Project Details:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
A QUANTIFIABLE OBJECTIVE (#)	1	2	No
OBJECTIVE #2 (E.G. COST) ($/UNIT)	100	90	No

THE FIRST STEPS OF THE DOCUMENTATION PROCESS ARE TO;
- ATTEMPT TO DESCRIBE THE OVERALL THE OBJECTIVES IN FEW SENTENCES &
- QUANTIFY OBJECTIVES VS. CURRENT PERFORMANCE

History of the international definition of R&D & how we use this model:

The Frascati Manual is a document setting forth the methodology for collecting statistics about research and development. The Manual was prepared and published by the Organisation for Economic Co-operation and Development (OECD).

In June 1963, OECD experts met with the NESTI group (National Experts on Science and Technology Indicators) at the Villa Falconieri in Frascati, Italy. Since then it has been revised several times. In 2002 the 6th edition was published.
The manual sets forth fundamental definitions for: basic research, applied research, and research & development. It also organizes Fields of science into main and subcategories.

Over the past 40 years, the NESTI group has developed a series of documents, known as "Frascati Family", which includes manuals on:
• R&D (Frascati Manual),
• innovation (Oslo Manual),
• human resources (Canberra Manual),
• technology balance of payments and patents as science and technology indicators.

Originally an OECD standard, it has become an acknowledged standard in R&D studies all over the world and is widely used by various organisations associated with the United Nations and European Union.

The Frascati Manual outlines three forms of research: Basic, Applied & Experimental development. “For a … project to be classified as R&D, its completion must be dependent on a scientific &/or technological advance, the aim of the project must be the systematic resolution of a scientific and/or technological uncertainty.” [Frascati Manual 2002, paragraph 135]

Field of Science/Technology:

Mechanical engineering (2.03.01)

Project Details:

Intended Results:	Develop new processes, Develop new materials, devices, or products, Improve existing processes, Improve existing materials, devices, or products
Work locations:	Commercial Facility, Research Facility, Lab
Key Employees:	Nick Tesla (Electrical technology - CET (2002) / Research Associate), Al Einstein (Physics - PhD. (1938) / Lead Researcher)
Evidence types:	Progress reports, minutes of project meetings; Test protocols, test data, analysis of test results, conclusions; Records of resources allocated to the project, time sheets; Samples, prototypes, scrap or other artefacts; Design, system architecture and source code; Project records, laboratory notebooks; Project planning documents; Photographs and videos; Design of experiments; Records of trial runs; Contracts

Scientific or Technological Advancement:

Uncertainty #1: Key Variables (for experimentation)

“The basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty and the resolution of scientific and/or technological uncertainty, i.e. when the solution to a problem is not readily

apparent to someone familiar with the basic stock of common knowledge and techniques for the area concerned." [Frascati Manual 2002 paragraph 84]

The paper includes some supplementary criteria for distinguishing R&D:
• What is new or innovative about this project?
• Is it seeking previously undiscovered phenomena, structures or relationships?
• Does it apply knowledge or techniques in a new way?
• Is there a significant chance that it will result in new (extended or deeper) understanding of phenomena,
• relationships or manipulative principles of interest to more than one organization
• Are the results expected to be patentable?

The most significant underlying key variables are:

VARIABLE #1 - temperature (unresolved), #2 - pressure (unresolved), #3 - fibre content (unresolved), Risers - location & orientations (unresolved), Vibration: locations, intensities & durations (unresolved)

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

Benchmark Method/Source	Measurement	Explanatory notes
Internet searches	1 Articles	LIST ANY RELEVENT "ARTICLES" OR REPORTS
Patent searches	2 patents	NOT COMMON HOWEVER, IF DONE WE SHOULD SPECIFY SINCE STRONG EVIDENCE
Competitive products or processes	3 products	IDENTIFY LIMITS + IF COMPETITORS HAVE DEVELOPED TECHNOLOGY CLARIFY "METHOD" NOT AVAILABLE TO US
Similar prior in-house technologies	4 products / processes	THIS IS GREAT FOR BENCHMARKING (QUANTIFYING) EXISTING PERFORMANCE LIMITS AND PROBLEMS
Potential components	5 products	OFTEN SUPPLIERS CAN TELL YOU HOW THEIR PRODUCTS MAY PERFORM & PROVIDE GUIDANCE
Queries to experts	6 responses	EXPERT OPINIONS ON THE LIMITS OF TECHNOLOGY INDICATE PROJECTS ARE ELIGIBLE

A) Define industry "standard practice"
"The basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty and the resolution of scientific and/or technological uncertainty, i.e. when the solution to a problem is not readily apparent to someone familiar with the basic stock of common knowledge and techniques for the area concerned." [Frascati Manual 2002 paragraph 84]

B) Technological objective beyond standard practice "…. If the primary objective is to make further technical improvement on the product or process then the work comes within the definition of R&D ……. if the primary objective is to develop markets, to do pre-production planning or control system working smoothly, then the work is no longer R&D." [Frascati Manual (2002) Paragraph 111]

Activity #1-1: Investigative Activities (Fiscal Year 2013)

This Activity is addressed in Fiscal Year 2013.

Activity #1-2: Continue year to year (Fiscal Year 2014)

This Activity is addressed in Fiscal Year 2014.

Activity #1-3: Input from all team members (Fiscal Year 2015)

Methods of experimentation:

Results:

Conclusion:

Project Name:	Miniature Printer - TAX CASE (6379249 Canada Inc.)	**Start Date:**	2014-01-01
Project Number:	1401	**Completion Date:**	2015-09-30

Project Details:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
Battery life (pages)	5	20	Yes
Jam rate (jams/1,000 sheets)	150	1	Yes
Ambient humidity limit (%)	85	95	Yes
Media thickness upper (mm)	0.08	0.1	Yes
Media thickness lower range (mm)	0.06	0.05	Yes
Speed (pages per minute) (ppm)	5	5	Yes
felt medium life (1000's / pages)	0.5	20	Yes
Overall reject rate (%)	20	0.1	Yes
Cost ($)	100	80	Yes

OBJECTIVES: The printer had to

- be small and light, the dimensions were to be 1.5” x 1.5” x 10” (22.5 cubic in.); 38mm x 38mm x 254mm (368 cm3)
- deliver a full-sized 8.5” x 11” sheet of copy or graphic;
- connect to a data source such as cellular phone, PDA or a laptop via the Bluetooth;
- use wireless technology permitting it to print without the need for a cable connection;
- be self-contained, meaning that the paper had to be inside the printer on a reel in a very tightly curled compact roll;
- the paper cartridge had to consist of 20 sheets of paper;
- the printer had to be battery operated and the battery had to function for a full cartridge of paper between recharges.

BACKGROUND TO THIS CASE STUDY:

This project is based on details of the Tax Court of Canada judgment in 6379249 CANADA INC. v HER MAJESTY THE QUEEN, 2015 TCC 77, March 31, 2015.

The company filed successful SR&ED tax claims for its 2007 and 2008 taxation years to develop a new printer. At the end of 2008, 200 printers were released onto the market for sale.

After its commercial release, the company investigated the customers’ complaints by testing approximately 50 printers and determined that the complaints were well-founded: paper was coming out of the printer curled and the battery stopped after five to ten pages had been printed. Although this did not occur on a regular basis, the occurrence was high enough that the company decided to stop manufacturing the printers and removed them from the market.

In 2009, they undertook a new SR&ED project with respect to the printer and claimed a SR&ED ITC in the amount of $103,628 for its 2009 taxation year and $49,688 for its 2010 taxation year.

Mr. Tuli stated that when he first investigated what had gone wrong with the printer, it was clear that two technological uncertainties still existed. The first one was that the paper did not come out flat from the printer and the second was that the battery died out too rapidly. After printing many pages, they observed that the felt on the slip clutch was degrading more rapidly than had been anticipated. They also observed that the motor stalled prematurely and the issue with the dynamic and static friction had not been resolved.

The government tax credit authority (Canada Revenue Agency) took the position that at the time of commercial production, there were no longer technological uncertainties with respect to the printer. In addition, the work performed on the printer during the 2009 and 2010 taxation years was routine engineering.

CLAIM HISTORY - ACCEPTED BY SAME REVIEWER IN 2007 & 2008

In prior claims Mr. Wierzbica stated that the development was SR&ED since some of the technologies contained in the printer were not conceived to work together, the technologies needed to be individually improved in order to work and fit in a very limited geometry & there was no publicly available technical information on how to build such a small device.

CURRENT CLAIMS - REJECTED FOR 2009 & 2010

With respect to the 2009 and 2010 years, Mr. Wierzbica opined that the appellant was not entitled to a SR&ED ITC. He stated that if Mr. Tuli, the appellant's technical expert, considered the attempted functionality accomplished in 2008, and accordingly released the printer onto the market, the technological uncertainty at the system/printer level had been resolved and could no longer exist in 2009 and 2010.

TECHNOLOGY BACKGROUND OF THE CLAIMANT:

Mr. Raja Tuli, the Chief Executive Officer ("CEO") graduated in 1988 from the University of Alberta in computer engineering. He has many inventions to his credit. He holds approximately 100 patents in different technologies, software and mechanical designs. Mr. Tuli stated that he holds at least nine patents in the field of printing technology. Before developing the miniature printer, he had previously designed and developed printers and slip clutches, which are components of printers.

TECHNOLOGY BACKGROUND OF THE CRA REVIEWER & EXPERT WITNESS: Mr. Wierzbica

Mr. Wierzbica has a doctorate in electrical engineering and technology, metrology, & is a member of Order of Engineers since 1981. He was employed for almost 20 years by Canadian companies in the high tech industry and developed a photoplotter which is a printer used primarily for the production of PCB's (printed circuit boards).

Mr. Wierzbica has held roles in the SR&ED directorate of Research Technology Advisors ("RTA"), CRA as policy advisor & a National Technology Sector Specialist for information technology, in Ottawa. In that capacity, Mr. Wierzbica advised on a national basis on CRA's policies with respect to the SR&ED and also assisted RTA's in their work, also on a national basis.

Field of Science/Technology:

Computer hardware and architecture (2.02.08)

Project Details:

Intended Results:	Improve existing processes
Work locations:	Commercial Facility
Key Employees:	Raja Tuli (Computer Engineering, 100+ patents held - BASc. (1988) / CEO)
Evidence types:	Records of resources allocated to the project, time sheets; Design of experiments; Test protocols, test data, analysis of test results, conclusions; Samples, prototypes, scrap or other artefacts; Records of trial runs

Scientific or Technological Advancement:

Uncertainty #1: Variables cited in tax case

PROBLEMS: Mr. Tuli stated that when he first investigated what had gone wrong with the printer, it was clear that two technological uncertainties still existed. The first one was that the paper did not come out flat from the printer and the second was that the battery died out too rapidly. After printing many pages, they observed that the felt on the slip clutch was degrading more rapidly than had been anticipated. They also observed that the motor stalled prematurely with further issues regarding dynamic and static friction to resolve.

HYPOTHESES: It was hypothesized that there could be external factors that had an effect on the paper curling after extended periods of time on the paper reel. It was further hypothesized that humidity could significantly contribute to the changes in the characteristics of the paper over time. A jig (moisture chamber) was developed to test the paper moisture content.

Mr. Tuli wanted to see if the moisture content could cause the paper to degrade and prevent the anti-curl mechanism from working. Since the paper was curled in a tight roll, it was hard to simulate the real environment with a jig. Mr. Tuli stated that they were not able to apply the moisture to the paper evenly. Mr. Tuli stated that they tried many techniques but they were not able to apply the moisture evenly on each page of the roll of paper. Research was done in order to find literature that could assist the appellant but nothing was found. At that point, they thought another solution would be to render the anti-curl mechanism in the printer even stronger.

The most significant underlying key variables are:

static versus dynamic load, clutch plate surface area & use of ridges, slip clutch (unresolved), moisture vs anti curl

mechanism, felt (friction, compression & degradation)

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

Benchmark Method/Source	Measurement	Explanatory notes
Internet searches	100 Articles	Before testing each hypothesis, Mr. Tuli stated that they looked at the current state of the art to see what was being done worldwide. Mr. Tuli stated that there was no published information with respect to a miniature printer with so many embedded technologies.
Patent searches	14 patents	The attached patents illustrate how they can be analysed with respect to each of the issues of technological uncertainty.
Competitive products or processes	5 products	We examined the methods used in several competitive products
Similar prior in-house technologies	54 products / processes	The CEO holds 9 patents on printer related technologies. These and other methods were contemplated during the design.
Potential components	7 products	Spoke to components suppliers who provide similar technology solutions

Activity #1-1: Felt on Slip Clutch & Static vs. Dynamic Friction Regimes (Fiscal Year 2014)

This Activity is addressed in Fiscal Year 2014.

Activity #1-2: Redesign of the slip clutch (Fiscal Year 2014)

This Activity is addressed in Fiscal Year 2014.

Activity #1-3: New print driver (Fiscal Year 2015)

Methods of experimentation:

Method	Experimentation Performed
Analysis / simulation:	400 alternatives
Trials:	70 runs / samples

Although there was an improvement in paper straightness, the problem was not yet resolved. The next phase of the development was to focus on the other major problem reported by the users, which was that the battery was draining too quickly.

Further advancement was then sought by contemplating the mitigation of power consumption problems caused by the difference between the static and dynamic regimes of the electric motor by electronic means that would control the supply of power to the motor. Until then, they had been using a simple motor control algorithm referred to as the old printer driver. The old printer driver did not make the difference between the static and dynamic regimes.

Mr. Tuli introduced in the design of the new printer driver a means for regulating the amount of electric power from the battery to the motor. The hypothesis was that by introducing a means to ensure that the power supply profile would continually match the expected power demand, overall power consumption would decrease and the printer's battery charge would last for a full cartridge of 20 pages.

Mr. Tuli hypothesized that once calibrated the new printer driver would manage the boosting of the electric motor so that additional energy would be applied only when strictly necessary for preventing the motor to stall. Once calibrated, tests were performed to verify the effectiveness of this anti-stalling tool. The test results confirmed the validity of the initial hypothesis, the calibrated power management algorithm (new printer driver) effectively prevented the motor from stalling

Results:

- Battery life: 22 pages (113% of goal) -- the printer driver improved the life of the battery and the motor applied the required force to the anti-curl mechanism.
- Jam rate: 27 jams/1,000 sheets (82% of goal)

- Media thickness upper: 0.09 mm (50% of goal)
- Media thickness lower range: 0.04 mm (200% of goal)
- Speed (pages per minute): 5 ppm (100% of goal)
- felt medium life: 18.5 1000's / pages (92% of goal)
- Overall reject rate: 4 % (80% of goal)
- Cost : 83 $ (85% of goal)

Conclusion:

CLIENT CLAIM:

A new printer driver algorithm was developed. It was concluded that the new printer driver was able to reduce the power consumption on the battery. The new printer driver considers the time elapsed since the last movement of the electric motor and the last registered speed of the paper and inferred the presence of static friction from these variables to control the power requirements.

The printer driver improved the life of the battery and the motor applied. The required force to the anti-curl mechanism. Unlike the old printer, the new printer driver followed a complex curve not found in the typical printer driver.

CRA POSITION:

Mr. Wierzbica,The respondent also submitted that the development of the new printer driver was also common knowledge, algorithms had been in existence for a very long time and no new scientific knowledge was gained with the new printer driver.

JUDGES RULING: ELIGIBLE

The calibrated power management algorithm (new printer driver) effectively prevented the motor from stalling. In addition, the printer driver improved the life of the battery and the motor applied the required force to the anti-curl mechanism. Unlike the old printer, the new printer driver followed a complex curve not found in the typical printer driver. The calibrated new printer driver is a technological advancement with respect to the previous technology;

Significant variables addressed: static versus dynamic load

Documentation:

Uploaded to RDBASE.NET: sample experiments withweb handling.pdf (135KB)

Activity #1-4: Moisture analysis (Fiscal Year 2015)

Methods of experimentation:

Method	Experimentation Performed
Trials:	1200 runs / samples

Mr. Tuli stated that further testing was performed to determine whether the new technological advancements had improved the efficacy of the printer. Mr. Tuli stated that even though the back tension force of the anti-curling mechanism was consistently up to specification, the tests provided occasional evidence of paper curling in some units after some time. It was hypothesized that the printing paper would eventually become curled because the paper's physical properties were changing over time. Mr. Tuli decided to investigate the problem of variation of the moisture content of the printing paper stock over time.

It was hypothesized that there could be external factors that had an effect on the paper curling after extended periods of time on the paper reel. It was further hypothesized that humidity could significantly contribute to the changes in the characteristics of the paper over time. A jig (moisture chamber) was developed to test the paper moisture content. Mr. Tuli wanted to see if the moisture content could cause the paper to degrade and prevent the anti-curl mechanism from working. Since the paper was curled in a tight roll, it was hard to simulate the real environment with a jig.

Mr. Tuli stated that they were not able to apply the moisture to the paper evenly. Mr. Tuli stated that they tried many techniques but they were not able to apply the moisture evenly on each page of the roll of paper. Research was done in order to find literature that could assist the appellant but nothing was found. At that point, they thought another solution would be to render the anti-curl mechanism in the printer even stronger.

Results:

- Ambient humidity limit: 92 % (70% of goal)

Conclusion:

CRA POSITION:

Mr. Wierzbica,With respect to the tests performed by the appellant to determine the impact of the moisture on paper, the respondent submitted that the impact of moisture on the paper is a very well-known phenomenon and that there was nothing scientific about building a jig.

JUDGES RULING: ELIGIBLE SUPPORT ACTIVITY

The building of jig for a small printer and trying to find a technique to apply moisture evenly into a roll of paper was also performed to remove one of the technological uncertainties, namely the paper curling.

Mr. Tuli stated that building a jig for such a small roll of paper was far from been obvious. Finding a technique to apply the moisture evenly was not known by people versed in the art. If it was known, the appellant would still not be working on it.

In any event, in my view, if the work performed in 2010 did not fall within the ambit of paragraph (c), it would be caught by paragraph (d) of the definition of SR&ED under section 248 of the ITA (supporting activity).

Significant variables addressed: moisture vs anti curl mechanism

Uncertainty #2: Uncertainty2

Technology or Knowledge Base Level:

There are no Activities associated with this uncertainty.

Project Name:	Engineering - Tax Case (Northwest Hydraulics)	**Start Date:**	2012-01-31
Project Number:	1500	**Completion Date:**	2016-10-28

Project Details:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
Decrease Bed load Deposition (%)	75	50	Yes
Reduce Downstream scouring (%)	96	80	Yes
Minimize Production cost ($)	25000	23000	Yes

[NOTE: THIS PROJECT DESCRIPTION IS REPRODUCED FROM FACTS OUTLINED IN THE TAX COURT OF CANADA Docket: 97-531-IT-G, Date: 1998/05/01]

[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 problems were to maintain a low flow channel near the intake during the dry season, to exclude sediment from entering the intake and reduce downstream scouring (erosion of materials due to high velocity).

The concept of a divide wall is not new, but this is an entirely different application when the following are taken into account: it's a highly braided river, the shape of the intake works, the alignment and the length and the height of the wall in combination with the gates that were used. Also the development of methods for maintaining this low-flow channel for the intake in this highly sediment laden river is an advance.

Field of Science/Technology:

Environmental and geological engineering (2.07.01)

Project Details:

Intended Results:	Develop new processes, Improve existing processes
Work locations:	Commercial Facility
Key Employees:	
Evidence types:	Progress reports, minutes of project meetings

Scientific or Technological Advancement:

Uncertainty #1: Geometry to address sediment & water levels

The East Rapti river is 1,800 metres wide and carries large amounts of sediment. The channel is "braided", that is to say it consists of a number of channels. The bank of the river in subject to erosion and is highly unstable. Moreover, the slope is steep giving rise to unusually high velocity.

How will the properties of the river affect the proposed dam? The unknown effect of heavy sediment movement and complicated structure combination (including weir, sluiceway, headgate, ejector, settling basin, fish ladder, log passage and river training works).

In the result three models were required:

(a) A model of the river; this required a distortion of the scale;
(b) an intake model; and
(c) a settling basin model.

For this purpose it is necessary to develop geometry for upstream training dikes and spurs, and an alignment for the intake structure.

The capacity of the sluice gate has to be increased and a flow divide wall has to be added. A downstream scour protection scheme has to be devised and a settling basin has to be modified to improve flushing.

[NOTE: EACH CHARACTERISTIC TAKEN ALONE AND IN ISOLATION WOULD PRESENT DIFFICULTIES.

CUMULATIVELY THEY MAGNIFY EACH OTHER.]

The most significant underlying key variables are:

geometry for upstream training dikes & spurs, alignment & shape for the intake structure, weir, sluiceway, headgate, ejector, scour protection scheme, settling basin geometry

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

Benchmark Method/Source	Measurement	Explanatory notes
Internet searches	21 Articles	
Patent searches	5 patents	various methods did not meet the performance requirement
Competitive products or processes	2 products	the concept of a divide wall is not new , but this is an entirely different application
Similar prior in-house technologies	14 products / processes	

Activity #1-1: Geometry to address sediment & water levels (Fiscal Year 2015)

Methods of experimentation:

Method	Experimentation Performed
Analysis / simulation:	63 alternatives

Baseline tests
- The baseline tests conducted before installation of the weir showed good simulation of a braided river.
- The high flow rates eroded the incised narrow channel system generated by low flows.

Results:

Conclusion:

Documentation:
Uploaded to RDBASE.NET: Northwest Hydraulic Consultants Ltd. v The Queen TCC.pdf (465KB)

Activity #1-2: Upstream training works (Fiscal Year 2015)

Methods of experimentation:

Method	Experimentation Performed
Analysis / simulation:	55 alternatives
Trials:	4 runs / samples
Physical prototypes:	2 samples

Tests with the weir indicated that upstream left-side training works are needed to protect the guidebank immediately upstream from the weir from erosive attack, prevent erosion of the left bank (Chitwan Park), and to direct approach flow to the intake.

An upstream training scheme consisting of three open dyke elements plus T-spur dykes both upstream and downstream from the open dyke sections was developed.

Results:

Conclusion:

Activity #1-3: Low Flow channel (Fiscal Year 2015)

Project Name:	Engineering - Tax Case (Northwest Hydraulics)	**Start Date:**	2012-01-31
Project Number:	1500	**Completion Date:**	2016-10-28

Methods of experimentation:

Method	Experimentation Performed
Trials:	18 runs / samples
Physical prototypes:	3 samples

[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.]

Bars built up in the 400 m wide approach channel during floods that isolated the intake during low flows. A series of tests[HOW MANY?] were conducted using submerged inner guide banks to create a low flow channel.

A 1 m high guidebank forming a channel 1/4 the width of the weir achieved acceptable results [NOTE: A DEFINITION OF ACCEPTABLE RESULTS WOULD BE BENEFICIAL].

Because the inner guide bank scheme concentrates flow and causes higher upstream water levels, a scheme using floodway gates was adopted for further study.

Results:

- Decrease Bed load Deposition: 60 % (60% of goal)
- Reduce Downstream scouring: 71 % (156% of goal)
- Minimize Production cost: 25000 $ (no improvement)

Conclusion:

A modified design using two 20 m wide gated floodways and one 20 m undersluice was effective in producing a low flow channel to the intake [NOTE: CITING MAX FLOW RATES WOULD HELP].

This was accomplished primarily with open floodway gates and a closed undersluice.

A larger radius right-side guidewall [NOTE: CITING HOW MUCH LARGER WOULD BE HELPFUL IN ADDING A DEGREE OF QUANTIFICATION TO THE TESTING] improves flow conditions when flow is guided by the right guidewall.

Significant variables addressed: alignment & shape for the intake structure, geometry for upstream training dikes & spurs, scour protection scheme, settling basin geometry, weir, sluiceway, headgate, ejector

Project Name:	Software R&D - International Guidelines (OECD)	**Start Date:**	2014-01-01
Project Number:	1501	**Completion Date:**	2016-10-26

Project Details:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
specialized: image/character recg'n, AI, GIS (x)	(not set)	(not set)	No
new theorems & algorithms (x)	(not set)	(not set)	No
advances in generic approaches (x)	(not set)	(not set)	No

Field of Science/Technology:

Computer sciences (1.02.01)

Project Details:

Intended Results:	Develop new processes, Develop new materials, devices, or products, Improve existing processes
Work locations:	Commercial Facility
Key Employees:	Al Einstein (Physics - PhD. (1938) / Lead Researcher)
Evidence types:	

Scientific or Technological Advancement:

Uncertainty #1: Clarify Computer Science vs. Business Problems

The most significant underlying key variables are:

level of o/s's, prog languages &/or tools (unresolved)

Technology or Knowledge Base Level:

Activity #1-1: Typically Eligible activities (Fiscal Year 2015)

Methods of experimentation:

Frascati Manual paragraph 140.

The following examples illustrate the concept of R&D in software.
Should be included in R&D:

– R&D producing new theorems and algorithms in the field of theoretical computer science.

– Development of information technology at the level of operating systems, programming languages, data management, communications software and software development tools.

– Development of Internet technology.

– Research into methods of designing, developing, deploying or maintaining software.

– Software development that produces advances in generic approaches for capturing, transmitting, storing, retrieving, manipulating or displaying

information.

– Experimental development aimed at filling technology knowledge gaps as necessary to develop a software program or system.

– R&D on software tools or technologies in specialized areas of computing

Results:

Conclusion:

Activity #1-2: Typically Ineligible activities (Fiscal Year 2015)

Methods of experimentation:

Software-related activities of a routine nature which do not involve scientific and/or technological advances or resolution of technological uncertainties are not to be included in R&D. Examples are:

– Business application software and information system development using known methods and existing software tools.

– Support for existing systems.

– Converting and/or translating computer languages.

– Adding user functionality to application programmes.

– Debugging of systems.

– Adaptation of existing software.

– Preparation of user documentation.

Results:

Conclusion:

Project Name:	Software - TAX CASE (ACSIS)	**Start Date:**	2015-01-01
Project Number:	1502	**Completion Date:**	2016-06-30

Project Details:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
CPU Hardware limitations (MHz)	500	100	Yes
Fault tolerance (%)	3	99.5	Yes

[2] The Appellant is a company based in Fredericton, New Brunswick. Its business activities focus on the development of health information systems, resource management software and process improvement consulting. This includes the creation of software applications for the centralized management of national, regional and local healthcare sectors.

[3] In 2004, Belize sought the assistance of the Appellant in implementing a national healthcare system in that country. The parties executed a contract on October 28, 2004. After commencing the project, the Appellant encountered a number of challenges in Belize, including poor telecommunication infrastructure. As a result of these challenges, the Appellant was unable to utilize its Electronic Health Record ("EHR") solution to address the project's goals, primarily because of the inability of the limited infrastructure in Belize to support this EHR technology. Consequently, the Appellant was unable to link the various health institutions, including health care centres, rural clinics, labs and pharmacies for the comprehensive exchange of data, as required pursuant to the terms of the project contract.

[4] According to the Appellant, it engaged in organized experimental and developmental activities to establish a new technology, the Accesstec Capacity Strengthening Information System, in order to adapt its existing EHR technology in an attempt to overcome the infrastructure challenges.

When the Appellant decided to proceed with the Belize project, rather than abandon it, the project necessitated consistent and dependable service despite the persistent and irregular connectivity issues encountered in Belize. Despite the constant interruptions in network service, each individual node had to function autonomously while maintaining the integrity of each patient's medical data in the absence of replicated data.

Mr. Kilburn explained that the Appellant's approach to even the simplest component of detecting when connectivity existed had to change because "… this was a different level of replication than … the Internet's not always on. It's on sometimes." (Transcript, April 9, 2015, page 38). The challenge was one of providing equal access to predictable data integrity where connectivity issues ran far deeper than would be encountered in a stable and secure environment such as Canada.

The goals and objectives consisted of creating a robust replication system capable of handling the infrastructure challenges in Belize.

The Appellant required a "write everywhere" replication system and "… undertook experimental development to attempt to create technology that could mimic the availability of stable communications infrastructure in a hostile network environment where nodes must optimize the utilization of the minimal network resources."

Transitioning of the replication algorithms to the conditions of the target environment required the algorithms to be more fault-tolerant in an attempt for the system to seize the advantage of connectivity when it was available

The technology that the Appellant was required to develop was meant to support and accommodate the applications that would preserve, transmit and store critical medical data with certainty and predictability in an unstable network environment. When conducting tests and formulating its hypotheses, the Appellant focussed on the following stated objectives:

1. Design and develop a system that would preserve, manage, transmit and store mission-critical data;
2. Achieve superior data security, stability and reliability within a hostile and volatile communications environment;
3. Achieve superior data confidentiality and protection;
4. Achieve system functionality on technologically-limited hardware;
5. Facilitate user self-reliability in order to achieve the solution user-adoption goals of system efficiency and data security;
6. Achieve perpetual and secure software updates in a volatile communications environment;
7. Ensure any source code released to users does not compromise the Appellant's ability to self-protect against intellectual property infringement;
8. Maintain failsafe conditions in an unpredictable environment;
9. Achieve solution functionality despite a low cost target; and
10. Advance the project's objectives while maintaining data integrity.

Field of Science/Technology:

Computer sciences (1.02.01)

Project Name:	Software - TAX CASE (ACSIS)	**Start Date:**	2015-01-01
Project Number:	1502	**Completion Date:**	2016-06-30

Project Details:

Intended Results:	Improve existing processes
Work locations:	Commercial Facility
Key Employees:	Colin Kilburn (Unknown - BSc. (1995) / Software developer)
Evidence types:	Design, system architecture and source code; Design of experiments

Scientific or Technological Advancement:

Uncertainty #1: Technological uncertainty

Initially, the Appellant attempted to duplicate the target environment conditions of Belize in the laboratory, focusing on the correct operation of replication algorithms, without the burden of network problems, in order to isolate potential defects in the algorithms. Transitioning of the replication algorithms to the conditions of the target environment required the algorithms to be more fault-tolerant in an attempt for the system to seize the advantage of connectivity when it was available.

[30] The technological uncertainties were summarized at Exhibit A-1, Tab 4 and consisted of fourteen in number. However, in light of the necessity of preserving the integrity of the database, the primary uncertainties included:
1. Database replication in an unreliable network environment had to be explored as available tools were inadequate and research was scarce;
2. Approaches had to be formulated to transport data, merge changes to database records from multiple databases, preserve and merge changes to records at multiple locations without loss of critical data while overcoming frequent network interruptions;
3. The unknown implications that multi-site, asynchronous data manipulation would have for the real world applications that it would need to support;
4. Even if uncertainties could be overcome, it was unknown if their developed hypothesis would be sufficient to enable the nation-wide, mission-critical data applications;
5. Recovery from data integrity problems when nodes were offline for any extended period of time; and
6. After extended periods of dis-connectivity and large amounts of changes queued up, how to exchange those changes to other nodes in an environment of infrequent connectivity.

The most significant underlying key variables are:

sequences and subscriptions, node and master behaviour

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

Benchmark Method/Source	Measurement	Explanatory notes
internet searches	20 Articles	The replication systems that were available were intended for different purposes and were not appropriate to achieving the Belize project goals. Those existing replication systems did not account for the nature of the severe underlying network problems.
Competitive products or processes	10 products	The Appellant searched unsuccessfully for an existing “off-the-shelf” replication software system.

Activity #1-1: Activity 1 (Fiscal Year 2015)

Methods of experimentation:

Method	Experimentation Performed
Analysis / simulation:	450 alternatives
Trials:	19 runs / samples

The claimant provided a SR&ED activity sample that elaborated on the systematic investigative process that occurred with respect to a particular task, of observing and analyzing replication functionality over dial-up, which was part of the larger project.

This was meant to serve as an example of one experiment of many project elements that took place over a three-week period in early 2006. The document outlined the objectives, procedures, observations conducted and investigative techniques that were pursued and utilized in respect to this one element. These various documents showed how the project evolved in respect to developing hypotheses, conducting various testing of theories, installing and refining algorithms and evaluating the outcome.

On cross-examination, Mr. Rutter stated that the Appellant did not “measure these connectivity issues”, except through observation and experience, because the Appellant had no control over the private company in Belize that was in charge of connectivity in that country. When asked how the Appellant measured effectiveness, Mr. Rutter testified that this measurement related more to the integrity of the data and the accuracy with which it reached its destination despite connectivity challenges.

Mr. Kilburn also explained how conducting unit tests eventually led to staging tests where algorithms were tested and refined in simulated environments. In summing up what the Appellant was doing, he stated: ... We formulate some assumptions. You develop your solution based on this and then you test the theories and see if it solves your problems.

The initial investigative trials revealed that algorithms were vulnerable to lost data due to poor connectivity. Measurement occurred at the design stage and, according to the testimony of both Mr. Rutter and Mr. Kilburn, preliminary testing occurred at the pseudo-code stage prior to using actual code. At the pseudo-code stage, vulnerabilities were reviewed and solutions looked at to make these aspects more reliable.

[37] Mr. Kilburn explained how refinements to ideas for prototypes occurred and how “implementation notes” were kept for the various components contained in the documents (Transcript, April 9, 2015, page 39). He referred to the content of these notes, which list “rough algorithms” for network behaviour, the three stages of full synchronization using the mobile connector, the operative requirements of the node manager in order for it to manage sequences and subscriptions, and node and master behaviour (Exhibit A-1, Volume 2, Tab 22). This exhibit contained copies of handwritten notes respecting such items as whiteboard sessions and online replication ideas in February, 2005, thoughts on conflict detection in June, 2005, potential concepts on how to implement automatic software updates in July, 2005, staging tests and data integrity completed in August, 2005, accounting data bootstrapping in September and October, 2005 and file transfer and file splitting. Attached to those notes was a SR&ED activity sample that elaborated on the systematic investigative process that occurred with respect to a particular task, of observing and analyzing replication functionality over dial-up, which was part of the larger project. This was meant to serve as an example of one experiment of many project elements that took place over a three-week period in early 2006. The document outlined the objectives, procedures, observations conducted and investigative techniques that were pursued and utilized in respect to this one element. These various documents showed how the project evolved in respect to developing hypotheses, conducting various testing of theories, installing and refining algorithms and evaluating the outcome.

[38] Mr. Kilburn testified that the “scientific method”, when applied to computer programming, does not have the same structure that would be employed in a science such as chemistry, where measurement is used in a different context. When asked on cross-examination if he tracked the number of tests that he ran, he stated that the tests conducted take many forms, average in the hundreds and “… there’s a tests [sic] that’s written once and is executed a thousand times.” (Transcript, April 9, 2015, page 70).

[12] Mr. Kilburn testified that he kept notes, whiteboard photos and computer script notes, which were completed contemporaneously with the planned testing being conducted. In conducting test cases, some of them were embedded in the software through unit tests, while others were developed through “idea development” from initial brainstorming to prototyping design of the various aspects of the health information system that had to be integrated within an environment of unreliable network connectivity. Unit tests and staging tests led to algorithms that could be refined and installed to try to simulate and validate theories based on available connectivity. Mr. Kilburn testified that logs, or notebooks of the software, tracked events and if there were errors or connectivity issues, an analysis of the logs was conducted. The code was modified to address the problems so that eventually, based on the anticipated environment, the code would behave as expected at every facility in Belize. In addition to constructing algorithms that would synchronize data across a multi-write network and ensure that mission-critical patient data had complete availability and absolute correctness,

Mr. Kilburn testified that logs, or notebooks of the software, tracked events and if there were errors or connectivity issues, an analysis of the logs was conducted. The code was modified to address the problems so that eventually, based on the anticipated environment, the code would behave as expected at every facility in Belize. In addition to constructing algorithms that would synchronize data across a multi-write network and ensure that mission-critical patient data had complete availability and absolute correctness,

Results:

- CPU Hardware limitations: 150 MHz (87% of goal)

- Fault tolerance: 99 % (99% of goal)

Conclusion:

According to the judge;

[41] The solution to the technological uncertainties that existed with the Belize project resulted in the creation of a multi-write database replication system. This approach was not only innovative but leading-edge in that it produced an integrated health information system that resulted in the successful establishment in Belize of the first nationwide health information system of its kind.

The evidence suggested that the available open source replication solutions were inappropriate as they were meant for very different purposes within the field, designed to work with strong connectivity infrastructure.

Since an appropriate replication solution was not available, the Appellant undertook experimental development work to create technology that could mimic a stable communications infrastructure in the hostile environment that existed in Belize.

Significant variables addressed: node and master behaviour, sequences and subscriptions

Documentation:

- Offline Documents: journals, whiteboards & computer scripts, Oral testimony accepted

Project Name:	Software - TAX CASE (ITC invoice to cash)	**Start Date:**	2015-02-01
Project Number:	1503	**Completion Date:**	2016-03-31

Project Details:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective	Has results?
interoperability (databases)	2	500	No
scalability (concurrent users)	200	500	No
Report generation time (sec / MB data)	2.5	1	No

In Mr. Sarmiento's view, the Appellant was not mapping or mining data, in respect to this particular project but, instead, was trying to discover the process flow in the otherwise unknown software system. According to his evidence, data mining is standard practice when the original databases and data sources are known so that information can be extracted in order to be converted. If the source is unknown, the technological challenge will be to retrieve information from that system, which he testified, goes beyond data conversion.

Specifically, the Appellant could not "map and mine data from Factorsoft, without knowing the structure of the database." The Appellant had no access to the proprietary software belonging to Bayside or of the business logic implemented in that software that processed the data. In this respect, the Appellant's activities went beyond data mapping and data mining.

Process mining involved the discovery of a process field inside an existing information system where there is no possibility otherwise of extracting the information. In doing so, the Appellant was attempting to, not only understand the structure of the database itself, but also pursue its goal of interacting with the entire system.

There were three technological objectives of the Appellant's Factorsuite Project.

First, the Appellant sought to interface Factorsuite with the third party software, FactorPC and Factorsoft, which was owned by Bayside, in order to ensure the functionality and integrity of calculations between these software applications.

Second, the Appellant sought to maintain this functionality and integrity with regard to its auto-faxing feature, so that personalized client reports could be transmitted efficiently and in real time.

Third, the Appellant sought to achieve "interoperability and scalability" between existing but disparate factor software applications and the Appellant's own Factorsuite technology so that data, which included balances, statements of account and historical transaction data, could be presented to clients instantaneously, precisely and with security (Exhibit A-2, pages 3 to 4).

Field of Science/Technology:

Computer sciences (1.02.01)

Project Details:

Intended Results:	Improve existing processes
Work locations:	Commercial Facility
Key Employees:	Isaac Newton (Mechanical engineering - MASc. (1974) / Research Manager)
Evidence types:	

Scientific or Technological Advancement:

Uncertainty #1: Process mining techniques

According to Mr. Caicedo's testimony, one of the underlying technological challenges was to achieve integration of all these technologies where it was difficult for the Appellant to actually change the technology. He explained that certain elements, however, could be introduced to the existing technology to achieve the desired result.

The Appellant's second witness, Victor Sarmiento, who was qualified as an expert in software development, elaborated on Mr. Caicedo's testimony. Mr. Sarmiento's company, Highweb & Page Group Inc., completed work on the Appellant's Project. According to his evidence, techniques, performed by the Appellant, in respect to establishing a relationship

between two known databases, consisted of more than data mining and data mapping and instead, according to his testimony, the Appellant was actually engaged in process mining:

A. […] The problem here and the challenge here was that we didn't know database A at all. It was a proprietary software from a company, and they did not disclose at all any of the details not only of the database, but also the business logic implemented in the software that processes that database. In that sense, it is not data mapping; it is not data mining.

STANDARD PRACTICES & RELATED METHODS:
What we did at the time was try to obtain knowledge from this system, simulating transactions through these unknown systems, and analyzing the results in order to get some conclusions of what this system was doing and how it was structured. Based on that, we were basically generating multiple transactions and analyzing not only the results, but all the history of these transactions that are stored. From that perspective, at the time – we are talking about 2007 – there was no name for this.

It wasn't until recently, in 2009, when the Institute of Electrical and Electronics Engineers created a task force for the development of this type of technique, and it was called process mining, which is a different aspect. The Institute of Electrical and Electronics Engineers published a manifesto in order to promote the development, the evolution and adoption of process mining. This document was published in 2011. We are referring to a discipline that we were performing to some extent back in 2007, when the Institute of Electrical and Electronics Engineers were working in establishing a task force two years later, in 2009, and to then publish this manifesto in 2011.

Mr. Pellissero set out three technological uncertainties related to the Appellant's activities:

The first one was how do we get information & move the data from Factorsoft to Factorsuite?

Their second claimed technological uncertainty was how do we move the information from Factorsuite, their own product, to ActFax, the third party product to fax out, because they were having problems with that.

The third technological uncertainty was to speed up the queries and/or queries that generate reports because they were experiencing slowness in this generating reports.

The most significant underlying key variables are:

proprietary (closed source) info - INELIGIBLE (unresolved)

Technology or Knowledge Base Level:

Activity #1-1: Activity 1 (Fiscal Year 2015)

Methods of experimentation:

Since the technology did not exist in the public domain, hypotheses were formulated and testing completed by employees, as well as an external company hired to do coding. As an example of the experimentation undertaken by the Appellant, he stated that, in attempting to reduce caching time, five or six different approaches were pursued and within each of these, testing was completed.
Is it possible that you have overlooked the fact that during testimony witness Victor Sarmiento stated clearly that the challenge was not to move data, but to achieve interoperability and scalability between these two disparate platforms? (Transcript, April 21, 2015, page 122)
Q. […] So in your determination of eligibility, is it conceivable that you have overlooked the fact that the information was unavailable even from the supplier of the software?

In respect to the first claimed uncertainty, the attempt to understand the structure of data belonging to a third party software vendor in order to have it work in conjunction with its own Factorsuite application, Mr. Caicedo testified that the processes of data mining and data mapping were used to determine the data in the database and its structure. Mr. Sarmiento described the technique that was utilized as process mining, which included the examination of event logs in order to determine how a program was functioning. Although Mr. Sarmiento referred to an article, first published in 2011 on process mining, the Appellant did not produce the article. The Appellant's agent, in his submissions, also indicated that the technique of process mining mayhave been available as early as 2008. According to Mr. Pellissero, the technique existed in 2007 and information on it was available. There can be no technological uncertainty if the resolution of a problem is reasonably predictable using already available standard procedures or routine engineering (Northwest Hydraulic, at paragraph 16). The Appellant failed to produce sufficient evidence to support its contention that uncertainty existed in the Factorsoft and Factorsuite interoperability and failed to adduce evidence to specifically identify the work that would have been conducted to accomplish such a process. The third party programs were running without apparent problems and as Mr. Pellissero explained: "… it … tells us that the programming language is coded syntactically correct, the underlying syntax in the program is good, the database was

generated according to what the database is doing, according to its limits and constraints." (Transcript, April 21, 2015, page 77). In fact, it is unclear from the evidence what the precise state of the available knowledge was at this time. Based on the facts, I would conclude that the techniques used, to determine what information or data was contained in the unknown programs and how it could eventually interact with the Appellant's own Factorsuite program, were the available standard procedures routinely used by a competent programmer.

[31] With respect to the second uncertainty alleged by the Appellant, the fax sending component of the program, it would appear from the evidence that programs, designed to generate client reports that were sent efficiently and in correct order, are routine and standard procedural work that competent computer programmers perform. The Appellant's solution involved the examination of the data that the faxes would contain and then a procedure was written and a holding area created where the faxes could be sent in the correct order. The evidence does not support that this procedure involved a technological uncertainty.

With respect to the third uncertainty, the requirement to find a system that would produce client reports in real time, the Appellant failed to convince me that the procedures to process reports, cache them and refresh them so that those reports that were used more frequently could be accessed more readily, were anything more than routine procedure for a competent programmer

Results:

Conclusion: