Knowledge Transfer Partnership Project as an Example of Best Practices for Innovation in the UK Lift Industry

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Abstract. This paper outlines the process, and provides an insight into the best practices that were implemented throughout the course of a Knowledge Transfer Partnership (KTP) project undertaken to develop an innovative Machine Room Less (MRL) lift system. The particular attention on Knowledge Transfer Partnerships, project management, composite materials, design process and new technology allows for evaluation of the effectiveness of the KTP scheme.

1 INTRODUCTION

Global economy and unrestricted access to products and markets forces companies in developed countries to have a continuous improvement and innovation strategy in place. This is even more important for Small and Medium Enterprises (SME's) as the ability to relocate their manufacturing operations to save labour costs is limited by a number of factors. The active strategy of Innovate UK, a leading innovation organisation that works for and with the businesses allows for a significant boost of available resources and funding [1].

2 KTP PROJECT OVERVIEW

2.1 Knowledge Transfer Partnership

Knowledge Transfer is commonly defined as: "*the exchange of information through networks where knowledge transfer is about transferring good ideas, research results and skills from universities and other research organisations, to business and the wider community to enable innovative new products and services to be developed" [2]*.

Knowledge Transfer Partnerships is a programme in the United Kingdom helping businesses to improve their competitiveness and productivity using knowledge, technology and skills [3]. A KTP aims to meet a core strategic need and to recognise novel solutions to help that business grow. The rationale behind KTP projects is that the successful commercial exploitation of new ideas will require knowledge, skills, technology and adaptability in order to implement it. A number of selected case studies accessible on the KTP portal would increase understanding of the programme impact on UK economy [4]. The desired outcome of a KTP project is to embed new capability into the company, improve efficiencies, optimize business performance, define arising business opportunities and to bring new technology to the market.

It is proven that "*businesses acquire new knowledge and expertise which is related to tangible outcomes on a large scale. For every £1 million of government spend the average benefits to the company amounted to a £4.25 million annual increase in profit before tax, £3.25 million investment* *in plant and machinery with 112 new jobs created and 214 company staff trained as a direct result of the project. [5]*.

2.2 Project Stakeholders

Project stakeholders include the company partner, the knowledge-base partner, KTP adviser, KTP sponsors and the associate. The company that can undertake a KTP Project is usually a UK based business (but in some cases it can also be a not-for-profit organization) regardless of size. The knowledge-base partner is a UK based higher education institution (HEI) which can be a public or privately funded university, college or research organization. The expertise of a knowledge- base partner would normally be aligned with the particular project. A KTP adviser is a mentor appointed to provide unbiased views on the project's progress and to provide solutions to any potential problems that could arise. KTP sponsors include Innovate UK and the company. The associate that is appointed to work on the project is a recently qualified graduate from a UK based educational institution. The associate is normally employed by the knowledge-base partner but is working at the company premises. Project progress and future actions were reviewed by the main stakeholders during Local Management Committee (LMC) meetings on a periodic basis. In the case of this project, the project team included three supervisors with both academic and professional qualifications, who were visiting the company on a regular basis and were able to advise on any related matter.

2.3 Project Benefits and Deliverables

In any project deliverables and products are the vehicle to acquire the benefits. For a company partner the benefits would include new knowledge and capability, enhanced performance and profitability. Although it is not always possible during a KTP project to deliver a commercial product, as the knowledge developed in academic institutions may need extensive or intensive adaptation to particular business applications, the real know-how obtained by the companies during the project allows for innovative change in businesses. This is quantitatively shown by statistical figures of annual increase in profit before tax and new jobs created [2]. In case of the knowledge–base partner, the acquired benefits would include enhanced knowledge, academic publications, research and teaching materials. The structure of the project would allow the associate to gain new skills related to technology, communication, management and organisation, and to increase competences by formal and informal training. A proportion of the project budget is reserved for the associate's personal development, allowing for career progress and increased employability. In this particular case, the associate working on the project had an opportunity to attend two week-long training sessions in project and business management. This training was critical to effective project management and understanding of project constrains. Additionally, the development budget allowed the associate to determine and attend a professional training in composite materials and relevant trade shows in line with project demands.

2.4 Project Proposal

It is an essential element of a KTP project that clear project objectives are communicated to all parties prior to commencement of any work. In case of any KTP Project the objectives need to be defined during the project funding application. These objectives were further clarified when the company and knowledge-base partner representatives agreed on the objectives which were written down in an initial project plan. At the grant application stage the original aim was defined as *to research, design, implement and embed an in-house mechanical design capacity to manufacture an innovative new range of energy efficient, green lifts*. This plan was drafted prior to the appointment of a KTP associate, therefore it was a base point for any possible developments in the future. This allowed preparation of a project proposal, where all known modern technologies, materials and solutions were outlined and analysed. Technologies were divided into energy storage, energy saving, energy regeneration, and energy generation. Most innovative and prospective options which were associated with highest risk were evaluated using a Strengths – Weaknesses – Opportunities and Threats (SWOT) analysis. This allowed for a constructive discussion by all parties in the project team.

2.5 Project Planning

The duration of this particular KTP Project was 18 months. Although the standardized PRINCE2 methodology in project management [6] could be implemented, it was found to be excessively bureaucratic and time consuming therefore a simplified methodology based on a Gantt chart was used during this project. Workload was initially divided into separate subsystems allowing for drafting an initial Gantt chart. This initial Gantt chart was reviewed and all necessary amendments were made where appropriate.

2.6 Project Management

Every project is unique, with different sponsor and stakeholder conditions, different goals and external factors. The successful delivery of a project requires all participants to work together as a team. Effective teamwork is based on both good informal and structured communications.

In the case of this KTP Project the communication means included: Local Management Committee meetings held every quarter, project team meetings held every month, weekly meetings and ad-hoc meetings with Company Supervisor, proposal submission (innovative technology or business opportunities as a result of research, meeting or visit to a relevant trade show), project presentations during LMC, meetings with Knowledge Base Partner using virtual meeting tools, email communication, preparation of agendas and meeting minutes, review of Gantt charts and project plans. Fig. 1 shows project drivers which are common for all projects that are undertaken by practicing engineers. It is evident that the risk of project failure must be minimized by ensuring the scope and quality of a project is achieved within specified timescales without exceeding a specific budget.

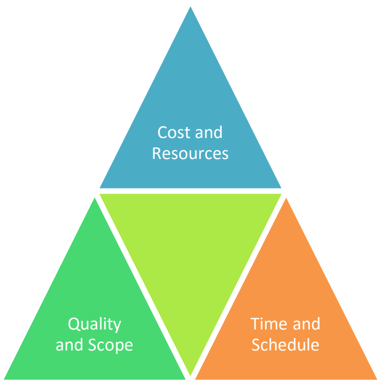

Fig. 1: Project Drivers

Project drivers were discussed by the Project Stakeholders during the early stages of the development allowing for a drafting of a comprehensive project plan based on KTP project proposal. During the project it has become apparent to the company that a large investment would be necessary to manufacture a new lift range. As a result the company decided to discuss partnership with established manufacturers of a standard range of components.

3 CASE STUDY

The case study to design a new, innovative Machine Room Less lift (MRL) includes use of a number of engineering techniques in order to optimise the design and installation process and reduce overall energy consumption throughout the product lifecycle of the proposed lift system.

Specification of a new lift system include: new, composite modular lift cabin, new drive with optimised selection of modern, coated rope suspension and Permanent Magnet Synchronous Motor (PMSM), Remote monitoring solution, and Energy monitoring capability (Fig.4). Although many of the technologies were previously successfully implemented in a lift system, the use of modern technology workflow in design, such as three dimensional Computer Aided Design (3D CAD) software, motion analysis, and Finite Element Analysis (FEA) including Composite Material Modelling constitutes a novel approach to a lift design. Apart from the main design, project work has also included the initial design of a new, adjustable counterweight system, studies on energy savings, energy monitoring devices, embedding load weighing device into remote monitoring and into a lift control system in order to determine lift energy consumption, improvements in functionality of a software based control system (standby and sleep modes), development of energy certification tool for all lifts, and research of laser alignment systems in lift installation.

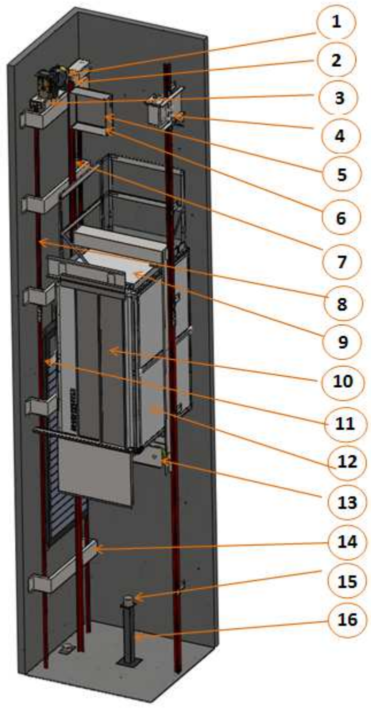

Fig. 2: 3D CAD model of a new lift system

The main benefits of the chosen methodology include reduced cost and time in product development. Additionally, 3D CAD along with motion analysis was used extensively to evaluate and visualize concepts, obtain feedback from stakeholders, communicate with customers and suppliers, and create General Arrangement drawings and manufacture drawings. Finite Element Analysis allowed determination of reaction forces in critical areas of the design. This significantly reduced the cost and time required to develop a product.

Advanced Composite Materials (ACMs) have broad, proven applications in aircraft, aerospace and sports equipment sectors [7]. Application of this technology in the lift industry is still marginal, as the financial benefits related to the cost of development are not as significant as in the previously mentioned sectors. The Knowledge Transfer Partnership scheme allowed us to minimize the cost of development with the help of the Knowledge-base partner. During the initial research a number of composite materials were evaluated, including fibre reinforced polymers (FRP) and glass reinforced polymers (GRP), and composite laminates with a number of core materials. The selected solution was a best option compromise between structural performance, mass and cost.

Mechanical performance of the structural components (including composite components) was evaluated using Finite Element Analysis (Fig. 5). Different operational scenarios were evaluated using Failure Mode Effect Analysis (FMEA) [8] and to limit the time of development the simulation work was concentrated only on worst case scenario loads. Results were confirmed using analytical calculations developed for composite panels (Fig. 6.).

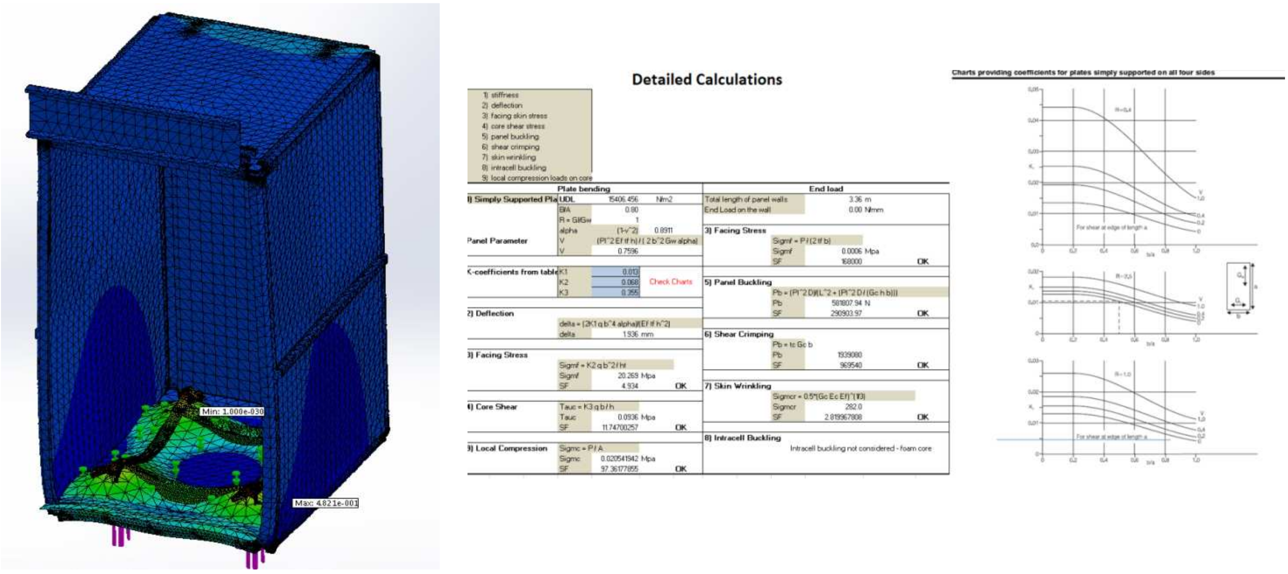

Fig. 3: Finite Element Analysis – plot of deflection of lift cabin and Composite Panel Calculations

Fig. 4: Prototype of a Cabin Floor under static load test

The FEA simulations allowed the most critical components in the design to be determined. This allowed the cost of development to be minimized, as it was only required to test the components in question. Tests performed by the cooperating company allowed the evaluation of material strength and the options made possible by using adhesive in the design. It has also allowed the full component build of the lift floor to be progressed. The work was carried out in a well-known strategy loop: Plan – Do – Check – Act. The development was also optimized for cost during the development and during Design for Manufacture stages.

A prototype of the floor was manufactured in the company using standard manufacturing procedures such as drilling, cutting, grinding, and adhesive joining. Welding, plasma cutting and waterjet cutting of structural members was done by cooperating subcontractors. Manufacturing procedures were documented in appropriate manuals associated with manufacturing drawings, required Risk Assessments and COSHH forms [9]. To ensure that the company benefits from the project design and manufacturing, a training package for manufacturing operatives was developed.

The lift system could be optionally equipped with a remote monitoring system which allows for determination of an efficient service schedule, thus reducing the costs to the maintenance company and the customer. In this case, the company had a remote monitoring system available which can also support a voice alarm transmission (iCOM), using GSM, for transferring data and voice utilising modern interface allowing for easy implementation into any architecture.

The system has modular design, allowing it to connect to other modules such as a continuous load monitoring module, temperature monitoring and even condition monitoring modules, which could monitor vibration in lift components that could indicate wear.

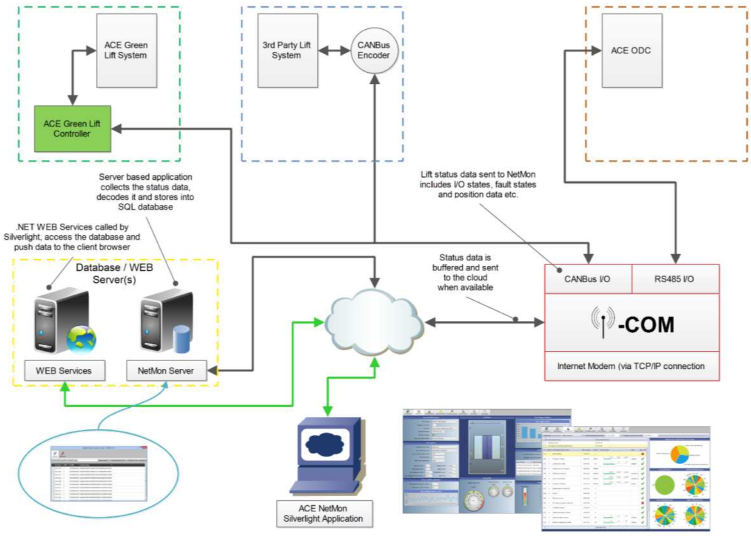

Fig. 5: Remote monitoring solution

The energy efficiency of any lift system could be benchmarked using interactive tools developed during the course of this project.

Although the full scale field tests of a new design were not feasible due to difficulties and associated cost, it is perceived that the energy efficiency and carbon footprint of a new design would be improved in many areas. Use of 3D CAD in design greatly reduces errors in the manufacturing (time and material waste) as the component can be evaluated in 3D prior to manufacture. A composite cabin has a potential of reduced mass, which would allow the use of a counterweight system of smaller weight, thus reducing both costs of materials, system footprint and installation time and effort. A composite cabin designed and built in the UK would also reduce the project footprint as the lead time can be shortened with an additional benefit of much better customer experience and flexibility in the design. A modern control system, with monitoring capability and energy saving modes would be beneficial in delivering greater benefits in energy consumption.

4 CONCLUSIONS

Development of the project was associated with many challenges and risks. It was possible to minimize the risks and turn challenges into opportunities by effective teamwork of the project team.

The technology of a design process of a new lift range and manufacture of a new composite cabin was successfully researched and embedded into the company. In a design process all required components were appropriately selected, ensuring energy efficiency and suitability for application in a new range of lifts. All required calculations and tools allowed us to design and specify the mechanical side of a complete lift system.

The energy efficiency was addressed in many areas of the project, including:

- the initial design of a new, adjustable counterweight system and studies showing possible savings achieved by using the new system,
- using energy monitoring devices on a standard range of lifts to determine real values of energy consumption in a lift system,
- embedding a load weighing device into remote monitoring and into a new range of control systems in order to determine lift energy consumption,
- improvements in functionality of a software based control system (standby and sleep modes),
- development of energy certification tool for all lifts,
- research of laser alignment systems in lift installation.

Business performance was discussed in many cases throughout the project duration; examples include optimisation of the manufacture and design of a standard lift control system (decreasing the cost and size of components) and use of energy certification tool in sales and marketing. During the project the Associate has also contributed to the company operations, gaining knowledge and helping in design, planning and project management activities on a number of occasions.

The Associate has acquired a wide range of knowledge related to the lift sector. In many areas the project was successful and allowed us to embed new capability into the company, to fill knowledge gaps, improve the design process, improve new project development, improve quality and efficiencies, propose solutions to optimize business performance, propose new business opportunities and to bring new technologies to the market. The knowledge-base partner has acquired understanding related to the lift market, real life implications, constrains and problems in the small enterprise and knowledge of all activities within the project which would allow for further innovations in the field of vertical transportation.

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BIOGRAPHICAL DETAILS

Rafal Kwiatkowski graduated in 2013, achieving Master in Mechanical Engineering and Energy Engineering at Heriot Watt University in Edinburgh. Between 2013 and 2015 he has been working on a development of a Green Lift at ACE Lifts Ltd.

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Stefan Kaczmarczyk is Professor of Applied Mechanics at the University of Northampton. His expertise is in the area of applied dynamics and vibration with particular applications to vertical transportation and material handling systems. He has been involved in collaborative research with a number of national and international partners and has an extensive national and international track record in consulting and research in vertical transportation and lift engineering. He has published over 90 journals and international conference papers in this field.

Charles Salter is the owner and Managing Director of ACE Lifts. He has over 35 years of lift industry experience, 25 of those establishing and running ACE Lifts (formerly Artisan Control Equipment). His area of expertise is in the electronic aspect of lifts; specifically control systems and remote monitoring and has contributed to a number of industry texts regarding these. Charles is currently studying for an MSc in Lift Engineering at Northampton University.

Laurel Mulhern is the Sales and Marketing Manager at ACE Lifts Ltd.