DETAILED PROJECT REPORT

"CENTER FOR VIRTUAL AND ADVANCED MANUFACTURING"

Proposal Submitted to

MINISTRY OF HUMAN RESOURCE DEVELOPMENT [MHRD]

GOVERNMENT OF INIDA

By

DEPARTMENT OF MECHANICAL ENGINEERING

KALASALINGAM UNIVERSITY

(Kalasalingam Academy of Research and Education)

ANAND NAGAR, KRISHNANKOIL – 626 190

VIRUDHUNAGAR DISTRICT, TAMILNADU

1. NAME AND FULL POSTAL ADDRESS OF THE INSTITUTION

Kalasalingam University
(Kalasalingam Academy of Research and Education)
Anand Nagar, Krishnankoil – 626 190
Srivilliputhur (via), Virudhunagar District
Tamil Nadu, INDIA

2. PROJECT TITLE WITH A BRIEF SUMMARY

"CENTRE FOR VIRTUAL AND ADVANCED MANUFACTURING"

Engineers and research scholars working in diversified fields of mechanical engineering will be brought together to address various issues associated with manufacturing; these technical experts will bring together their expertise to accomplish innovative knowledge to create novel ways of working, new principles, and most recent tools & techniques in order to make highly efficient manufacturing systems.

3. **Total cost of the project :** Rs. 29 Crores

4. PROJECT SUMMARY

4.1 PREAMBLE

Any new product is aimed at optimal efficiencies in design, manufacturing and its operational performance. It necessitates modeling and simulation of the product while it is in the design phase and at times during the conceptualization stage itself. In the world of competitive market it is imperative to ascertain optimal products and processes ensuring minimum cost, environment friendliness, adequate safety and competitive prices to avoid costly modifications/changes in the design of the product and processes at the time of or after launching the products. This can be achieved only through modeling, simulation, analysis and testing of products and processes during the planning phase.

In the global market, with the ever-changing needs and demand of the customers, products (both the industrial and consumer products) need to undergo changes with a view to improve upon their functional and aesthetic values. Hence, any inevitable change in the existing design or manufacturing methods or processes also calls for modeling, simulation, analysis and testing of any subsystem or the whole system under investigation. During its application, any product undergoes complex thermal and/or mechanical stresses and when it exceeds the predefined limits, the actual performance characteristics of the product show wide deviation from the specified. The visualization, understanding the basis and subsequent corrective measures are possible only through modeling, simulation and testing of the existing system. It is possible to test the modifications/changes with the model itself before they are actually implemented in the real system.

Hence for any developing country like ours, the need of the hour is to establish centers for virtual and advanced manufacturing. As simulation experiments are conducted in the laboratory, only on the model of the real system, the industrial experts seldom have faith on the results of the simulation. Hence it is imperative to build the confidence in them about the modeling, simulation, analysis and testing, by proper training through this kind of centers.

4.2 OBJECTIVES OF THE CENTER

The primary objectives of the proposed center will be

- To cultivate the practice of modeling and analysis before any product design is certified for manufacturing in Industries (to avoid costly modification in future)
- To evaluate the performance of any end product, model the performance characteristics, simulate and experiment the performance of the model for the changes in the operating parameters (to effect the improvement in the performance of the end product)
- To analyze the existing processes/system through modeling and experimentations, diagnose the causes for poor performance and suggest process modifications. The resulting effect of process modification on the equipments/machinery/product will also be studied through modelling and simulation of the relevant subsystems for any change in the system design (to ensure the optimum functioning of the overall system)

- To indigenize the critical components/spares of the imported machinery through reverse engineering (To validate the design procedure through simulation of the model created with the help of 3D scanning and rapid prototyping).
- To attain new knowledge to create new ways of working, new principles, and new support tools in order to create highly efficient manufacturing systems.
- To train the experts/end users of the industry in model building, simulation and analysis (to build the confidence and faith in the results produced through the virtual modeling and simulation experiments).

Besides these, the most fruitful outcome of this center would be that all the budding engineers passing out of the institute and getting employed in various industries will have hands on experience with real-time projects of the center. Beyond imparting knowledge and skill to the students, the center will inculcate the habit of modeling, simulation and testing in them to practice in their profession, which is the very need of the industry.

The purpose of this center is to be a technology power house in manufacturing related technologies. It has teams of experts focused on different aspects of manufacturing technologies. Expert teams will focus on the

- development of new state of art manufacturing technologies,
- disseminate these technologies to the Students and Industries

4.3 METHODOLOGY TO BE ADOPTED TO ACHIEVE THE OBJECTIVES

- Collaborations with prospective Manufacturing Industries/Institutions in India and Overseas.
- Problem Identification and selection in consultation with Industrial Experts/R&D organisation
- Methodology formulation, model design, model development, tool and techniques selection, problem solving (tobe carriedout in the proposed center, Kalasalingam University)
- Performance measurement, testing and validation (tobe carriedout in the collaborating institutions/organizations)
- Implementation, filed testing, refinement of the solutions.

- Periodically organize advanced training programs/specialized courses to the students/industrial persons
- Periodically organize special lectures/expert lectures/group discussions to the students/industrial persons

4.4 POSSIBLE OUTCOMES

- Technology transfer and exchange of experience in the area of Manufacturing
- Networking of experts and resource persons in the area of virtual and advanced manufacturing
- Advanced tools and techniques for Automated Manufacturing system
- Efficient Manufacturing system for industries and enterprises.

4.5 STIPULATED PERIOD OF COMPLETION: 5 Years

5 INTRODUCTION

Fluctuation of production volume caused by the recent variation of the demands and increased production volume at the time of putting a new model into the market is giving negative influences on the production efficiency. In recent years, such fluctuation tends to occur more and more frequently due to the changes in customers' needs, market trend, and so on. Manufacturing Flexibility is seen as the key answer for surviving in markets characterized by frequent changes and evolutions of the technological requirements of products.

It is significant to master increasing versatility, shorter product cycles, volatile markets and new product innovations with profitability right from the outset and with a minimum of risk. These emerging requirements with respect to flexibility and scalability are too big a challenge for contemporary automation solutions and production systems. Even modern systems fail to reduce time and overheads required for retooling, reprogramming and the production downtime that they entail. Adaptive, reconfigurable production systems program themselves within a couple of minutes, instead of taking hours or even days. At the same time, they adapt to accommodate new products or variants, thus removing the weaknesses of legacy systems. This gives us the ability to produce more flexibility and conquer new markets.

Faculty at the department of mechanical engineering at Kalasalingam University (KLU) has diversified fields of research interests from design, manufacturing, materials and industrial engineering applications. They are interacting with each other and complement their research expertise to form a network to work on virtual and advanced manufacturing.

The proposed center will have the entire infrastructure facilities required to adequately model, simulate and analyse any kind of manufacturing system. It will have facilities to test critical components before the conclusions are derived through analysis. The key focus areas of this center is

- Virtual Reality Applications in Manufacturing
- Automated Manufacturing
- Precision Machining and advanced testing
- Rapid Prototyping

5.1 PRESENT STATE OF THE ART

Based on the literature review, identified gaps in these research and application efforts, the present an outlook for the future of Virtual Manufacturing (VM) technologies

- Existing design technology is mainly focused on supporting detailed design activity. CAD software systems, while providing increasingly sophisticated means of manipulating shape and form represented in the computer, are poor at representing the information critical at conceptual design. For VM to have an impact on this critical phase of design, it will be crucial in next-generation systems to seamlessly integrate conceptual-stage design analysis tools into some form of conceptual design system that can effectively aid designers in creating and managing the ideas that will eventually lead to a shape to be manufactured.
- Virtual manufacturing requires a robust information infrastructure that comprises rich information models for products, processes and production systems. Despite the large effort of the International Standards Organization (ISO) to develop product information models, there has been a substantial lag in the adoption of

these models by CAD vendors and industry. Furthermore, although modeling of manufacturing processes has been the subject of vast research in the engineering and material science fields, there has been little work to use sophisticated process models in an integrated fashion with product design. Finally, there are at least two views of the production system that needed to be supported for virtual manufacturing: Representation of the system's capabilities and performance (static view), and representation of the system's dynamical behavior (dynamic view). The existing work in this area needs to be enhanced and integrated. Thus, substantial research is necessary to develop the information infrastructure of VM.

- Virtual manufacturing, when mature, is expected to greatly support assessing the manufacturability of a candidate design and to provide accurate estimates for processing times, cycle times and costs (including inventory), as well as product quality. This is because VM will be able to model both the processes employed for the product's manufacture and the production process. The potential of VM to support manufacturability assessments and provide accurate cost, lead time and quality estimates is a major motivation for further research and development in this area.
- Virtual manufacturing (VM) may play a significant role in distributed manufacturing, since it may improve design critiquing and process planning. These improvements will result in better designs and more informed partner selection. Furthermore, VM is expected to support distributed design if it provides protocols and computer aids for negotiation.
- Virtual environments may provide visualization technology for VM and the Virtual Prototyping may provide technology for making virtual prototypes, which is an essential component in the virtual product life cycle, for VM. The technologies from virtual enterprise, such as information exchange protocols and standards, can benefit VM.
- Virtual Manufacturing can provide an application environment for the technologies from the virtual reality and virtual prototyping. VM may provide information about the product, process, production, and shop floor control to be shared over networks.

During the past several years many analytical based techniques (Isermann et al, 1997) have been proposed for the fault diagnosis of technical plants. The important aspect of these approaches is the development of a model that describes the 'cause and effect' relationships between the system variables using state estimation or parameter estimation techniques. The problem with these mathematical model based techniques is that under real conditions, no accurate models of the system of interest can be obtained. In that case, the better strategy is of using knowledge based techniques where the knowledge is derived in terms of facts and rules from the description of system structure and behaviour. Classical expert systems (Venkatasubramanian et al, 2003) were used for this purpose. The major weakness of this approach is that binary logical decisions with Boolean operators do not reflect the gradual nature of many real world problems. Fuzzy Logic based techniques have been proposed to develop fault diagnostic systems (Devaraj and Yegnanarayana, 1999). The advantage of fuzzy logic-based approach is that it gives possibilities to follow human's way of fault diagnosing and to handle different information and knowledge in a more efficient way. Recently Artificial Neural Network based methods (Leonard and Kramer, 1999) have been successfully applied for many pattern recognition problems.

In rotary systems, such as pumps, compressors, gearboxes, turbines, etc., the vibration and noise signal are commonly used for condition monitoring. The vibration profile provides a good indicator of the status of operation, since it changes with any fault developing in a vibrating structure. Various methods have been developed for identifying faults in vibration signals, demonstrating varying degrees of success. Fault are detected and diagnosed by analyzing signals with fault features. The Fourier transform (FT) can be used for analysis of non-stationary signals, but the Fourier spectrum does not provide any time-domain information about the signal. Recently, the Short-Time Fourier Transform (STFT) and the Wavelet Transform (WT) (Xieping Gao, 2002; Zhang Yali, 2004), have been introduced in the analysis of transient signals. Wavelet transformation is a good tool for time-frequency localization. It could characterize non-stationary signal locally and self-adaptively (Stefanos, 2002). A LabVIEW based data acquisition system for Vibration Monitoring and Analysis (Asan Gani, 2002) and Lab VIEW Application for analysis of mechanical vibrations from industrial environment (Ioan Lita et al 2005).

Today there is a high demand for high-precision products. Precision Manufacturing provides an introduction to precision engineering and manufacturing with an emphasis on the design and performance of precision machines and machine tools, metrology, tooling elements, machine structures, sources of error, precision machining processes and precision process planning. As well as discussing the critical role precision machine design for manufacturing has had in technological developments over the last few hundred years. In addition, in the area of machining in order to achieve good precision and accuracy, proper understanding on the machining parameters of both conventional and non-conventional methods are needed. Excessive tool wear and the formation of build up edges in the conventional machining like turning, drilling milling, lapping, honing, etc. makes finished products become less accurate [Abdullah Kurt, 2009 & Ding et.al., 2005]. Hence many researchers focused on the unconventional machining like electrical discharge machining [Muller et.al., 2000], abrasive jet machining [Adnan Akkurt, 2009], laser beam machining [Anoop et. al., 2009], etc. on the machining of hard materials. Still in the area of tool wear monitoring, better process control, etc. could be identified as the challenging field [Ibrahim et. al., 2009].

In the field of manufacturing, could be machining, joining, casting, etc. the role of property testing and characterization plays a vital role. The effective testing and characterization leads to proper understanding the manufacturing process, errors etc. Mechanical properties like tensile strength, hardness, fatigue strength, creep strength are investigated by many researchers [Antich et. al., 2006 & Harish, et.al., 2009]. Main focus is given to improve the properties by varying the process parameters and/ or introducing new processing methods [Winowlin et. al., 2008 & Parker, 1980]. Fractography with the help of scanning electron microscope gives a better understanding of the material properties. The metallurgical changes like crystallization, precipitation, etc. which modifies the mechanical and other properties need additional attention. X-ray diffractometer [Das et. al., 2007], FTIR [Bessadok et. al., 2007], DSC and DTA [Nikki, et. al., 2007] could be effectively used in this domain. The quality of characterization could be further improved by the proper usage of Atomic Force Microscope and Transmission Electron Microscope [Tanem et. al., 2009 & Lindquist et. al., 2009]. Hence the Advanced Testing group will be improving the qualities of the manufacturing process and the basic research by means of effective testing and characterization.

5.1.1 Literature Reference:

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5.2 FUNDING AVAILABLE FROM OTHER SOURCES

NIL

5.3 LEVEL OF INFRASTRUCTURE AVAILABLE WITH REFERENCE TO TECHNOLOGY UNDER CONSIDERATION

Basic equipment/machineries/software and other needed infrastructure facilities for the initiation of the work are available in Kalasalingam University, Krishnankoil.

5.4 NATURE OF ONGOING ACTIVITIES PERTAINING TO PROJECT UNDER SUBMISSION IN THE INSTITUTION

- Optimization in automated manufacturing systems, with an objective of ensuring flexibilities of the systems, maximizing the system utilization, maximizing the tool life, minimizing the running costs, maximizing the customer satisfaction through zero defects, minimum manufacturing lead times and so on.
- Flexible Manufacturing Systems-An Integrated approach to automate production operations.
- Parallelization of a Multi-Objective Evolutionary Algorithm Designed for Scheduling of FMS
- High precision assembly modelling using selective assembly to minimize clearance variation without sacrificing the benefit of manufacturing with wider tolerance.
- Characterization and Mechanical property testing of new materials like metal matrix, polymer matrix composite materials, Crystallization behavior of deposits using XRD and DSC.
- Influence of hybridization of natural fiber composites on mechanical properties
- New Approaches for Electroless Deposition Process to Improve the Ni Recovery through Floatation-Adhesion Model

- Machining studies on functionally graded composite materials
- Optimization of Cellular Manufacturing System using intelligent heuristics
- Manufacturing Cell Formation Using Neural Networks
- Fractional Cell Formation Using Neural Networks
- Remote Manufacturing system
- Optimization studies in Supply Chain Management
- Study and analysis on conjugate thermal system
- Development of Intelligent System for fault diagnosis in rotary equipments.
- Fuzzy System Approach for Fault Diagnosis in LPG Bottling Plant
- LabVIEW based data acquisition and analysis for condition monitoring of rotary equipments.
- Software Based Measurement and Control System for Building Parameters Using Virtual Instrumentation
- Machining studies and influence of cutting force on the surface integrity.
- Machining studies on bimetallic piston with CBN tool through Taguchi Method

6. BUDGET (*Please See ANNEXURE I for details*)

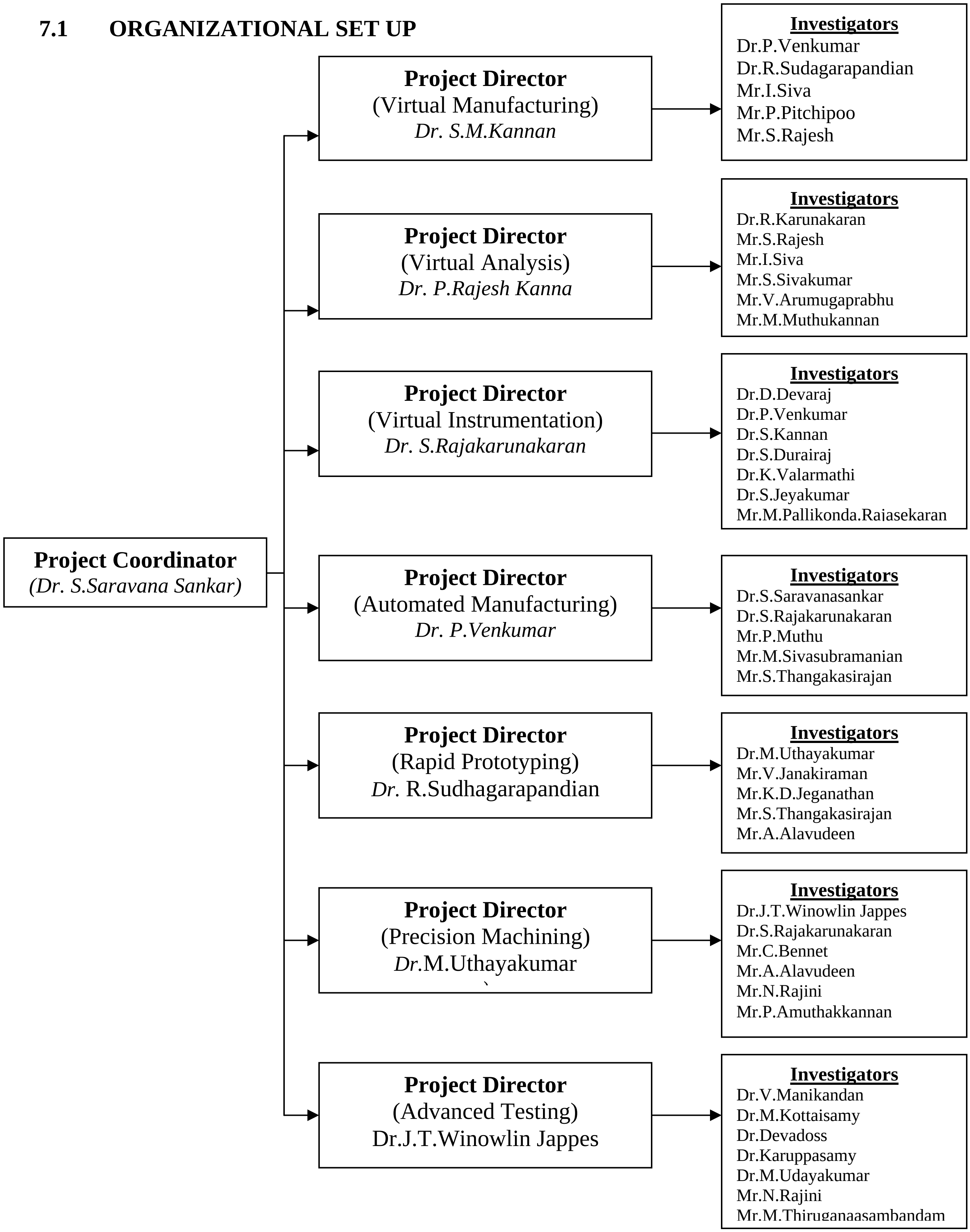
	I year	II Year	III year	IV Year	V Year	Total
a. <u>Non-Recurring</u>						
Equipments/Machineries/ Operating softwares*	10,55,00,000					10,55,00,000
b. <u>Recurring</u>						
Salaries						
Professor (1/stream)	63,00,000	63,00,000	63,00,000	63,00,000	63,00,000	3,15,00,000
Assistant Professor (2/stream)	84,00,000	84,00,000	84,00,000	84,00,000	84,00,000	4,20,00,000
Lecturers (4/stream)	1,00,80,000	1,00,80,000	1,00,80,000	1,00,80,000	1,00,80,000	5,04,00,000
JRF (8/stream)	1,00,80,000	1,00,80,000	1,00,80,000	1,00,80,000	1,00,80,000	5,04,00,000
Consumables	40,00,000	15,00,000	15,00,000	15,00,000	15,00,000	1,00,00,000
Contingency	3,00,000	3,00,000	3,00,000	3,00,000	3,00,000	15,00,000
Travel	3,00,000	3,00,000	3,00,000	3,00,000	3,00,000	15,00,000
Total						**29,28,00,000**

* Breakup details for Non-Recurring (Equipments/Machineries/Operating softwares)

S.No.	Stream	Amount
1.	Virtual Manufacturing	90,00,000
2.	Virtual Analysis	25,00,000
3.	Virtual Instrumentation	75,00,000
4.	Automated Manufacturing	90,00,000
5.	Rapid Prototyping	1,25,00,000
6.	Precision Machining	2,50,00,000
7.	Advanced Testing	4,00,00,000
Total		10,55,00,000

7. PLAN OF EXECUTION OF PROJECT

7.1 ORGANIZATIONAL SET UP



7.2 **PRINCIPAL INVESTIGATOR WITH DESIGNATION**

- Dr.S.Saravana Sankar, Senior Professor and Head
- Dr.S.M.Kannan, Senior Professor
- Dr.P.Venkumar, Professor
- Dr.J.T.Winowlin Jappes, Professor
- Dr.S.Rajakarunakaran, Associate Professor
- Dr.P.Rajesh Kanna, Associate Professor
- Dr.R.Sudhagarapandian, Associate Professor
- Dr.M.Uthayakumar, Associate Professor

Please see AnnexureIV for bio-data of PIs

7.3 NAME OF THE FACULTY AND OTHER INVOLVED WITH DESIGNATION AND FIELD OF SPECIALISATION

Name	Designation	Specialization
Dr.S.Saravanasankar	Senior Professor	Industrial Engineering
Dr.D.Devaraj	Senior Professor	Power System Engineering
Dr.P.Venkumar	Professor	Industrial Engineering
Dr.J.T.Winowlin Jappes	Professor	Manufacturing Engineering
Dr.V.Manikandan	Professor	Manufacturing Engineering
Dr.S.Kannan	Professor	Power Systems Engineering
Dr.S.Durairaj	Professor	Power System Engineering
Dr.M.Kottaisamy	Professor	Materials Science
Dr.Karuppasamy	Professor	Material Science
Dr.S.Rajakarunakaran	Associate Professor	Industrial Safety Engineering
Dr.R.Sudagarapandian	Associate Professor	Industrial Engineering
Dr.R.Karunakaran	Associate Professor	Refrigeration & Air conditioning

Dr.M.Uthayakumar	Associate Professor	Production Engineering
Dr.S.Jeyakumar	Associate Professor	Thermal Engineering
Dr.K.Valarmathi	Associate Professor	Process Control and Instrumentation
Mr.A.Alavudeen	Assistant Professor	CAD/CAM
Mr.M.Pallikonda.Rajasekaran	Assistant Professor	Bio Medical Signal Processing and Instrumentation
Mr.P.Muthu	Selection Grade Lecturer	Production Engineering
Mr.M.Thiruganaasambandam	Selection Grade Lecturer	Energy Engineering
Mr.V.Janakiraman	Selection Grade Lecturer	CAD/CAM
Mr.C.Bennet	Selection Grade Lecturer	Energy Engineering
Dr.Devadoss	Senior Lecturer	Materials Science
Mr.N.Rajini	Senior Lecturer	Engineering Design
Mr.P.Pitchipoo	Senior Lecturer	Industrial Engineering
Mr.I.Siva	Senior Lecturer	Manufacturing Engineering
Mr.S.Sivakumar	Senior Lecturer	Maintenance Engineering & Management
Mr.M.Sivasubramanian	Senior Lecturer	Manufacturing Engineering
Mr.V.Arumugaprabhu	Lecturer	CAD/CAM
Mr.M.Muthukannan	Lecturer	Energy Engineering
Mr.S.Rajesh	Lecturer	CAD
Mr.S.Thangakasirajan	Lecturer	Manufacturing Engineering
Mr.K.D.Jeganathan	Lecturer	CIM
Mr.P.Amuthakkannan	Lecturer	Manufacturing Engineering

7.4 SUGGESTED PLAN OF ACTION FOR DEVELOPMENT OF INFRASTRUCTURE

The University will provide the following infrastructure facilities:

Sr. No.	Infrastructural Facility
1.	Workshop Facility
2.	Water & Electricity
3.	Laboratory Space/ Furniture
4.	Standby Power Generator
5.	AC Room or AC
6.	Telecommunication including e-mail & fax
7.	Transportation
8.	Administrative/ Secretarial support
9.	Information facilities like Internet/ Library
10.	Computational facilities
11.	Guest House

Additional required infra structural facilities, if any will be developed based on the need of project requirement.

7.5 PLAN FOR INTERNAL MONITORING AND EVALUATION OF PROGRESS IMPLEMENTATION, IF APPROVED

Proposed plan for internal monitoring and evaluation of progress:

- Formation of Monitoring committee (comprises both internal and external experts). Monitoring the progress of the center (every six months).
- Formation of Evaluation committee (comprises experts from industries and R&D organization). Evaluate the progress of the center (Research publications, Expert lectures/training programmes organized, industrial case studies, etc.)

8.0 LIST OF RESEARCH PUBLICATIONS IN THE CONCERNED OR ALLIED AREAS

Please see AnnexureII

9.0 EXISTING FACILITIES CONCERNED WITH THE PROJECT UNDER REFERENCE

Please see AnnexureIII

10.0 ANY LINKAGE WITH SISTER INSTITUTION, RESEARCH LABORATORIES, INDUSTRY AND OTHER AGENCIES. IF YES, GIVE NAMES. STATE WHETHER MOU HAS BEEN SIGNED.

Probable Indian industrial collaborations:

- Keane India Limited, Chennai
- FLSmidth, Chennai
- TAFE, Madurai
- TVS Group of Industries, Chennai
- Robert Bosch, Coimbatore
- Cethar Vessels, Trichy
- CMTI, Bangalore
- L&T ECC, Chennai
- Hitec Arai Limited, Madurai

11.0 IS IT AN INTERDISCIPLINARY PROJECT? IF YES, NAME THE PARTICIPATING DEPARTMENTS.

Yes. The participating departments are

- Department of Electrical and Electronics Engineering
- Department of Electronics and Communication Engineering
- Department of Electronics and Instrumentation
- Department of Computer Science and Engineering
- Department of Chemistry

Dr. S. SARAVANA SANKAR
Senior Professor and Head
[Project Coordinator]
Department of Mechanical Engineering
Kalasalingam University

Dr.C.Thangaraj
Vice Chancellor
Kalasalingam University