Plastics Industry

The following guidelines are intended to provide examples of "experimental development" projects which would qualify for Canadian SR&ED (Scientific Research & Experimental Development) tax credits.

Content Summary:

801 - New Materials - Example 1:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective
Heat distortion temp. (Deg C)	55	150
Minimizing detrimental properties (%)	90	95
Max cost increase ($ per batch)	450	485
Minimize defect rate (parts per batch)	40	1
Improve production speed (Units per min)	12	15

[NOTE: THIS PROJECT DESCRIPTION IS BASED ON THE CRA'S EXAMPLE OF AN ELIGIBLE PROJECT FROM THEIR SR&ED PLASTICS INDUSTRY APPLICATION PAPER: INFORMATION CIRCULAR 94-1, NEW MATERIALS, EXAMPLE 1]

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

An experimental development program is formulated to determine if a modified material can be produced to meet the new customer requirements of high heat distortion, while minimizing the introduction of other detrimental properties.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

- Internet searches: 17 sites / articles -- No sufficient info on high heat distortion found
- Patent searches: 5 patents -- Info on cross-linking of polymers but for different application
- Similar prior in-house technologies: 1 products / processes -- If current polymer could be successfully cross-linked it might meet required temp resistance.
- Queries to experts: 2 responses -- No solution on cross-linking and detrimental properties provided.

The polymer initially offered by Company X cannot meet the high heat distortion requirement of a new application opportunity. The company understands the principle of cross-linking of polymers, and formulates the hypothesis that if it's currently offered thermoplastic polymer could be successfully cross-linked, it could form a thermoset polymer during customer processing that then might achieve the temperature resistance required for this new application. However, Company X is uncertain about the degree of cross-linking that might be required, and the other detrimental properties that might be unavoidably introduced.

Field of Science/Technology:

Materials engineering & metallurgy (2.05.01)

Intended Results:

- Improve existing processes
- Improve existing materials, devices, or products

Work locations:

Commercial Facility

Scientific or Technological Advancement:

Uncertainty #1: Degree of cross-linking

What degree of cross-linking is required in the polymer to meet the high heat distortion requirement of the new application opportunity?

Which other detrimental properties might be unavoidably introduced by the cross-linking? Can these be compensated for via other process changes?

[NOTE: WHERE POSSIBLE THE CRITICAL POLYMER PROPERTIES SHOULD BE LISTED IF IT IS UNCERTAIN WHETHER THEY WILL BE NEGATIVELY IMPACTED BY THE PROCESS CHANGE.]

Project Name:	New Materials - Example 1	**Start Date:**	2008-02-09
Project Number:	801	**Completion Date:**	2008-06-14

The most significant underlying key variables are:
degree of cross-linking vs. thermal tolerance, material viscosity, chemistry of the polymerization reactions

Activity #1-1: Developing New Polymer Formulations

Work performed in Fiscal Year 2008:

Methods of experimentation:

- Process trials: 17 runs / samples - 5 initial samples of varying degrees of cross-linking, followed by 4 samples of each of the 3 most promising cross-link levels.

  Through manipulation of the chemistry of the polymerization reactions, we generated 5 initial samples of varying degrees of cross-linking [NOTE: LIST RANGES WHEN POSSIBLE]. These samples were tested for thermal tolerance and effects, as well as the other critical properties required in the new application opportunity [NOTE: PROPERTIES, VALUES, AND THE RESULTS, BOTH POSITIVE AND NEGATIVE, SHOULD BE STATED IF POSSIBLE FOR THE UNCERTAIN PROPERTIES OF INTEREST]. The 3 samples with greater degree of cross-linking met the high heat distortion requirement, however 1 of these was suspected to be too viscous for the process.

  For further testing purposes, 4 samples of each of the 3 cross-link levels were produced, and these were used in a full trial run of a similar part production on a lab based moulding machine. This run confirmed that the highly cross-linked polymer was too viscous to perform well (i.e. flow evenly into all parts of the mold) in the short moulding time allotted. The other two cross-linking levels performed comparably in moulding capability, and thus the one with less cross-linking was chosen for full production trials in the new application.

Results:

- Heat distortion temp.: 155 Deg C (105% of objective)
- minimizing detrimental properties: 96 % (120% of objective)
- Max cost increase: 490 $ per batch (114% of objective)
- Minimize defect rate: 20 parts per batch (51% of objective)

Conclusion:

Of 5 different degrees of cross-linking, the 2 lowest levels were found to have insufficient high heat tolerance, while the greatest level of cross-linking resulted in too high a viscosity for the moulding process.

The remaining two levels both exhibited suitable properties for the new application, thus the one with a lower degree of cross-linking was chosen for a production run due to cost differences.

Future developments in this area will focus around monitoring production runs of the new application to determine defect rates. Minor changes in the degree of cross-linking may be correlated to these defect rates to produce a better polymer. Other cross-linking methods might also be explored.

Key variables resolved: chemistry of the polymerization reactions, degree of cross-linking vs. thermal tolerance, material viscosity

801 - New Materials - Example 1

Benchmarks:
Internet searches: 17 sites / articles
Patent searches: 5 patents
Similar prior in-house technologies: 1 products /
Queries to experts: 2 responses

Objectives:
Heat distortion temp.: 150 Deg C
minimizing detrimental properties: 95 %
Max cost increase: 485 $ per batch
Minimize defect rate: 1 parts per batch
Improve production speed: 15 Units per min

Uncertainty: 1 - Degree of cross-linking

Key Variables: chemistry of the polymerization reactions, degree of cross-linking vs. thermal tolerance, material viscosity

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Developing New Polymer Formulations	Process trials: 17 runs / samples	minimizing detrimental properties: 96 % (120 %) Max cost increase: 490 $ per batch (114 %) Minimize defect rate: 20 parts per batch (51 %) Heat distortion temp.: 155 Deg C (105 %)	chemistry of the polymerization reactions degree of cross-linking vs. thermal tolerance material viscosity	0.00	0.00	0.00	2008

802 - Development of an UHMW-PE Abrasion Resistant:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective
Flexural modulus (GPa)	3.5	5
Maintain abrasion resistance (%)	100	100
Maintain impact resistance (%)	100	100
Maximum cost ($ per batch)	74	80

[AUTHOR'S NOTE: THIS EXAMPLE HAS BEEN ADAPTED FROM THE "PLASTICS MATERIALS, PROCESSING, EQUIPMENT & TOOL MAKING GUIDANCE DOCUMENT & CASE STUDIES" - APRIL, 2004. THIS DOCUMENT IS AVAILABLE FOR DOWNLOAD AT (www.cra.gc.ca/sred). THIS DOCUMENT WAS PREPARED BY A JOINT CANADA REVENUE AGENCY (CRA)-INDUSTRY SECTOR COMMITTEE.]

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

The objective is the development of a new product, which maintains abrasion and impact resistance while offering increased flexural modulus.

Additionally find a way to increase the flexural modulus without loss of abrasion resistance and impact resistance.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

- Internet searches: 17 sites / articles -- 6 articles on cross-linked sheet
- Patent searches: 4 patents -- none were for similar application
- Similar prior in-house technologies: 1 products / processes -- In-house product needs higher flexural modulus, while maintaining abrasion & impact resistance.
- Queries to experts: 2 responses -- No info on flexural modulus

A company launched a new cross-linked sheet to meet their customer's need for improved abrasion resistance. After launching the product the company received a customer feedback indicating a liking for the abrasion resistance and impact resistance of the new material but a higher flexural modulus was desired. The company decided that it was necessary to try to develop a product that would maintain the abrasion resistance and impact resistance achieved through cross-linking as well as meets this new primary requirement of an increased flexural modulus.

Field of Science/Technology:

Materials engineering & metallurgy (2.05.01)

Intended Results:

- Improve existing materials, devices, or products

Work locations:

Commercial Facility

Scientific or Technological Advancement:

Uncertainty #1: To provide a less flexible product

Increasing the cross-linking of a polyethylene resin increases both the abrasion resistance and the impact resistance. At the same time this increased cross-linking will reduce the flexural modulus of the polymer. The obvious way to provide the customer with a less flexible product (by reducing the cross-linking) cannot be used since this will reduce abrasion resistance and impact resistance of the product. Hence a more creative solution must be found to meet these seemingly contradictory requirements.

The most significant underlying key variables are:
abrasion resistance, impact resistance, tensile strength, flexibility, izod impact strength, material formulation

Activity #1-1: Performing Experiments

Work performed in Fiscal Year 2008:

Methods of experimentation:

- Process trials: 35 runs / samples - 5 blends tested each on 7 different loading levels.

[AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

- The company carried out an extensive series of small scale laboratory experiments [HOW MANY?] to determine what effect a variety of additives have on the flexural modulus of the cross-linked product. Several additives were found that increased the flexural modulus of the product to the required levels.

- The flexural modulus, abrasion resistance and all of the other secondary properties including: tensile strength, izod impact strength, coefficient of thermal expansion and coefficient of friction were tested on several [HOW MANY?] blends of each of these additives at a variety [HOW MANY?] of loading levels. These experiments provided an optimum blend.

- A production trial was carried out to determine what effect this formulation had on the processing of the product. Using standard processing parameters problems were encountered during both the mixing of the blend and compression moulding of the new material formulation. Laboratory experimentation [HOW MANY EXPERIMENTS?] in addition to several [HOW MANY?] production trials were carried out to determine how to obtain thorough mixing of the product and what the optimum pressure and temperature cycles are for the new formulation.

Results:

- Flexural modulus: 5 GPa (100% of objective)
- Maintain abrasion resistance: 100 % (100% of objective)
- Maintain impact resistance: 100 % (100% of objective)
- Maximum cost : 81 $ per batch (116% of objective)

Conclusion:

[AUTHOR'S NOTE: AN IDEAL DESCRIPTION WOULD CONTAIN A CONCLUSION FOR THE CURRENT ACTIVITY. CAN WE PROVIDE ANY FURTHER TECHNICAL CONCLUSIONS AS TO WHY THESE "RESULTS" AND RELATED "INTEGRATED ISSUES" WERE NOT "READILY PREDICTABLE" TO YOU FROM A TECHNICAL STANDPOINT?]

ADDITIONAL CRA COMMENTS REGARDING ELIGIBILITY:
Through these trials & experimentation we developed the knowledge that allowed us to develop a product that met both the primary property requirements of improved abrasion resistance and higher flexural modulus as well as the secondary property requirements of maintained tensile strength, izod impact strength, coefficient of thermal expansion and coefficient of friction.

Key variables resolved: abrasion resistance, flexibility, izod impact strength, impact resistance, material formulation, tensile strength

802 - Development of an UHMW-PE Abrasion Resistant

Benchmarks:	Internet searches: 17 sites / articles Patent searches: 4 patents Similar prior in-house technologies: 1 products / Queries to experts: 2 responses	**Objectives:**	Flexural modulus: 5 GPa Maintain abrasion resistance: 100 % Maintain impact resistance: 100 % Maximum cost : 80 $ per batch
Uncertainty:	1 - To provide a less flexible product	**Key Variables:**	abrasion resistance, flexibility, izod impact strength, impact resistance, material formulation, tensile strength

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Performing Experiments	Process trials: 35 runs / samples	Flexural modulus: 5 GPa (100 %) Maintain abrasion resistance: 100 % (100 %) Maintain impact resistance: 100 % (100 %) Maximum cost : 81 $ per batch (116 %)	abrasion resistance flexibility, izod impact strength impact resistance material formulation tensile strength	0.00	0.00	0.00	2008

803 - New Processes - Example 2:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective
Reduce Cost of part ($/part)	7	2.5
Reduce cost of mould ($ per set)	35000	5000
Minimize cycle time (Sec per cycle)	25	13

[NOTE: THIS PROJECT DESCRIPTION IS BASED ON THE CRA'S EXAMPLE OF AN ELIGIBLE PROJECT FROM THEIR SR&ED PLASTICS INDUSTRY APPLICATION PAPER: INFORMATION CIRCULAR 94-1, NEW Processes, EXAMPLE 2]

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

The objective is to produce, in one step using resin transfer moulding, an insulated box comprising two fiberglass reinforced plastic skins sandwiching an insulating core of polyurethane foam.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

- Internet searches: 12 sites / articles -- Insufficient info on Resin transfer moulding
- Patent searches: 4 patents -- Different applications of glass-fibre reinforced plastic process
- Similar prior in-house technologies: 1 products / processes -- Existing process uses metal moulds.
- Potential components: 3 products -- Existing machines for glass-fibre reinforced plastic parts

Resin transfer moulding is a relatively new process in which glass-fibre reinforced plastic parts are made. With this process, inexpensive moulds can be made using composite materials instead of metals. The glass-fibre reinforcement is placed in the two-part mould. The mould is then closed before the resin (usually thermosetting polyester resin) is forced into the closed mould using low-pressure air. There are many variations of this principle which are used or developed depending on the design of the part to be produced.

Field of Science/Technology:

Composites (including laminates, reinforced plastics, cermets, combined natural and synthetic fibre fabrics) (2.05.04)

Intended Results:

- Improve existing processes
- Improve existing materials, devices, or products

Work locations:

Commercial Facility

Scientific or Technological Advancement:

Uncertainty #1: Process Cost

It is uncertain as to the most economical method for part production.

[NOTE: IT WOULD BE BEST TO SPECIFY A COST RANGE HERE, OR TYPICAL COST TARGET OR COST IMPROVEMENT SOUGHT]

The most significant underlying key variables are:
material formulation, processing speed, manufacturing method

Activity #1-1: New Process Development and Trial

Work performed in Fiscal Year 2008:

Methods of experimentation:

- Analysis / simulation: 3 alternatives - Design work to determine appropriate test process.

- Process trials: 12 runs / samples - Samples produced using the test process developed above.

  [AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

  After some design work, a test process was settled upon which involved placing two layers of glass fibre mat in the mould with the polyurethane foam insulting layer between the two layers of glass fibre mat. This process was tested to determine the overall cost. It was determined to be reasonable for the type of part produced.

  [NOTE: MORE SPECIFIC STATEMENTS AS TO THE COSTS AND RESULTS ARE PREFERRED. ALSO, ONE SHOULD ELABORATE FURTHER ON THE VARIABLES WHICH WOULD AFFECT THE COST, THE ALTERNATIVE DESIGNS CONSIDERED AND ATTEMPTED, AND IF ANY DESIGNS WERE REJECTED AS INFEASIBLE]

Results:

- Reduce Cost of part: 2.75 $/part (94% of objective)

Conclusion:

A process was found which was a reasonable cost for the type of part produced.

[NOTE: HERE AGAIN, ONE SHOULD STATE WHY THIS PROCESS SUCCEEDED, REFERING IN PARTICULAR TO IMPORTANT PROCESS VARIABLES, AND WHY OTHER PROCESS CHOICES WOULD FAIL TO MEET STANDARDS, OR BE LESS DESIREABLE THAN THE PREFERRED PROCESS]

Key variables resolved: manufacturing method, material formulation, processing speed

Uncertainty #2: Box Surface Finish

There is concern that the inclusion of glass fibre will result in exposed fibres at the part surface. To be successful, the liquid resin injected into the closed mould has to completely encase the glass fibre mat on both sides of the polyurethane foam.

The most significant underlying key variables are:
glass fibre content, surface, thicknesses, methods of injection, types of glass fibre

Activity #2-1: Glass Fibre Development

Work performed in Fiscal Year 2009:

Methods of experimentation:

- Process trials: 5 runs / samples - Different types of glass fibre tested.

  [AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

  Special glass fibre mat had to be made that provided space at the outer surfaces for the resin to flow through and make a finished part that had resin on the surface instead of exposed glass fibres.

  Several types of glass fibre were tested in the mould, and cross sections were drawn from the resulting parts to determine the surface thickness to the nearest fibre level.

  The best thickness was achieved by a "high loft" glass fibre mat. This was decided to become the new raw material for resin transfer moulding.

  [NOTE: THIS REPORT SHOULD BE MORE SPECIFIC IN THE NUMBER AND TYPES OF MATERIALS TESTED. IT SHOULD ALSO CITE OTHER IMPORTANT VARIABLES FOR THE FINAL PART, SUCH AS SMOOTHNESS AND FINISH CHARACTERISTICS, STRENGTH OR DURABILITY, ETC]

Results:

- Reduce cost of mould: 7000 $ per set (93% of objective)
- Minimize cycle time: 15 Sec per cycle (83% of objective)

Conclusion:

The best thickness (and minimum chance of glass fibre exposure) was achieved by a "high loft" glass fibre mat. This was decided to become the new raw material for resin transfer moulding.

[NOTE: ONE SHOULD ALSO STATE WHETHER THE WORK IS COMPLETE, OR IF FUTURE DEVELOPMENT IS EXPECTED / PLANNED]

Key variables resolved: glass fibre content, methods of injection, surface, thicknesses, types of glass fibre

803 - New Processes - Example 2

Benchmarks:
Internet searches: 12 sites / articles
Patent searches: 4 patents
Similar prior in-house technologies: 1 products /
Potential components: 3 products

Objectives:
Reduce Cost of part: 2.5 $/part
Reduce cost of mould: 5000 $ per set
Minimize cycle time: 13 Sec per cycle

Uncertainty: 1 - Process Cost

Key Variables: manufacturing method, material formulation, processing speed

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - New Process Development and Trial	Analysis / simulation: 3 alternatives Process trials: 12 runs / samples	Reduce Cost of part: 2.75 $/part (94 %)	manufacturing method material formulation processing speed	0.00	0.00	0.00	2008

Uncertainty: 2 - Box Surface Finish

Key Variables: glass fibre content, methods of injection, surface, thicknesses, types of glass fibre

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Glass Fibre Development	Process trials: 5 runs / samples	Reduce cost of mould: 7000 $ per set (93 %) Minimize cycle time: 15 Sec per cycle (83 %)	glass fibre content methods of injection surface thicknesses types of glass fibre	0.00	0.00	0.00	2009

804 - New Equipment - Example 3:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective
Speed increase (%)	0	10
Improve positioning accuracy (inches)	0.01	0.005
Improve payload capacity (Lb)	1200	1500
Minimize cost of robot ($ per units)	12000	10000

[NOTE: THIS PROJECT DESCRIPTION IS BASED ON THE CRA'S EXAMPLE OF AN ELIGIBLE PROJECT FROM THEIR SR&ED PLASTICS INDUSTRY APPLICATION PAPER: INFORMATION CIRCULAR 94-1, NEW EQUIPMENT, EXAMPLE 3]

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

The objective of this project is to develop a new robot design, with the goal of improving the performance characteristics (speed, positioning accuracy, payload capacity) of our automated injection moulding equipment. This project will involve the development of new drive mechanisms, control software or rigid, lightweight structural components.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

- Internet searches: 12 sites / articles -- no sufficient info on new automated injection moulding equipment
- Patent searches: 6 patents -- Robots with automated injection moulding equipment for different environment
- Similar prior in-house technologies: 1 products / processes -- Existing process uses a less advanced automation system.
- Potential components: 3 products -- New drive mechanisms, control software or rigid, lightweight structural components.

Manufacturers of injection moulding equipment have been adopting technology from other industries and applying it to upstream and downstream operations to create automated moulding cells, resulting in productivity gains and cost savings. Much of this automation effort involves the use of robotics.

Field of Science/Technology:

Robotics and automatic control (2.02.02)

Intended Results:

- Develop new materials, devices, or products
- Improve existing processes

Work locations:

Commercial Facility

Scientific or Technological Advancement:

Uncertainty #1: Drive Mechanism and Structural Component Designs

How must the drive mechanism design change to achieve a 10% speed increase?
Which structural materials should be used to provide a suitable payload capacity?

[NOTE: THE IDEAL DESCRIPTION COULD ILLUSTRATE THE MAJOR TECHNICAL PARAMETERS TO BE ADDRESSED IN ANY DESIGN ALTERNATIVES CONTEMPLATED]

The most significant underlying key variables are:
payload capacity, drive mechanism design, Structural Materials

Activity #1-1: Prototyping & Testing of Parts

Work performed in Fiscal Year 2008:

Methods of experimentation:

- Physical prototypes: 2 samples - First prototype approach had to be scrapped due to it damaging the surface on the end product.
- ... Prototype revisions: 10 revisions - 3 revisions of first prototype, and 7 revisions of second prototype. Preventing surface damage and smoothness of operation were the two main challenges.

  [AUTHOR'S NOTE: NO DETAILS WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

  [NOTE: ALL DESIGN, PROTOTYPING, AND TESTING OF RELATED COMPONENTS WOULD BE ELIGIBLE TO THE EXTENT THEY ARE AIMED AT RESOLVING ONE OR MORE STATED TECHNICAL UNCERTAINTIES]

Results:

- Speed increase: 8 % (80% of objective)
- Improve payload capacity: 1400 Lb (66% of objective)
- Minimize cost of robot: 9000 $ per units (150% of objective)

Conclusion:

[NOTE: THE IDEAL CONCLUSION WOULD ALSO BRIEFLY DETAIL HOW THESE RESULTS COMPARED WITH INITIAL EXPECTATIONS AND OUTLINE ANY FURTHER CONCLUSIONS WHICH COULD AFFECT FUTURE DEVELOPMENTS OF THIS NATURE]

Key variables resolved: drive mechanism design, payload capacity, Structural Materials

Uncertainty #2: Optimize Motion Profiles

It is unknown how changes in robot performance characteristics will interact. In particular, the effects of increased robot speed on the positioning accuracy must be determined.

The most significant underlying key variables are:
Robot Speed, Positioning accuracy, payload capacities, control software

Activity #2-1: Develop Motion Profiles

Work performed in Fiscal Year 2009:

Methods of experimentation:

- Analysis / simulation: 1 alternative - Calibration curve created as function of speed and payload capacity, using testing outlined below.
- Process trials: 30 runs / samples - 3 payload capacities, each tested over 10 speed intervals.

  [AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

  Once the new drive mechanism and structural components had been installed, the mould was put through test runs at a range of speeds (speeds tested were spaced at 2% intervals, beginning at 80% of the new maximum speed, and ramping up to 100%), each test using the same calibration based on the previous drive mechanism. The error in position accuracy was recorded for each run to provide a new calibration curve.

  This test was repeated at various payload capacities [HOW MANY?] to confirm structural integrity, and to generate a final calibration curve as a function of both variables.

  [NOTE: ANY WORK WHICH AIMS AT RESOLVING THE "SYSTEM UNCERTAINTIES" RELATED TO INTEGRATING THE NEW COMPONENTS INTO THE OVERALL SYSTEM WOULD GENERALLY QUALIFY AS SR&ED ACTIVITIES]

Results:

- Speed increase: 10 % (100% of objective)
- Improve positioning accuracy: 0.006 inch (80% of objective)

Conclusion:

It was concluded that the machine position calibration could not compensate for the error on the test run of the largest payload capacity, executed at the maximum speed. Future developments may look at changes to the drive mechanism to allow this mode of operation.

Suitable calibration curves were developed for all other test runs, and a composite 2-variable curve was generated to correct accuracy based on both the run speed and payload capacity.

[NOTE: AGAIN, THE IDEAL CONCLUSION WOULD BRIEFLY DETAIL HOW THESE RESULTS COMPARED WITH INITIAL EXPECTATIONS AND OUTLINE ANY FURTHER CONCLUSIONS WHICH COULD AFFECT FUTURE DEVELOPMENTS OF THIS NATURE]

Key variables resolved: control software, payload capacities, Positioning accuracy, Robot Speed

804 - New Equipment - Example 3

Benchmarks: Internet searches: 12 sites / articles
Patent searches: 6 patents
Similar prior in-house technologies: 1 products /
Potential components: 3 products

Objectives: Speed increase: 10 %
Improve positioning accuracy: 0.005 inch
Improve payload capacity: 1500 Lb
Minimize cost of robot: 10000 $ per units

Uncertainty: 1 - Drive Mechanism and Structural Component Designs

Key Variables: drive mechanism design, payload capacity, Structural Materials

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Prototyping & Testing of Parts	Physical prototypes: 2 samples ... prototype revisions: 10 revisions	Speed increase: 8 % (80 %) Minimize cost of robot: 9000 $ per units (150 %) Improve payload capacity: 1400 Lb (66 %)	drive mechanism design payload capacity Structural Materials	0.00	0.00	0.00	2008

Uncertainty: 2 - Optimize Motion Profiles

Key Variables: control software, payload capacities, Positioning accuracy, Robot Speed

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Develop Motion Profiles	Analysis / simulation: 1 alternatives Process trials: 30 runs / samples	Improve positioning accuracy: 0.006 inch (80 %) Speed increase: 10 % (100 %)	control software payload capacities Positioning accuracy Robot Speed	0.00	0.00	0.00	2009

1001 - New material for existing product design:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective
Maximum Cost of moulded parts ($/part)	0.06	0.04
Cost of production ($ per part)	0.02	0.01
Maximum Cost of mould ($)	55000	59000
Maximum Cost of material ($ per batch)	250	275
Increase production speeds (cycles per hour)	2.3	4

[AUTHOR'S NOTE: THIS PROJECT DESCRIPTION IS BASED ON THE CANADA REVENUE AGENCY'S (CRA) EXAMPLE OF AN ELIGIBLE PROJECT FROM THEIR PLASTICS INDUSTRY SR&ED APPLICATION PAPER (INFORMATION CIRCULAR 94-1)]

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

Bob works with an injection moulder and wants to develop a less costly material for making a part currently moulded from nylon 6, 6.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

- Internet searches: 17 sites / articles -- Insufficient info
- Patent searches: 4 patents -- Formulations work with different processes.
- Similar prior in-house technologies: 1 products / processes -- Want to use existing mould, but it was designed for use with nylon.
- Queries to experts: 3 responses -- No info on alternate materials obtained

Field of Science/Technology:

Materials engineering & metallurgy (2.05.01)

Intended Results:

- Improve existing materials, devices, or products

Work locations:

Commercial Facility

Scientific or Technological Advancement:

Uncertainty #1: Departures from standard practice

We are uncertain whether changes in viscosity and rheology resulting from the presence of fibres would permit the use of the existing mould. There was no known flow modeling software capable of predicting the performance or flow characteristics of the proposed material.

[NOTE: IT IS BEST TO PHRASE THE "UNCERTAINTIES" AT THE HIGHEST TECHNICAL LEVELS POSSIBLE AND ILLUSTRATE THE UNDERLYING PROBLEMS THROUGH SECTION III BELOW: I.E. INVESTIGATIVE "ACTIVITIES" AND RELATED CONCLUSIONS.]

The most significant underlying key variables are:
performance, flow characteristics, viscosity, rheology, fibre content

Activity #1-1: Testing

Project Name:	New material for existing product design	**Start Date:**	2010-01-01
Project Number:	1001	**Completion Date:**	2010-12-31

Work performed in Fiscal Year 2010:

Methods of experimentation:

- Analysis / simulation: 1 alternative - Model developed - correlation of nylon vs. polypropylene flow variables.
- Process trials: 41 runs / samples - Polypropylene samples used to develop model, as outlined below.

[NOTE: CORRELATE RESEARCH STEPS TO THE UNCERTAINTIES IN QUESTION. IDEALLY WE CAN PROVIDE ABILITY TO DISPLAY CROSS-REFERENCES TO SUPPORTING TECHNICAL DOCUMENTATION INCLUDING LAB NOTES, DRAWINGS, RESEARCH PAPERS AND OTHER CORPORATE PAPERS OF TECHNICAL RELEVANCE.]

-We prepared samples of glass-fiber reinforced polypropylene of various compositions and fiber content and attempts to injection mould parts. This involved examination of 34 polypropylene samples: notes, preliminary hypotheses, & related test results (48 pages) - June 11- August 5

-These were used as a base to define the spectrum of expected viscosity & relays parameters under differing fiber levels, temperatures and pressures. Technical meeting notes (18 pages) - August 15-18

-The prototypes were then tested against the anticipated performance parameters. These tests involved the correlation of nylon vs. polypropylene flow variables & concluded that the desired mould could be formed - August 18-28 (22 pages)

-The prototype results were then combined with results from the additional industry models above. The resultant model was then developed involving the correlation of nylon vs. polypropylene flow variables & related conclusions regarding inter-relations of viscosity & rheology on mould parameters - August 30 (12 pages including seven prototype models subsequently revised)

For each research step we should briefly provide allocations or reasonable estimates for each of the following:

-Labor hours / employee
-Costs of any subcontracting, Universities or other third parties + brief explanation of their involvement
-Materials used in prototypes or experimental production + clarify if the prototypes were sold

[NOTE: THESE DETAILS CAN BE PROVIDED FROM YOUR ACCOUNTING SYSTEM (IF YOU USE JOB COSTING SYSTEM) OR AS SEPARATE SUMMARIES OTHERWISE. THE CRA ALSO REQUIRES THAT AT LEAST 90% OF THE WORK MUST BE PHYSICALLY PERFORMED IN CANADA. SUBCONTRACTORS MUST BE CANADIAN.]

Results:

- Maximum Cost of moulded parts: 0.04 $/part (100% of objective)
- Cost of production: 0.016 $ per part (40% of objective)
- Maximum Cost of mould: 60000 $ (125% of objective)
- Maximum Cost of material: 271 $ per batch (84% of objective)
- Increase production speeds : 3.8 cycles per hour (88% of objective)

Conclusion:

We determined that a polypropylene of a specific molecular weight and at defined levels of glass-fibre filling can indeed be successfully moulded, and that it can match the properties of the part previously made from nylon.

We refined our predictive models for injection moulding to include polypropylene of certain restricted glass fibre contents.

[IDEALLY, AN IDEAL DESCRIPTION WOULD PROVIDE FURTHER EVIDENCE OF RESULTS OR CONCLUSIONS, WHICH WERE UNEXPECTED AT THE OUTSET OF THE WORK.]

Key variables resolved: fibre content, flow characteristics, performance, rheology, viscosity

Project Name:	New material for existing product design	**Start Date:**	2010-01-01
Project Number:	1001	**Completion Date:**	2010-12-31

1001 - New material for existing product design

Benchmarks:
Internet searches: 17 sites / articles
Patent searches: 4 patents
Similar prior in-house technologies: 1 products /
Queries to experts: 3 responses

Objectives:
Maximum Cost of moulded parts: 0.04 $/part
Cost of production: 0.01 $ per part
Maximum Cost of mould: 59000 $
Maximum Cost of material: 275 $ per batch
Increase production speeds : 4 cycles per hour

Uncertainty: 1 - Departures from standard practice

Key Variables: fibre content, flow characteristics, performance, rheology, viscosity

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Testing	Analysis / simulation: 1 alternatives Process trials: 41 runs / samples	Maximum Cost of moulded parts: 0.04 $/part (100 %) Cost of production: 0.016 $ per part (40 %) Maximum Cost of mould: 60000 $ (125 %) Maximum Cost of material: 271 $ per batch (84 %) Increase production speeds : 3.8 cycles per hour (88 %)	fibre content flow characteristics performance rheology viscosity	0.00	0.00	1,500.00	2010