McGILL UNIVERSITY VALUE ENGINEERING WORKSHOP 2020 winter

INPUT FOR ASSIGNMENT TO PROJECT TEAMS

FAMILY NAME_____ GIVEN NAME(S)_____

STUDENT NUMBER_____ **Please print**

To balance talent on each team we need to know your ability to work in French, your preference for project type, a list of **required** courses that you have not yet completed, ability to use FEM software and briefly about your relevant work experience. Download course notes VENotes01i.pdf to help follow Ms. Parrot's lectures.

French: Yes[ ]/No[ ] Mandarin*: Yes[ ]/No[ ]

Preferred project type: Design[ ] Manufacturing[ ]

Missing required courses
MECH[ ], MECH[ ], MECH[ ], MECH[ ], MECH[ ], MECH[ ]
If more than a couple remain you should consider dropping MECH 497.

FEM in heat transfer: Yes[ ]/No[ ] FEM in stress analysis: Yes[ ]/No[ ]

Relevant work experience:

PROJECT SELECTION

Please write the letters, A, …, F, of the project below in order of preference, 1st, …, 4th .

First_____ Second_____ Third_____ Fourth_____

LIST OF PROJECTS AVAILABLE

A	**Siemens 1**	Gas turbine cost reduction
B	**Siemens 2**	Improve stator vane inlet mechanism
C	**Skyfold**	Improve safety of panel raising/lowering
D	**CAE**	3-D printing of cockpit parts
E	**Ville de Laval**	Municipal building repurposing
F	**Jiaxipera***	Refrigerator noise reduction
G	**Rapid Precision**	Smart harness analysis

4 or 5 students to a team. Talents to be matched based on information you gave. 1st or 2nd choice will be respected. Sometimes necessary to accept 3rd or even 4th choice.

Siemens Project Power Turbine

Project Attachment Statement of Work 1

Project Number: 1**.**

PROJECT TITLE: Siemens Aero-Derivative Gas Turbine SGT-A35 GT30 Power Turbine Cost Reduction.

OBJECTIVE: The objective of the Value Engineering is to devise a new power turbine configuration that can achieve a cost reduction of 40% with respect to the current cost, comprising manufacturing and build costs. The new configuration has to comply with the following requirements:

1. Functionality and performance of the system are to remain unchanged.
2. All gas-washed surfaces are to be retained and the numbers of blades and stator vanes are to be unchanged.
3. Changes to materials, methods of manufacture, fitments and assembly may be done provided they do not affect the function and integrity of the mechanical components.
4. The final solution must be inherently resistant to corrosion and sulfidation and may be accompanied by suitable protective coating.

DESCRIPTION: The purpose of the power turbine is to convert the gas generator high pressure gas stream into a torque output resulting in 34 to 38 MW of power output. The power output is used to drive equipment that normally comprises either a generator for power generation or mechanical drive equipment.

The power turbine configuration consists of a four-stage rotor with a bladed disc assembly at each stage and a static casing with stator vane assemblies between each rotor stage. Each rotor stage has blade tip fin seals running against static seal segments fitted into the casing. The stator vane stages have inter-stage seals at their inner diameter.

This sealing is important for efficiency, it prevents the gases from bypassing the blades and vanes which would result in a reduction in the torque output from the gases. Since the gas path temperature exceeds 800 C, the bore of the rotor is bathed in cooling air delivered by the compressor, with air passages in the inter-stage seals used to meter small amounts of this air into the inter-stage seals and blades exposed to the gas path.

The SGT-A35 GT30 power turbine is derived from the Rolls-Royce Trent 800 aero fan gas turbine. Here, the power turbine features one turbine stage less than the original design to match the required power extraction of the SGT-A35 GT30 gas generator. As a result of its pedigree, the power turbine uses donor components that were designed based on the aero fan gas turbine requirements. This makes the power turbine expensive to manufacture and assemble, which restricts the competitiveness of the SGT-A35 GT30 gas turbine relative to other gas turbine OEMs.

UNCERTAINTY OF Unsure how to reduce the cost of the configuration by 40% since several

THE WORK: previous cost reduction schemes have already been implemented. Although the complexity of the power turbine components may offer scope for cost reduction, their complexity is inherent in the design features derived from the aero fan donor components and in order to retain the efficiency of the power turbine, these cannot be readily simplified, let alone discarded.

DELIVERABLES: The deliverables required are:

1. To establish the terms of reference of the workshop.
2. A scheme defining the proposed changes to the power turbine components. A geometrical cross-section representation to scale will be needed together with any changes to the air system.
3. The proposed manufacturing methods for realizing the new scheme. The different phases of the manufacturing processes are to be identified.
4. A should cost of the manufacturing and assembly of the proposed scheme.
5. A risk analysis with mitigation and the probability of success in achieving the cost reduction without detriment to the function, operation and service life of the power turbine.
6. The final proposal is to be submitted for final evaluation to the SIEMENS Project Manager and the McGill Principal Investigator by 6 April 2020.

SCHEDULE: 6 January 2020 to 6 April 2020.

NO. OF HOURS One full semester winter 2020.

UNIVERSITY: McGill University

STUDENT NAME(S):

UNIVERSITY PROJECT SUPERVISOR:

SIEMENS PROJECT RESPONSIBLE:

PROJECT COST: $4000

Siemens Project Compressor Inlet

Project Attachment Statement of Work 2

Project Number: 2.

PROJECT TITLE: Siemens Aero-Derivative Gas Turbine SGT-A35 GT30 Intermediate Pressure Compressor Variable Inlet Guide Vanes Actuation Cost Reduction.

OBJECTIVE: The objective of the Value Engineering is to devise a simpler actuating system that can achieve a cost reduction of 50% with respect to the current cost, comprising manufacturing and build costs. The new configuration has to comply with the following requirements:

1. Functionality and performance of the system are to remain unchanged.
2. All gas-washed surfaces are to be retained and the numbers of blades and stator vanes are to be unchanged.
3. Changes to the actuating mechanism, the control systems and its circuitry can be done, with a choice of using a modified or different power source.
4. Changes to materials, methods of manufacture, fitments and assembly may be done provided they do not affect the function and integrity of the actuating mechanism and the mechanical components.

DESCRIPTION: The purpose of the compressor is to supply high pressure air to the combustor. This is an axial flow compressor where the air inlet is at atmospheric pressure and is increased through sequential stages of the compressor rotor. To permit the starting of the gas turbine and operation at variable shaft speeds, a set of variable guide vanes direct the flow angle of the incoming air onto the compressor blades.

The configuration itself consists of a compressor casing assembly with a series of variable guide vanes attached to the casing and that pivot through an actuating system that is hydraulically operated. The compressor rotor consists of a drum assembly with blades. The rotor drum is supported by shaft bearings. The positioning of the variable vanes is done through a feedback system commanded by an onboard control system that measures the gas turbine operating parameters to regulate the positioning of the vanes.

The SGT-A35 GT30 compressor is derived from the Rolls-Royce RB211 aero fan gas generator. The SGT-A35 GT30 compressor features an additional zero-stage to provide the required air pressure to the gas generator. As a result of its pedigree, the compressor uses donor components that were designed based on the aero fan compressor requirements. This makes the compressor expensive to manufacture and assemble, which restricts the competitiveness of the SGT-A35 GT30 gas turbine relative to other gas turbine OEMs.

UNCERTAINTY OF THE WORK: Unsure how to reduce the cost of the actuating system configuration by 50% since several previous cost reduction schemes have already been implemented. Although the complexity of the system and its components may offer scope for cost reduction, their complexity is inherent in the design features derived from proven donor components. In order to retain the efficiency and

safe operation of the compressor, these cannot be readily simplified, let alone discarded.

DELIVERABLES: The deliverables required are:

1. A scheme defining the proposed changes to the variable guide vane actuating mechanism, together with any changes to the power source and the electrical control system.
2. A geometrical cross-section representation to scale will be needed for changes that affect fit and form.
3. The proposed assembly and setting method for realizing the new scheme are to be identified.
4. A should cost of the proposed scheme.
5. A risk analysis with mitigation and the probability of success in achieving the cost reduction without detriment to the function, operation and service life of the compressor and the actuating system.
6. The final proposal is to be submitted for final evaluation to the SIEMENS Project Manager and the McGill Principal Investigator by 6 April 2020.

SCHEDULE: 6 January 2020 to 6 April 2020.

NO. OF HOURS One full semester winter 2020.

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UNIVERSITY PROJECT SUPERVISOR:

SIEMENS PROJECT RESPONSIBLE:

PROJECT COST: $4000

Value Engineering Project Outline.
Skyfold Inc.
Enhanced Security System.

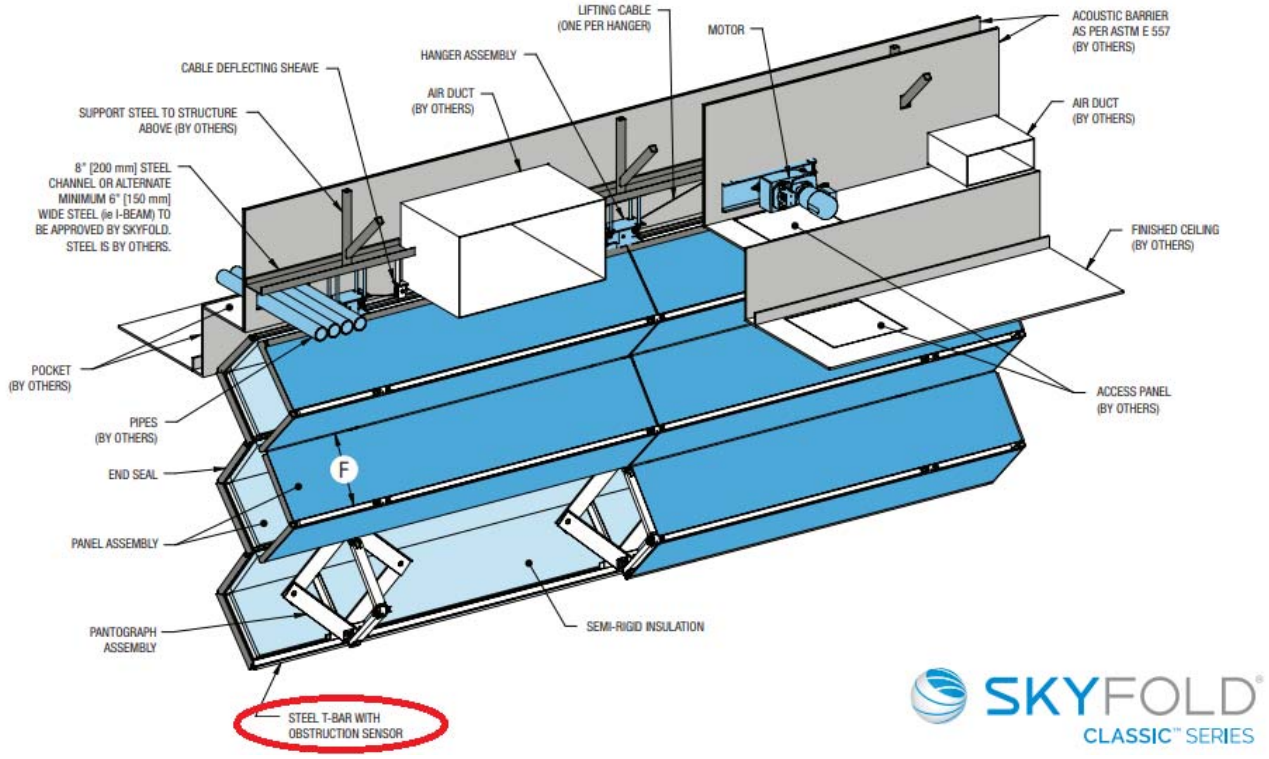
Skyfold is the acoustic leader in vertically folding retractable walls. Our walls are innovative, custom, electric and premium multipurpose space solutions that allow architects, interior designers, contractors and end-users to redefine how a space is used. The easy-to-use, self-retracting system and vertical motion of the operable wall give users the flexibility to quickly divide or expand spaces. When deployed, Skyfold becomes a two-sided, rigid wall and acoustic barrier with acoustic ratings of up to STC 60 (RW 59) and NRC/SAC of up to 0.65. When not in use, the Skyfold wall disappears into the ceiling for the user to maximize their floor space

When the system descends from the ceiling, the Skyfold safety system should prevent the partition from contacting any obstructions. (Person, furniture etc.)

The current safety system is not sufficient to guarantee the complete safety of the system and therefore relies on two operators to be present (one on each side) to monitor the partition's descent. The current system uses a pneumatic switch connected to a long rubber bladder running down the length of the partition. A new safety system should be able to prevent damage to the partition and all other things in the room. Preference would be given to solutions where no physical contact is made for the safety to work.

Due to the pantograph lifting mechanisms, when the partition is operated, the panels on either side of the wall fold outwards into the room. The partition gets wider as it is pulled up into the storage pocket, this property is similar on the way down and creates surfaces that are not covered by the current safety system. These surfaces could impact people or objects and the system would not detect the fault. The new safety system needs to extend this protection to cover the width of the system throughout the travel of the partition.

While the system currently in use is as cost effective as possible, we are looking at an enhanced safety with best cost ratio.



SKYFOLD
CLASSIC™ SERIES

3D Printing of Aircraft Cockpit Components, etc.

At CAE we are equipped with a new Stratasys F900 3D printer that can produce very large composite parts made from engineering-grade thermoplastics. As we are always innovating and finding more efficient manufacturing procedures, we are looking to begin 3D printing structures that have traditionally been made from either sheet metal or machined parts.

We are looking to identify which cockpit structures are ideal candidates to migrate from traditional manufacturing processes to 3D printing. Using the available materials and build volumes of our printers, the task is to select the optimal structures and which materials they need to be fabricated from. The objective is three-fold, reduce part cost, minimize weight and manufacturing time. The expected delivery is a 3D CAD model of the selected structure, proposed materials and the method of how it will be printed.

CAE Participants

Zachary Neuman – Mechanical Designer

Ville de Laval

Project title: Retrofitting an industrial warehouse into a multipurpose municipal building

Project description: With constant increase in employee numbers and the creation of a new department, Ville de Laval bought an industrial warehouse located at 2785 Francis Hughes Street in the Laval industrial Park. The warehouse is an old manufacturing site with a footprint of 35000 square feet of office space and 112500 square feet of warehouse. (1280 sq. m & 4115 sq. m)
The project main goal:

Architectural
- Validate if the building satisfies building code requirements
- Reorganize the existing office space to satisfy employee needs
- Increase the office space using existing warehouse space
- Retrofitting building envelope
- Build storage facility in remaining warehouse space
- Build a vehicle maintenance and cleaning facility in remaining warehouse space
- Increase parking space.

HVAC and electrical
- Validate if the existing HVAC and electricity systems meet the building code requirements
- Optimize the HVAC and electrical systems to reduce consumption and to meet operational needs.

Jiaxipera Compressor Co., Ltd.
Jiaxing, Zhejiang, China

Project title: Noise reduction design of a variable frequency refrigerator compressor

Project description
Jiaxipera Compressor is the largest, global supplier of refrigerator compressors. One of the major complaints from customers about refrigerators is the noise from the compressor. Jiaxipera Compressor wishes to reduce the sound powerlevel of the compressor by at least 3 db when operating at a speed of 4500 rpm. The cost to accomplish this must not increase by more than 3% of total. Jiaxipera will participate in the course via Skype, e-mail and other electronic means. A tech paper dealing with refrigeration compression noise issues is included as reference material. At least one member of the student team must be capable of reading and understanding Mandarin because of writing on technical drawings supplied by client. Notice this is described as "a variable frequency refrigeration compressor". It is therefore suspected that frequency refers to operating speed hence variable refrigeration capacity under operating conditions. The domestic refrigerator compressor in your kitchen runs at constant speed. The variable speed feature makes noise reduction by tuning frequency response of the mountings, etc., quite difficult.

NB See <www.cim.mcgill.ca/~paul/Jiax.pdf> an investigation carried out by company engineers.

2020 01 03

Company**:** **Rapid Precision Industries Ltd.**

Title: **Smart harness**. (Josef Slanik Eng., <jslanik@yahoo.ca> (514)966-5011

Company profile:

Rapid Precision Industries Ltd. has a state of the manufacturing facility and engineering department with advanced capabilities in machine and system design to provide services to industries such as aerospace, defense, telecom, mining and others. Our engineering group delivers turnkey automated systems for food, medical and communication industries.

Project description:

The harness is a solid link between the two points. The combination of two or more harnesses joined at discrete nodes creates two or three dimensional structures. Harness stiffness can be varied actively. At least one node is fixed. Known forces act at free nodes. We are interested in how the system reacts to applied forces.

There are several methods and mechanisms by which stiffness variations can be induced. Some of these are confidential and will be disclosed to the VE team after they become party to an NDA. It is assumed that during the brain storming part of the course some additional "mechanisms" will be discovered and employed.

The smart harness systems have multiple applications with varying requirements in terms of performance, cost, reliability, etc. It is a central part of the project to evaluate the different types of the smart harness systems considering their respective cost/benefit ratio.

Due to the complexity of the problem a full analysis of the flexural rigidity of the harness is not expected. Nevertheless, familiarity with the Euler-Bernoulli beam equation, bending stiffness of materials and similar subjects is highly desirable. "Spring back" phenomenon will not be considered. Extensive use of Finite Element Analysis is expected. SolidWorks level of accuracy will be sufficient.

We realize that this project requires, apart from value engineering analysis, a substantial understanding of the subject matter and a good dose of engineering creativity. We hope that the team will find it interesting and rise to the challenge.