Contents

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

KEY CRITERIA SUMMARY

1401 - Miniature Printer - TAX CASE (6379249 Canada Inc.)				
BENCHMARKS	**ACTIVITIES BY YEAR**			
Internet searches: 100 Articles Patent searches: 14 patents Patent searches: 14 patents Competitive products or processes: 5 Similar prior in-house technologies: 54	2014			
Potential components: 7 products	'1-1	'1-2	'1-3	'1-4
Potential components: 50 products	Clutch & Static	slip clutch	New print driver	Analysis
OBJECTIVES	**RESULTS**			
Battery life: 20 pages	8	12	21	
Jam rate: 1 jams/1,000 sheets	140	95	22	
Ambient humidity limit: 95 %	87	92	94	94
Media thickness upper: 0.1 mm		0.11		
Media thickness lower range: 0.05 mm			0.06	
Speed (pages per minute): 5 ppm			6	
felt medium life: 20 1000's / pages	14.5	17	18.5	
Overall reject rate: 0.1 %	17	11	6	
Cost : 80 $			87	
UNCERTAINTIES & KEY VARIABLES	**CONCLUSIONS**			
1 - Variables cited in tax case				
clutch plate surface area & use of ridges		Y		Y
degradation)				
moisture vs anti curl mechanism				
slip clutch				
static versus dynamic load	Y		Y	
	METHODS			
Analysis			400	
Trials	2300		70	1200
Prototypes	7			14
Lines of code	4300			
	COSTS			
Hours	200	750	500	200
Materials $		7500		5000
Subcontractor $				

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; Photographs and videos; 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 (unresolved), felt (friction, compression & degradation) (unresolved)

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

View Prior Art Docs

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

Methods of experimentation:

Method	Experimentation Performed
Trials:	2300 runs / samples
Physical prototypes:	7 samples

Mr. Tuli stated that they looked for literature on how the felt could affect the paper tension (the slip clutch) and the motor. Mr. Tuli stated that they did not find any literature on the impact of the felt on the slip clutch and on the motor.

The purpose of the slip clutch in the printer was to provide back tension to straighten the paper. The slip clutch was composed of two concentric disks that were pressed against each other with a piece of felt in between. The first hypothesis was that the felt disc was degrading too quickly and this had an effect on the slip clutch and the paper straightening. Although it was recognized that felt would degrade over time, the appellant did not expect that the felt would degrade so rapidly.

Mr. Tuli analysed different felt materials to determine how they potentially compressed or degraded over time within the anti-curl system and what effect the felts had on the curling of the paper. The test results with respect to the felt materials were documented and an analysis of the testing led to the conclusion that the best quality felt material was producing the worst results, namely the motor was stalling even more frequently than before

Results:

- Battery life: 8 pages (20% of goal) -- felt with cross web provided improved batterylife
- Jam rate: 140 jams/1,000 sheets (6% of goal)
- Ambient humidity limit: 87 % (20% of goal)
- felt medium life: 14.5 1000's / pages (71% of goal) -- molded felts with cross weaves provided best performance
- Overall reject rate: 17 % (15% of goal)

Conclusion:

CLIENT CLAIM:

After observing the behaviour of the motor, Mr. Tuli realized that until now, they had failed to consider the effects of the static and dynamic regimes separately, since all testing had been dynamic tests. They noticed that a felt with a lower static friction coefficient combined with a more consistent dynamic friction coefficient would better resist compression over time.

The difference in the motor's power consumption between the static and dynamic regimes could be minimized with the proper selection of the felt material. The tests performed allowed the appellant to select a better balanced felt and properly balance the motor's power consumption between the static and dynamic regimes. The minimization of the difference in power consumption between the two regimes minimized the frequency of motor stalling.

CRA POSITION:

Mr. Wierzbica, trying to find the best felt was not SR&ED.

With respect to the analysis of static versus dynamic friction regime, the respondent submitted that, in electrical engineering, it is common knowledge that the power consumption of an electric motor differs significantly in its dynamic condition from its static condition.

JUDGES RULING: ELIGIBLE

The experiment with respect to the felt allowed the appellant to discover that the felt used in the disk between the paper reel and the clutch had a positive effect on the paper tension and the power of the motor;

The identification of the static versus dynamic load aspect of the electric motor as the main factor to adjust the battery life is a technological advancement with respect to the previous technology;

Significant variables addressed: static versus dynamic load

Documentation:

- Uploaded to RDBASE.NET: 2015_TCC_77 6379249 CANADA INC. Printer development WIN.pdf (223KB)
- Offline Documents: Felt properties & testing

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

Methods of experimentation:

Mr. Tuli then decided to circumvent the degradation of the felt with another hypothesis, the redesigning of the slip clutch.

A redesigned slip clutch could reduce the impact of the felt degradation and ensure longer term efficacy of the clutch mechanism to maintain paper straightening. An investigation was carried out to determine methods to increase the surface area of the clutch component that was in direct contact with the felt disk.

By making the slip clutch bigger, less force would be applied to it. However, it was important not to increase the overall diameter of the clutch in order not to modify the size of the printer. Various options were considered, the slip clutch was redesigned whereby the two surfaces of the clutch and the reel in contact with the felts would have a series of concentric interlocking grooves or ridges that would increase the effective surface area of the clutch.

Mr. Tuli stated that they could not find any publication on this. In his view, that type of slip clutch had never been done before. The test results demonstrated that the new design reduced the force applied on the felt, therefore allowing the felt to maintain its friction force for longer periods of time.

Results:

- Battery life: 12 pages (46% of goal)
- Jam rate: 95 jams/1,000 sheets (36% of goal)

- Ambient humidity limit: 92 % (70% of goal)
- Media thickness upper: 0.11 mm (150% of goal)
- felt medium life: 17 1000's / pages (84% of goal)
- Overall reject rate: 11 % (45% of goal)

Conclusion:

CLIENT CLAIM:

The conclusion was the new clutch design led to an increase in tension on paper when passing through the anti-curl system, resulting in improved paper straightness.

In Mr. Tuli's view, these improved design features of the aforementioned elements of the anti-curl system represented technological advancements over the previous base of technology.

CRA POSITION:

Mr. Wierzbica submitted that the new design slip clutch remained almost the same as the previous slip clutch. The only changes were the modifications of the two plates in order to increase the surface area so the pressure would be smaller on the felt. Mr. Wierzbica did not see any value in having concentric interlocking grooves or ridges.

JUDGES RULING: ELIGIBLE

The new clutch design using concentric ridges, led to an increase in tension on paper when passing through the anti-curl system, resulting in improved paper straightness. Mr. Tuli stated that he had designed many slip clutches and such a design had never been done before; This improved feature is a technological advancement with respect to the previous technology.

Significant variables addressed: clutch plate surface area & use of ridges

Activity #1-3: New print driver (Fiscal Year 2014)

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: 21 pages (106% of goal) -- In addition, the printer driver improved the life of the battery and the motor applied the required force to the anti-curl mechanism.
- Jam rate: 22 jams/1,000 sheets (85% of goal)
- Ambient humidity limit: 94 % (90% of goal)
- Media thickness lower range: 0.06 mm (no improvement)

- Speed (pages per minute): 6 ppm (100% of goal)
- felt medium life: 18.5 1000's / pages (92% of goal)
- Overall reject rate: 6 % (70% of goal)
- Cost : 87 $ (65% 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 with web handling.pdf (135KB) – click to view**

Activity #1-4: Paper Moisture Analysis (Fiscal Year 2014)

Methods of experimentation:

Method	Experimentation Performed
Trials:	1200 runs / samples
Physical prototypes:	14 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: 94 % (90% 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: clutch plate surface area & use of ridges

AUTHOR'S NOTE: In this case the claimant was successful in its tax credit claim despite the fact that they did not supply the level of experimental evidence which we have provided in this example.