of the existing space in Machinery Hall to represent what the space would look like if our proposed lighting efficiency and furniture design was implemented into this space as well as some mock-ups of the proposed lighting fixtures.

B. Expected data which shall be gathered through research, are lighting product specifications and requirements needed to provide an energy efficient design into our existing space.

Our expected data resulting from testing should include: existing conditions of the space in terms of lighting, the amount of energy it takes to run our mock-ups and how much energy they produce. With our collected testing information we will be able to select energy efficient lights that would be implemented into the design and tested in virtual form.

C. Some of the potential products that may evolve due to research and testing are new lighting types, new design techniques, new ways of lighting, as well as an educational space which can be displayed as an energy efficient example for other students, employees, and professionals.

D. Our potential outputs through the execution of assigned tasks are to gain knowledge on energy efficient lighting, and to share our known and learned information with other group members. We will also work together as a group to provide the best product while being team players.

E. Our expected results in terms of prototypes and other deliverables is to have several working mock-ups using energy efficient lighting techniques and to also have virtual images presenting the energy efficient lights and furniture layout within the space .

F. Our expected results will not only address the problem provided by our sponsor/customer by providing the research data and design for the space using energy efficient techniques. Furthermore, it can benefit many who are interested in studying, producing and designing energy efficient spaces Through the use of the energy efficiency lab, class room and seminars that can take place in the space.

G. During all phases of IPRO 337's project from conception, research, design, mock-ups, testing and analysis through completion of the final product; each part is pertinent to completing our proposed solution. All of our decisions need to be based on some sort of research and/or test which will need to be conducted in

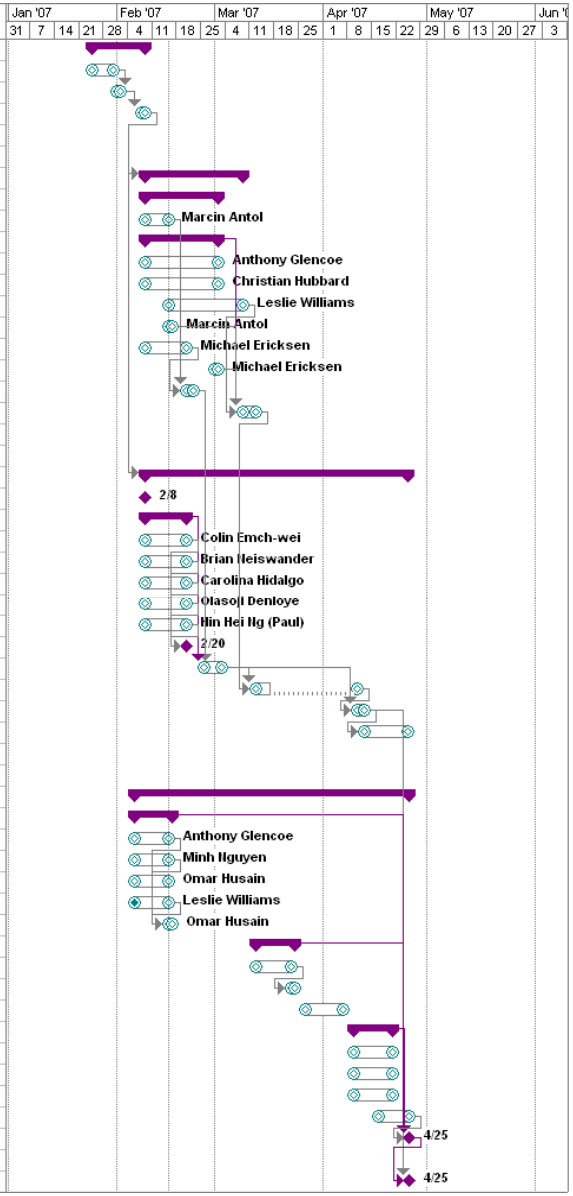
order to provide the best design and most successful energy efficient design possible for our space.

5.0 Project Budget

ITEM	UNIT PRICE	QTY	PRICE	PURPOSE
Florescent lights	$25.00	2	$50.00	to test and develop new lights with other materials
60 bright white LED Light Bulb	$29.99	1	$29.99	Testing lighting output
18 LED Light Bulb	$14.95	1	$14.95	Testing lighting output
LED Light Bulb Wired	$2.00	100	$200.00	To test lighting output and develop new lights
Electrical tape	$3.99	1	$3.99	for connecting wires
wire nuts	$10.99	3	$32.97	Connecting wires
led rope lights	$17.99	2	$35.98	to test effects of light and develop new lights
Motion and Heat sensors	$100.00	3	$300	To test different lighting effects in zones
Sheet metal materials	$350.00	1	$350.00	used to develop new lights and reflectors
IPRO day	$150.00	1	$150.00	poster printing and set up materials
Total:			$1,171.87	

6.0. Schedule of Tasks and Milestone Events

ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**Project Organisation**	**11 days**	**Thu 1/25/07**	**Thu 2/8/07**		**Complete Team**
2	Define the project	4 days	Thu 1/25/07	Tue 1/30/07		
3	Determine project requirements	1 day	Thu 2/1/07	Thu 2/1/07	2	
4	Division Into Teams and Task Division	1 day	Thu 2/8/07	Thu 2/8/07	3	
5						
6						
7	**Research Team Tasks**	**20 days?**	**Fri 2/9/07**	**Thu 3/8/07**	**4**	
8	**Energy Efficient Lighting Research**	**15 days?**	**Fri 2/9/07**	**Thu 3/1/07**		
9	Research on Flourescent Light Sources	5 days?	Fri 2/9/07	Thu 2/15/07		Marcin Antol
10	**Led Lighting Research**	**15 days?**	**Fri 2/9/07**	**Thu 3/1/07**		
11	Application and History	15 days?	Fri 2/9/07	Thu 3/1/07		Anthony Glencoe
12	Products	15 days?	Fri 2/9/07	Thu 3/1/07		Christian Hubbard
13	Alternate Lighting Sources	15 days?	Fri 2/16/07	Thu 3/8/07		Leslie Williams
14	Light Sensors	1 day?	Fri 2/16/07	Fri 2/16/07		Marcin Antol
15	Lighting Fixtures (Luminaires) - Conventional	8 days?	Fri 2/9/07	Tue 2/20/07		Michael Ericksen
16	Lighting Fixtures (Luminaires) - Non-Conventional	1 day?	Thu 3/1/07	Thu 3/1/07		Michael Ericksen
17	Compile Conventional Lighting Report for Design Team	2 days?	Wed 2/21/07	Thu 2/22/07	9,15	
18	Compile Non-Conventional Comparitive Lighting Report for De:	2 days	Fri 3/9/07	Mon 3/12/07	10,13,14,16	
19						
20						
21	**Design Team Tasks**	########:	**Thu 2/8/07**	**Wed 4/25/07**	**4**	
22	Sub Team Division Finalized	0 days	Thu 2/8/07	Thu 2/8/07		
23	**Lighting Simulation**	**8 days?**	**Fri 2/9/07**	**Tue 2/20/07**		
24	Develop Rendering Environment	8 days?	Fri 2/9/07	Tue 2/20/07		Colin Emch-wei
25	Measurement of Light/Materials Research	8 days?	Fri 2/9/07	Tue 2/20/07		Brian Neiswander
26	Existing Space Measurements	8 days?	Fri 2/9/07	Tue 2/20/07		Carolina Hidalgo
27	Research of Current Spatial Condition	8 days?	Fri 2/9/07	Tue 2/20/07		Olasoji Denloye
28	Space Layout (Furniture Layout)	8 days?	Fri 2/9/07	Tue 2/20/07		Hin Hei Ng (Paul)
29	Rendering Environment Complete	0 days	Tue 2/20/07	Tue 2/20/07	24,25,26,27,28	
30	Test Conventional Lighting using Light Rendering	5 days	Mon 2/26/07	Fri 3/2/07	23,17	
31	Test Non Conventional Lighting using Rendering	5 days	Tue 3/13/07	Tue 4/10/07	30,18	
32	Report Best Lighting Effects	2 days	Wed 4/11/07	Thu 4/12/07	30,31	
33	Model Development	8.5 days	Fri 4/13/07	Wed 4/25/07	32	
34						
35						
36	**Deliverables Team Tasks**	**57 days?**	**Tue 2/6/07**	**Wed 4/25/07**		
37	**Prepare Project Plan**	**9 days?**	**Tue 2/6/07**	**Fri 2/16/07**		
38	Part I : Sec 1.0-2.0	8 days?	Tue 2/6/07	Thu 2/15/07		Anthony Glencoe
39	Part II : Sec 3.0-5.0	8 days?	Tue 2/6/07	Thu 2/15/07		Minh Nguyen
40	Part III : Section 6.0	8 days?	Tue 2/6/07	Thu 2/15/07		Omar Husain
41	Part IV : Section 7.0	8 days?	Tue 2/6/07	Thu 2/15/07		Leslie Williams
42	Compile Completed Project Plan and Submit on iKnov	1 day	Fri 2/16/07	Fri 2/16/07	38,39,41	Omar Husain
43	**Prepare Midterm Report**	**9 days**	**Tue 3/13/07**	**Fri 3/23/07**		
44	Task Division among Team	8 days	Tue 3/13/07	Thu 3/22/07		
45	Final Report Revision and Submit	1 day	Fri 3/23/07	Fri 3/23/07	44	
46	Meeting Minutes Report	9 days	Tue 3/27/07	Fri 4/6/07		
47	**IPRO Day Deliverables**	**9 days**	**Tue 4/10/07**	**Fri 4/20/07**		
48	Website	9 days	Tue 4/10/07	Fri 4/20/07		
49	Poster	9 days	Tue 4/10/07	Fri 4/20/07		
50	Abstract	9 days	Tue 4/10/07	Fri 4/20/07		
51	IPRO Day Presentation	7 days	Tue 4/17/07	Wed 4/25/07		
52	Deliverables Complete	0 days	Wed 4/25/07	Wed 4/25/07	37,43,47,51	
53						
54	PROJECT COMPLETION	0 days	Wed 4/25/07	Wed 4/25/07	52,32	



7.0. Individual Team Member Assignments

A.

First Name	Last Name	Major / Minor	Skills and Strengths	Experience and Academic Interests	Team	Assignments done for IPRO so far.
Marcin	Antol	Computer Engineering	- Oscilloscope usage - Finite State Machines - ACDC Circuit analysis - MATLAB - Java, C, Unix - Microsoft Word, Excel, and Powerpoint.	- Worked for eclipse night club: perform light shows by controlling and operating all light fixtures.	Product Research	-Research on different light sources and how they work.
Patrick	Bowles	Electrical Engineering/ Computer Engineering	- Website Design	- Built website from scratch for last IPRO team. - Interned at Catepillar. - Co-op at Panduit Corp. - Currently in the NUPOC(nuclear) program for the U. S. Navy.	Product Research	-independent research in order to better understand problem we're facing. - found possible solutions to the lighting problem
Olasoji	Denloye	Electrical Engineeriing	- JAVA programming with Eclipse, Interactive C. - MS Office(Word, Excel, Powerpoint, Publisher, Vision). - Calculus, oral, and written communication skills.	- Designed and built robot using interactive C programming, with simple intelligent behavior. - Wrote executive summary of robot prototype. - Designed and implemented apllication for Pet Clinic management using JAVA Eclipse.	Design	- Research of different energy efficient lighting technologies. - went to IPRO games.
Colin	Emch-wei	Architecture/CAD technology design	- Model building, 3D modeling in CAD, Photoshop and Illustrator CS,		Design	-Measurements of space. - Computer drawings, models, and renderings of space.

			- CAD drafting - Design			- meeting minute taker.
Michael	Ericksen	Civil Engineering	- Autocad - knowledge in construction planning and scheduling. - Hardworking - Good at working with people in and outside of a group.	-Have worked with electricians on construction projects. - Interned two summers with Weis Builders as a field intern and as a project engineer. - Interested in construction management and in structures. - Experience as a demolition laborer and carpenter assistant.	Product Research	-Research on LED - obtained some contact info for electrical contractors.
Anthony	Glencoe	Architecture,	- Designing. - Multi tasking - Communicating w/ clients. - Multi projecting - Overseeing design projects from start to finish. - Dedicated	- Architectural design manager and planner. - Construction background. - Worked for both contractors and architects in and out of the field. - Dedicated current employment of 3 yrs. 5 mos. While attending IIT. - Interested in succeeding in all that he does. architecture, construction, end results, working, and learning from others. - Helping other people.	Product Research/ Deliverables	- Researched lighting types and different products. - Contacted a design expert and built a contact for questions w/ a Phillips expert. - Went to project managing workshop. - Helped team communicate and move towards goals. - Agenda maker. - Helped with 3 parts of project plan.
Carolina	Hidalgo	Architecture	- Autocad - Autodesk Viz - Sketchup - MS office(word, excel, powerpoint) - Model making - Straight forward about working.	- Intern at Teng Architects	Design	- Research on different energy efficient lighting solutions. - Helped measure space. - Research on materials for space.

			- Reliable, responsible, effective comunicator			
Christian	Hubbard	Architecture	- Proficient in Autocad, Form Z, 3D Studio Max, Adobe Photoshop & Illustrator. - Model building. experience w/ wood, acrylic, and plaster.	- Interested in the link between individual and group psychologies and the built environment.	Product Research	- Research information on LED lighting systems and fixtures. - Research information on solar/ hybrid lighting systems.
Omar	Husain	Mechanical Engineering	- Computer programming/ Application(VB, C++, MATLAB). - Autocad. - Improving MS Project and Project management skills.	- Intern (product design) successfully completed at UT Houston Summer 2006. - Aircraft engineering intern(Air Sahara airlines, India 2005) - Interested in innovative design engineering	Design/ Deliverables	- Research on photometry - Attempting to efficiently organize project to optimize time efficiency.
Brian	Neiswander	Aerospace Engineering	- MATLAB, GUI design. - C++ and JAVA OOP (Microsoft visual studio.net, Eclipse SDK). - Adobe photoshop, after effects, Premiere. - PTC ProEngineer. - IDT provision. -Macromedia, Dreamweaver, Fireworks. - Woffram Mathematics. - Autocad.	- Research assistant for PhD candidate, IIT 2006. - Helped design, model and build dual-axis transitional 3d PIV system to investigate flow effects of an urban boundary layer. - Currently doing research using oil interferometry analysis. - Investigated the use of wireless.	Design	- Researched general efficient lighting information. - Researched LED components. - Recorded light data and created contour map of natural light levels inside Machinery Hall. - Helped measure out vertical dimensions of Machinery Hall.
Hin Hei	Ng	Architecture	- Technical report writing. - Analysis using excel. - Studious. - Hardworking.	- Interested in aeronautics. - Experience working in the satellite field (Lockheed Martin).	Design	- Worked on the beginning of a business plan. - Researched possible donors (large corporations). - Wrote objectives section of the project plan.

Minh	Nguyen	Electrical Engineering	- Works well in groups.	- LED - Energy- efficient applications - renewable energy	Product Research/ Deliverables	- Research on new lighting applications that maximize energy- efficiency.
Leslie Ann	Williams	Architecture	- Proficient with AutoCAD, 3D studio max, Adobe photo shop, adobe illustrator, adobe premiere and Microsoft Office. - Sketch up. - Dreamweaver. - Fast learner. - Hard working. - Works well as an individual or as part of a team.	- Experience at HOK Architecture firm. - Worked as an on sight intern at McCormick Place expansion summer 2006. - Experience at a drywall subcontractor as an estimator. - Interested in construction management. - Interested in interior design.	Product Research/ Deliverables	-Went to IPRO games -Went to project plan workshop. - Helped with 2 parts of project plan. - Organized team schedules into one Master Schedule. - Researched existing lighting technologies.

B. Team Leaders

- Anthony Glencoe
- Leslie Ann Williams

C. Sub- Teams

1. Product Research Team

    - Marcin Antol
    - Patrick Bowles
    - Michael Ericksen
    - Anthony Glencoe
    - Christian Hubbard
    - Minh Nguyen
    - Leslie Ann Williams

2. Design Team

    - Olasoji Denloye
    - Colin Emch-wei
    - Carolina Hidalgo
    - Omar Husain
    - Brian Neiswander
    - Hin Hei Ng

3. Deliverables Team

    - Anthony Glencoe
    - Omar Husain
    - Minh Nguyen
    - Leslie Ann Williams

D. Sub- Team Leaders

- Minh Nguyen- Product Research Team
- Colin Emch-wei- Design Team
- Omar Husain- Deliverables Team

E. Sub Team Responsibilities

1. Product Research Team

    - Research existing energy efficient lighting solutions.
    - Research conventional lighting solutions.

- Research Led lighting solutions.
- Research most efficient lighting solution for the best price.

2. Design Team
   - Design a scheme for proposed space.
   - Draw floor plan of space in Autocad.
   - Make a 3D model of space and render model on computer.

3. Deliverables Team
   - Keep track of Deliverables and deadlines.
   - Go to project management workshop and do project plan.

F. Sub- Team Individual Responsibilities

1. Product Research Team

   - Marcin Antol- Research energy efficient Fluorescent lighting solutions.
   - Patrick Bowles- Research daylight harvesting systems.
   - Michael Ericksen- Research light/motion sensors.
   - Anthony Glencoe- Research Led lighting solution.
   - Christian Hubbard- Research solar hybrid solutions and LED lighting solutions.
   - Minh Nguyen- Research Led lighting solutions and light/motion sensors.
   - Leslie Williams - Research daylight harvesting systems and solar hybrid solutions.

2. Design Team
   - Olasoji Denloye- Research materials for space.
   - Colin Emch-wei- Computer aided simulation.
   - Carolina Hidalgo- Research materials for space and assigning uses to space.
   - Omar Husain- Research photometric standards(lighting levels).
   - Brian Neiswander- Research materials for space and assigning uses to space.
   - Hin Hei Ng- Design/ furniture layout of space.

3. Deliverables Team

   - Anthony Glencoe- Parts 1.0, 4.0, and 5.0 of project plan.
   - Omar Husain- Part 6.0 of project plan.
   - Minh Nguyen- Parts 2.0 and 3.0 of project plan.
   - Leslie Ann Williams- Parts 7.0 and 8.0 of project plan.

8.0 Designation of Roles

A. Assign Meeting Roles

- **Minute Taker:** Colin Emch-wei
- **Agenda Maker:** Anthony Glencoe
- **Time Keeper:** Anthony Glencoe and Minh Nguyen

B. Assign Status Roles

- **Weekly Timesheet Collector/ Summarizer:** none. As a group, we decided that we each will do our part to keep the project moving smoothly and we don't need timesheets to keep track of our work. We will keep track within our own sub groups and then update each other so that everyone is moving in the same direction and towards the same goal.
- **Master Schedule Maker:** Leslie Ann Williams
- **IGroups:** Leslie Ann Williams