Implementing Time Compression Technologies to Assist Small to Medium Size Enterprises for Product Development

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ABSTRACT

Computer Aided Engineering (CAE), Computer Integrated Manufacture (CIM), Rapid Prototyping (RP), and Information and Communication Technology (ICT) are all modern engineering methods whose benefits are well recognised by large organisations who have the resources, knowledge and technical expertise to implement the above. Time Compression Technologies embrace all of the above systems and technologies for the benefit of manufacturing industries. The current paper presents, through case studies, a systematic approach of introducing, educating and training personnel in small to medium size enterprises (SME'S) the benefits of implementing Time Compression Technologies.

The project is part of a collaborative programme with the North East Universities in the United Kingdom, and is funded by the Government Office North East and European Regional Development Fund.

Key Words – Time Compression Technologies, Rapid Prototyping, Computer Aided Engineering (CAE), Information & Communication Technology (ICT)

1.0 BACKGROUND TO RCAE PROJECT BEING FORMED

The Economy of the North East has been transformed in the last 25 years.
During 1981 – 1986 over 55 000 jobs in primary industry and 80 000 jobs in the manufacturing industry were lost. Many of the lost jobs were due to the decline of the ship building industry and decommissioning of working coal mines *[1]*.

A detailed local economic study carried out by the Centre for Regional Development Studies (CURDS) showed that the Over 99 % of the regions companies are Small Medium Sized Enterprises (SME's), with 95 % being small (less than 50 people) *[2]* as shown in figure 1.

Small Medium Enterprises (SME'S) can be categorised by the following defining factors,

- Less than 250 employees
- Turnover of less than 40 million Euros

A Regional Economic strategy was developed by the North East Regional Assembly and One Northeast which served as a milestone, being the first such strategy of its kind for this region.
The Regional Economic Strategy (RES) will help to deliver change and deliver success by allowing the region to unlock its potential by implementing the following strategies,

- Creating a knowledge driven Economy
- Establishing a entrepreneurial Culture
- Building an adaptable highly skilled work force.
- Placing Universities at the heart of the regions economy

Information and knowledge are replacing capital and energy as the primary wealth creating assets.
In the 20th century technological developments have resulted in the major source of wealth creating work changing from physically based work to knowledge based.

The key factors now driving the economy are knowledge and technology, creating what is termed a knowledge driven economy *[4]*.

An interdisciplinary project which addresses the Regions Economic Strategy (RES) was proposed by three of the Northeast of England's Higher Education establishments each having their unique expertise and experience that contribute to the foundation and delivery of the project.

The Regional Computer Aided Engineering Project (RCAE) was proposed to help establish and assist Small to Medium sized Enterprises (SME'S) in the North East of England to become further advanced in Computer Aided Engineering (CAE) and thereby improve their competitive position. Nationally & Internationally.

The project serves to inform, train, and assists SME's in the use and application of a range of Computer Aided Engineering tools and techniques.
The project is part funded by the European Regional Development Fund (ERDF), other public sources and private sector contributions.

The financial Model of the project is a 40: 40: 20 model this means;

40 % of total project cost subsidised by European Regional Development Fund (ERDF)
40 % Of Total project cost contributed by the Higher Education Institutions (HEI's) to cover project overheads.
20 % of total Project cost to be raised by Private Sector Cash generation through project activity.

This financial model has been used in previous ERDF funded projects and has proved successful.

2.0 BUSINESS PLAN

A comprehensive business plan was compiled for the project by two of the executive members.

2.1 Project Objectives

The Regional CAE project will bridge the gap between academic expertise and SME's needs by using the staff and student expertise in the partner organisations to provide intensive company specific consultancy to SME's.

A significant contribution will be made to improving the ICT knowledge base of manufacturing SME'S in the region , equipping them with the know how to exploit CAE technologies to their full advantage . Figure 1 shows countries for ICT application.

The Regional RCAE project will work with the RES to help improve graduate retention in the region.
"The North East's workforce has the lowest number of people with degrees or equivalents in the UK *[5]."* The numbers of workers with no qualifications in the Northeast is also well above the UK average shown in Table 1.how the UK compares with other
The project will help companies operate more competitively, with the prospect of developing new products and processes, winning new orders and creating and safe guarding jobs in the region.

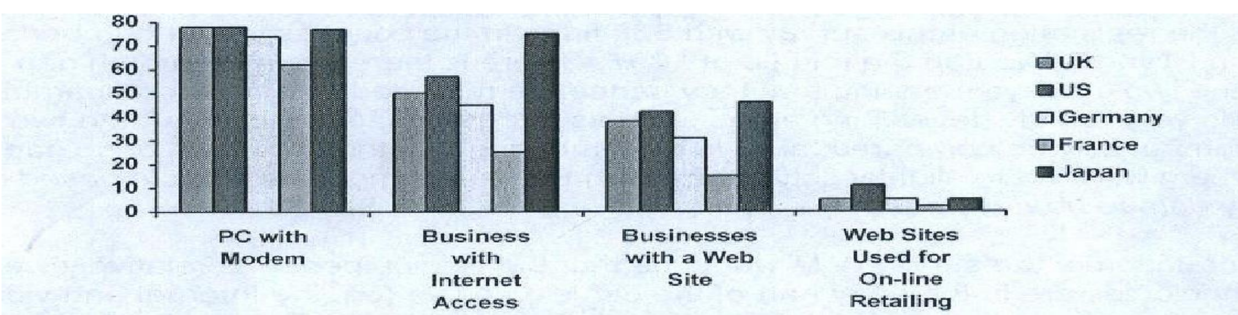

Figure 1: Benchmarking Progress with ICT's

Table 1: Proportion of population with degree level qualification 2001 *[6]*

Region Of Study	**Degree or Equivalent**	**No Qualification**
North East	**10.4**	**19.1**
UK average	15.2	16.4

The three Higher Education Institutes pooling their skills, knowledge and facilities have allowed for all areas of Computer Aided Engineering to be comprehensively covered.

The Regional Computer Aided Engineering project hopes to address the regions poor Research & Development investment which continues to lag behind other UK regions, as shown in figure 2.

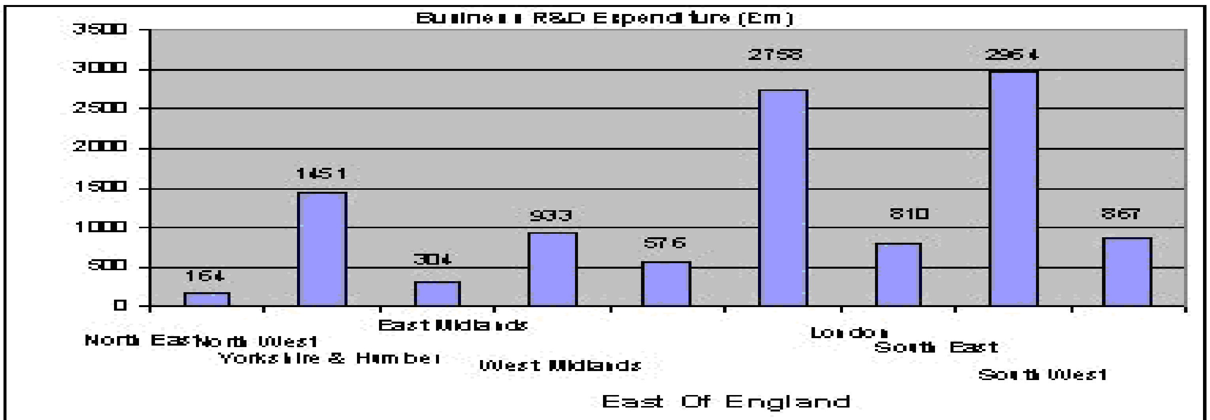

Figure 2 : Regional Expenditure on R&D by source of funding *[7]*.

A recent study by the Regional Technology Centre North, of a structured sample of over 350 Regional companies, found that those companies reporting an increase in turnover in the past three years were the companies who were more involved in product and process improvement and the use of ICT's *[8]*.
It has been recognised that the route to long term success lies in increasing investment, delivering greater benefit from innovation, encouraging best practise and improving skills levels to support growth and development in the region.

2.2 Project Delivery Partnership

Teesside University –Computer Integrated Manufacture (CIM) expertise and CAE based knowledge & facilities. Experience of participating in projects part funded by the Economic Social Fund (ESF) and the European Regional Development Fund (ERDF), Teesside serve as the lead partner in the project.

Northumbria University – Long serving industrial links in local industry. Very strong in CAE & Time Compression Technologies knowledge and facilities – specialising in Time Compression Technologies. Extensive manufacturing knowledge and expertise.

Durham University – Well established Red Brick University with good industrial links and an active student placement system in industry. Excellent Computer aided Design (CAD) computer labs and facilities.

The HEI's working in collaboration enables a regional coverage of a full range of CAE services that can be delivered locally.

2.3 Location

The project will operate across the North East of England in areas supported by Objective 2 funding as shown on the map in figure 3.

North East of England Objective 2 Programme Area:-
European money has been allocated to areas that have been classified as economically deprived due to recent social changes. Money has been allocated by the objective 2 programme. The objective 2 programme will bring over £500million to the region from 2000 – 2006.
Objective 2 funds are allocated to areas that are adjusting to industrial and service sector changes, which the North East complies with due to the decline of industries like coal mining, steel industry and recently the loss of major employers in the manufacturing industry *[9]*.
The North East Objective 2 region is divided into three classifications of eligibility for Objective 2 funding .The region is split into electoral wards and each ward has been classified as ,

- Core – These area's are the main target areas for the objective 2 funding, these areas have been deeply effected by the industrial and social changes and will suffer from high levels of unemployment.
- Transitional Areas - Transitional areas are wards that were eligible for the funding that was available during 1994 – 1999 under the Objective 2 Programme but did not qualify for the objective 2 funding for 2000 – 2005 although they are eligible for special funding to help them complete there social and industrial restructuring.
- Ineligible - These areas are financially prosperous with low levels of employment and virtually unaffected by the industrial changes that have affected the rest of the region. There are very few areas that are in this category in the North East.

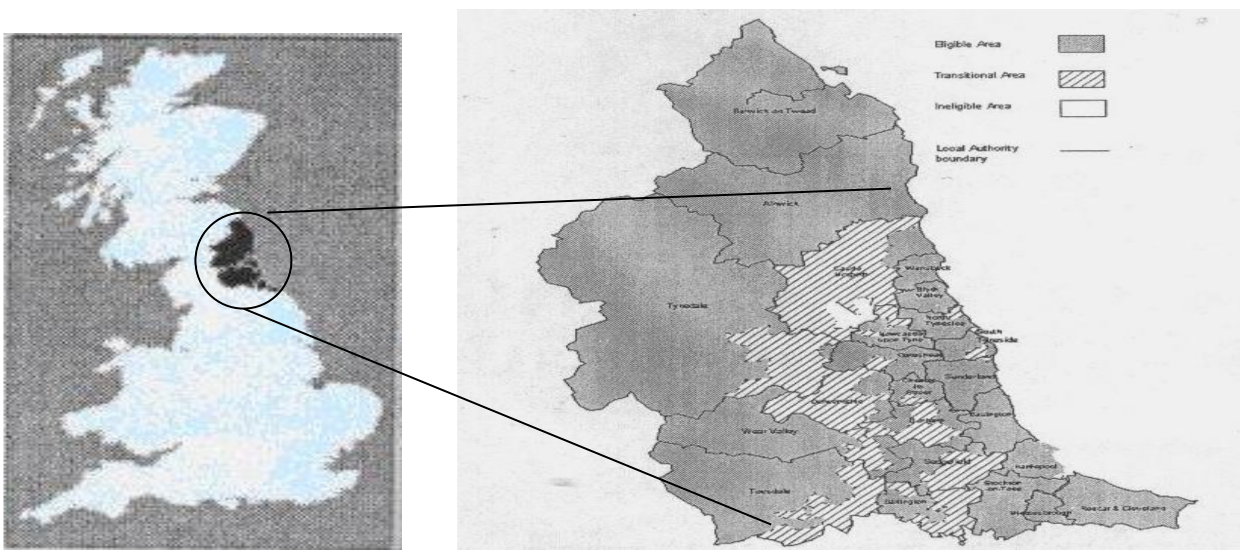

Figure 3: North East Objective 2 region *[10]*

Operating in Transitional areas was ruled out largely due to the small number of target SME's, coupled with the very short timescale now remaining for delivery in transitional areas, and made it unrealistic to plan effective delivery there.

2.4 Targets of Delivery
The Regional CAE project has targets split into two categories these being,

2.4.1 SME Assistance Targets
SME's to be given assistance categorised as;
O1.2 –10 – 24 Days Assistance
O1.3 –25+ Days of assistance

These SME's can receive assistance from the project Computer Aided Engineering developers or by structured and scheduled undergraduate and graduate placement programmes within companies.
Each participating HEI's offers a different industrial placement programme allowing problems of varying levels of complexity and duration to be solved.

The undergraduate and graduate industrial placement programmes serve as an integral part of the project and is key to attaining successful project delivery.
The Placement programmes offered by each Higher Education Institutes are as follows,

University of Durham (Type 1 Placement)	- Final Year MSc in Design Manufacturing & Management - 2 Weeks (2 undergraduates each placement)
University of Teesside (Type 2 Placement)	- Graduate Students on one year Advanced Manufacturing Systems (AMS) or Computer Aided Engineering (CAE) course. - 4 – 12 week placements
University of Northumbria (Type 3 Placement)	- Third Year of BEng Degree Course - 9 months Placement

2.4.2 Financial Targets

Table 2 shows the projects targets, these targets are split into two types of financial targets these are,

Specialist Consultancy: - This financial target is an in kind contribution which ERDF funding is matched to. This specialist consultancy target will be achieved from time contributed to the project delivery from sources that are not in the project partnership.
For example - CAE software vendors whom may give time demonstrating products and technologies to SME’s linked direct to project activities.

Private Sector Cash: - This target is a monetary target that must be achieved through project activity such as the cost of producing prototype parts or producing machining programmes for Computer Numerically Controlled (CNC) machinery. Each of the HEI’s from the partnership has specific knowledge and facilities that will help to achieve the project target.

Table 2: RCAE Project Targets & Results

Outputs/Results	Number
O1 SME's Assisted , of which	55
O1.2 SME's Receiving assistance of 10 - 24 days	15
O1.3 SME's receiving assistance of 25 Days +	40
R1 Gross New turnover in SME's	£3m
R2 Gross safeguarded turnover in SME's	£2.3m
R3 Gross new jobs created in SME's	65
R4 Gross safe guarded jobs in SME's	33
R5 SME Investment	£50,000
RR1 SME's Implementing outcome of assistance	45
RR2 No of RR1 Improving environmental performance	45
RR3 No of RR1 Improving application of ICT's	45
RR4 No of RR1 implementing new/improved products	20
RR5 No of RR2 implementing process improvements	20

2.5 Delivery Mechanisms

Project is centrally managed by University of Teesside, who also coordinate the service delivery from the other partner premises.

Project manager based at Teesside whose responsibilities include

- Taking central role in project delivery
- Networking
- Identifying new opportunities
- Project monitoring and reporting

The responsibilities the project manager has are vitally important elements to ensure the success of the project. Project officers have been appointed across the three sites to undertake delivery and coordinate SME'S project activity. The project officers have provided a range of services allowing them to have developed there own personnel skills and knowledge through the duration of the project , making all participating parties in the project further better informed and skilled through their involvement.

Progress meetings take place on a monthly basis where the project activity, performance, outputs and spend are monitored and discussed. These monthly meetings are imperative to the projects success.

2.6 Private Sector Involvement

Working in partnership with private-sector CAE technology providers the project will be instrumental in helping develop the market for their services.
Consequently the project has supported the expansion of private sector provision in the region.

2.7 Project Team

A dedicated project team was assembled from representatives of the partner organisations, University of Northumbria, Teesside and Durham with the following staffing structure,

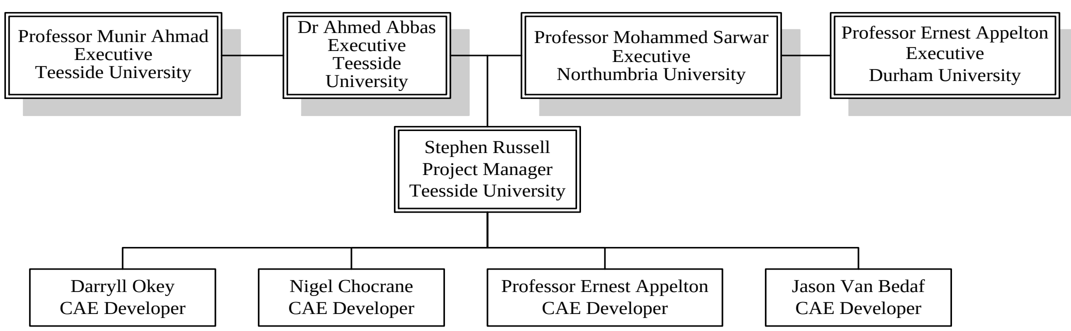

Figure 4: RCAE Project team Structure

2.8 ***Marketing & Promotion***

The project was promoted and marketed in parallel to project delivery in the following ways:

The Regional CAE was marketed on a regional basis and used the existing developed network of regional and sub-regional services, centres of excellence and business support services to promote assistance available to eligible regional SME'S.
The following mechanisms were used:

- Targeted marketing to SME'S within the core area
- Promotion via members of the project steering group
- Website presence
- Regional business support networks
- Links with other regional development programmes
- Technology and Knowledge transfer Events

ERDF support was strongly promoted through:

- Use of ERDF logo on letterhead and literature with acknowledgement of ERDF support at events
- Use of logo on all documentation for partner and beneficiary companies
- Promotion of support via project website and media releases
- Promotion via in-house publications receiving wide regional circulation, such as Universe, the University of Teesside's magazine.

3.0 CASE STUDIES

Case studies give a brief summary of project activity demonstrating direct assistance that SME'S have received resulting in product and process improvements, lead time reduction, increased profitability and improvements in quality.

3.1 Tech Projects Ltd Case Study

Background - Tech Projects Ltd is a local based company specialising in the design and manufacture of sheet metal products and associated machinery.

Enquiry - Tech Projects are constantly trying to enhance their customer base and the range of services that it can offer to their customers. A current customer had a requirement to replicate an assembly jig that had been damaged during welding, in a material that would withstand the wear and tear of everyday use in the workshop environment.

Actions - The staff in the Centre for Rapid Product Development in the School of Informatics, Engineering & Technology at Northumbria University worked with Tech Projects and utilised the following Computer Aided Engineering (CAE) technologies and expertise to meet the companies' requirements

- **Reverse Engineering -** Using the Renishaw Cyclone™ contact scanner. Point cloud data was collected for each part of the jig. The point cloud data was processed and a STL triangle file format was created so that the parts could be machined on a CNC milling machine at Northumbria University.

- **Computer Aided Manufacture (CAM) -** Using Delcam PowerMILL™ Computer Aided Manufacture software, tool paths were created to allow the parts to be machined

- **Manufacture -**Using the tool paths created using the CAM software; the parts were machined in aluminium using the Cincinnati Milacron ™ CNC at Northumbria University.

Benefits:

- New service available to customers
- Long standing Problem solved
- Cost effective solution reached
- Increased Productivity
- Enhanced ICT application
- Un rivalled lead time gained through implementation of CAE technologies

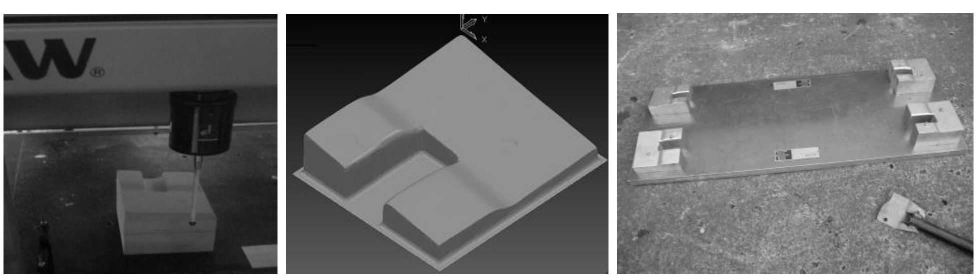

Figure 5: Steps of Reverse Engineering process for Jig Assembly

3.2 Kim Thomson Design Case Study

Background - Kim Thomson Design Specialises in the design and manufacture of contemporary jewellery predominately manufactured from acrylic sheet Pieces are displayed throughout the UK at exhibitions and galleries.

Enquiry - Limitations in terms of product range produced owing to current manufacturing processes have been experienced.
The staff at the Centre for Rapid Product development based in the School of Informatics, Engineering & Technology at Northumbria University worked with the company to utilise Computer Aided Engineering (CAE) technologies to overcome this problem.

Actions -The staff at the Centre for Rapid Product Development applied their extensive knowledge and expertise in Computer Aided Engineering Technologies to over come the problem including,

- **3D Computer Aided Design (CAD) -**Three products designs were modelled using SolidWorks™ 3D CAD software. This allowed design to be quickly and effectively produced. Using rendering techniques the 3D models could be visualised in the material that they were going to be manufactured in.
- **Rapid Prototyping -**Using the Envisiontec Perfactory™ Rapid Prototyping machine, which uses the Stereolithography process (SLA), prototype parts were produced in acrylic, which can be used directly as a master for building a shell around, to allow investment casting.

Benefits

- New Product range
- Enhanced application of ICT
- Pieces can be manufacture in different materials
- Reduced design lead time
- Reduced manufacturing lead time

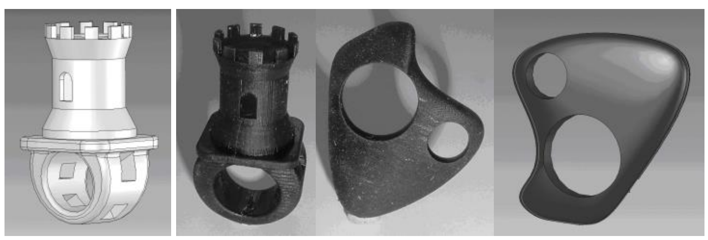

Figure 6:- Example of 3D CAD models and corresponding Rapid Prototyped parts

The reduction in lead times that can be achieved by implementing Time Compression technologies can be seen in Table 3.

Table 3: Time savings experienced through implementation of Time Compression Technologies

Task	Original Methodology	CAE Methodology (time taken hrs)
Component Design	5	3
Component Manufacture	9	3.5
Component Finishing	3	0.5
Total time	**17 Hours**	**7 Hours**

4.0 Discussion

The benefits to the project recipients and project providers can be summarised as:

4.1 Benefits to the North East Region

- Direct Assistance and advice provided for the implementation of CAE systems with SME's within the North East region.
- Provision of a regional impartial Resource for CAE related information, advice and guidance.
- Provision of structured support to assist companies in implementing CAE systems
- Company case studies generated via company based student placements
- Dissemination of Literature
- Network opportunities for Companies and project organisations

4.2 Benefits to University of Northumbria

- Regional exposure of University of Northumbria and raising its profile.
- Interdisciplinary activities with North East regional HEI's.
- Networking with SME'S and hence spin-offs for student placement, part time courses, consultancy.
- EC funding can introduce SME'S to the University.
- The project is in line with the UNN policy in bidding for larger bids, which are strategic and meet the needs of the School of Engineering and Technology

4.3 Benefits to the School of Engineering and Technology

- University and regional exposure of the School of Engineering and Technology with the North East HEI's and GONE.
- Introducing SME'S and their employees to the activities of The School of Engineering and Technology.
- Assisting with future industrial placements via the contacts made with SME'S.
- Possibility of future Knowledge Transfer Partnerships (KTPs)

- Undergraduate student projects.
- Enhancing student experience.
- Possible future students for undergraduate and postgraduate UNN courses.
- Opportunity for staff development at no additional cost.
- Production of learning material
    - CAD/CAM
    - Business Integration
    - Solid Modelling

  (A substantial output, which can be used as short course material/undergraduate students).

5.0 Conclusions

The clear conclusions that can be provided from the RCAE project are: -

- Delivered 'company specific' solutions to CAE-related particular technical problems in SME'S

- Developed and embed improved and increased CAE technical capacity and capability within SME'S.

- Provided an additional, technically CAE focused, resource for SME'S through the supply, and placement, of highly skilled and motivated young people.

- Facilitated and promoted graduate recruitment by SME'S, thereby increasing and improving engineering graduate retention within the region.

- Developed effective working relationships between Project partner development staff, university academic staff, and manufacturing SME'S in the selection and application of CAE tools and technologies.
- Established the use and application of CAE as the basis for the on-going development of a continuous improvement and innovative culture within the North East of England Region.

6.0 Acknowledgements

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