# INSTRUCTIONS

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| * Please make sure you are using the latest version of this form posted on  [**www.mitacs.ca/en/programs/accelerate/apply-now**](http://www.mitacs.ca/en/programs/accelerate/apply-now) * Please **do not modify, remove** text or instructions in each section/subsection **or reformat** this form in any way. A modified form will result in a delay in the internship evaluation process. * Detailed information onhow to write your proposal can be found in the [*Accelerate Guide: Writing your proposal document*](http://www.mitacs.ca/sites/default/files/uploads/page/writing_your_proposal_-_accelerate_2017.pdf). * Send your draft proposal to your [Mitacs Business Development Representative](http://www.mitacs.ca/en/contact-us/business-development) **prior** to obtaining all signatures and submitting. * The proposal should be written and submitted **at least eight (8) weeks prior to the planned start date of the internship.** * The start date of the internship has to be **after** research approval and the **receipt** of the partner funds at Mitacs. * Partner funds can be sent directly to Mitacs prior to approval to expedite the process. * If applicable, proposals with a not-for-profit partner must seek partner and project eligibility approval before proceeding. Please contact a [Mitacs Business Development Representative](http://www.mitacs.ca/en/contact-us/business-development) to discuss the eligibility of an NFP organization **BEFORE** submitting your application (see section 2.7). * If applicable, [conflict of interest declarations](https://www.mitacs.ca/sites/default/files/uploads/page/mitacs_conflict_of_interest_declaration_july2016.docx) must be received by Mitacs **before** submitting your application (see section 4.1/4.3). * If you cannot see the items listed in the drop downs, please refer to the Appendix B: Options and type the corresponding answer on the space provided. |

**Please note:**

If required, your **Mitacs Business Development Representative** can assist you with:

* Identifying your Office of Research Services (ORS) or equivalent representative.
* Assessing the eligibility and completeness of the proposed research.

# APPLICATION CHECKLIST

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| **A complete internship application package must include the following :**   * The proposal application **completed and signed** by all parties in Word form. *The Mitacs Accelerate Memorandum* (see Section 7) with signatures must be submitted as a scanned PDF file. * List of six external expert, arms-length reviewers and their contact information. * Intern(s) CV (a [CV template](https://www.mitacs.ca/sites/default/files/uploads/page/mitacs_accelerate_intern_cv_template_2017.doc) is available on the Mitacs website). * Lead Academic Supervisor's CV **only** for projects with **6 IUs and up** (CCV as per Tri-Council or other CV format). * Excel budget spreadsheet: *Accelerate Resource Plan and Invoicing*. * Any supplementary documents (as applicable). * Appendix A - Accelerate Intern Consent Form signed.   \* **An incomplete application or a modified form will result in a delay in the internship evaluation process.** |

For more information, contact a [**Mitacs Business Development representative**](http://www.mitacs.ca/en/contact-us/business-development)**.**

**Mitacs Accelerate Proposal Application**

### Research Proposal Summary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| * 1. **Title of project:** | Optimizing modern day vinyl presses | | | |
| * 1. **Type of project:** Please indicate (x) | (\_) Standard | | | |
| (\_) Cluster (minimum of 6 internships and 3 interns) | | | |
| (X) Masters Fellowship (maximum 3 internships) | | | |
| (\_) PhD Fellowship (maximum 6 internships) | | | |
| * 1. **Number of Internship units:** | 3 | | | |
| * 1. **Keywords to identify reviewers:** (3-10 specific keywords; 50% technically related, 50% discipline-related) | vinyl records, audio, manufacturing, signal processing, physics, materials, engineering | | | |
| * 1. **Academic discipline:** | Physical Sciences | |  | |
| * 1. **Project priority sectors:** | Advanced Manufacturing | Entertainment & Media | | Technology |
| Please **rank up to three** top priority sector(s) of your project: | 1 | 2 | | 3 |

* 1. **List of participants:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Supervisor(s)** | | **Department** | | **Academic Institution** | |
| John Vanderkooy | | Physics and Astronomy | | University of Waterloo | |
| Jim Martin | | Physics and Astronomy | | University of Waterloo | |
|  | |  | |  | |
| **Partner organization(s)** | **Contact name at partner organization** | | **Province of organization** | | **Partner Legal Status** |
| Viryl Technologies | James Hashmi | | Ontario | | For Profit Canadian Private Corporation |
|  |
|  |  | |  | | Select Legal Status |
|  |
|  |  | |  | | Select Legal Status |
|  |

* 1. **Proposed work plan for internship unit(s) (IU):**

Please summarize the work plan for the project by showing which intern will work when. This table provides a high level overview of the proposed research project and information about intern(s) to the reviewers. Please refer to the [**Accelerate Guide: Writing your proposal**](https://www.mitacs.ca/sites/default/files/uploads/page/accelerate_writing_your_proposal_19may2015.pdf)to assist you.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Years** | | | | **Year 1** | | | | | | **Year 2** | | | | | | | **Year 3** | | | | | |
| **Months** | | | | **1-4** | | **5-8** | | **9-12** | | **1-4** | | **5-8** | | | **9-12** | | **1-4** | | **5-8** | | **9-12** | |
| **Intern Name** | **Degree Program** | | **IU** |  | | | | | | | | | | | | | | | | | | | |
| Christopher Zaworski | Physics | | 3 | X | | X | | X | | X | | | X | |  | |  | |  | |  | | |
| **Total Internship Units** | | | **3** |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |
| **Total Project Funding** | | **$40 000** | |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |
|  | |  | |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |

### Description of Proposed Research

* 1. **Project title:** Optimizing modern day vinyl presses
  2. **Research Abstract** (Approx. 200 words):

Please include: Research problem to be addressed and its significance, objectives, and proposed methodology. This section will be used to recruit reviewers; it differs from section 7.2. (Public Project Overview) and must clearly summarize the research proposed.

This project is a collaboration between the University of Waterloo and Viryl Technologies, a company based in Toronto that manufactures the WarmTone—a fully automated, cloud-serviced vinyl record press. The goal of this research is to establish measurements that can quantitatively assess the audio quality of a vinyl record, better understand the underlying physics that cause vinyl surface noise, pops and clicks, distortion and other unwanted audio defects and lastly study how the conditions under which a vinyl press operates affects the final audio of a record. The first stage of this project is to develop reliable, scientific and quantitative measurements of audio quality for a vinyl record. Then a number of records will be manufactured at Viryl, while varying the manufacturing conditions within the WarmTone’s standard operating parameters. The audio signals on these records have been designed by the researchers at the University of Waterloo and will be used to isolate and measure any changes in audio quality that result from these changing operating parameters. The project’s key milestones are to: press a control group of test records, develop software tools to analyze the digital recordings of these records, decide upon what manufacturing parameters will be explored and schedule when the records will be pressed alongside Viryl engineers, complete the pressing and recording of the records and analyze the data to produce the final reports and masters thesis.

* 1. **Background** and review of relevant prior work (minimum 500 words):

Vinyl records are currently experiencing a renaissance, Nielson Music has reported the 12th consecutive year of growth for vinyl sales in 2017—vinyl now holds a 14% share of physical album sales an all time high for Nielsen, which began its tracking in the 90s.[2] With this boom being a relatively recent development, this revenue is seeing a slow crawl to be reinvested in the vinyl manufacturing industry. Michael Palm of the University of North Carolina’s 2017 article, notes the backlog and bottlenecking that occurs in the vinyl supply chain.[3] A major cause for this backlog is the labour-intensive process of manufacturing records, as well as the unavailability and age of the equipment used in the manufacturing process. It is not uncommon for modern record plants to employ presses dating back to the 1970s. This can cause unwanted and expensive delays, with thousands of dollars spent to replace obsolete parts.[4]

Alongside this increase in sales is an uptick in research into improving the archaic manufacturing method of records. Much of this research is focused on a radical shift of the phonographic medium as a whole. 3D printed records have long been a fascination however there are serious limitations in their audio reproduction that thwart their advent, such as a greatly reduced audio resolution and a bit rate that is one-fourth that of a standard MP3 file.[5] Other attempts at reinventing vinyl such as HD Vinyl, while making waves in the industry, have been met with debate and skepticism. Listeners are uncertain that the new production methods will be able to replicate the sound quality of a traditional vinyl press.[6]

This project fills a distinct void, rather than attempt to reinvent the medium, this research is focused on optimizing the pressing method already utilized by the industry to obtain the best possible audio quality using modern materials and analysis. Viryl Technology’s WarmTone press is one of the few new presses available on the market. The WarmTone is fully automated and cloud-serviced, however still maintains the old pressing techniques from vinyl’s heyday. This project will develop reliable, scientific and quantitative measurements and tests of the audio quality of a vinyl record—something that is too often saturated with claims from hobbyists and enthusiasts. There are many myths, misconceptions, or unsubstantiated claims in the vinyl community. The most common offender is the belief that heavy weight records are superior in audio quality compared to lighter weight records (180g vs 140g) however there is no scientific evidence to support or contradict this statement.[7]

Phonographic records were a common area of study during the prime of vinyl manufacturing in the 1960s and 70s. James Kogen’s 1967 paper *The Skating-Force Phenomenon,* is a study into the forces exerted on a phono cartridge during playback of a record[8]. While Kogen presents his own findings he agrees that more research into the subject is needed for conclusive results. Current research on the subject continues, as recently as 2009 results have been published looking at digitally modelling phonograph tracking distortion, a type of distortion that occurs due to the difference between the shape of the playback needle and cutting head.[9]

The analysis used in this project will draw heavily on accepted standards of audio measurement and quality and apply these to the measurement of vinyl records. Robin[10] describes a method of measuring signal to noise ratios of analog broadcasting systems, involving sending a 1 kHz signal of known amplitude through a broadcasting system and comparing it to the baseline noise with no signal. This technique is similar to how the researchers intend to measure the signal to noise of a vinyl record in this project, comparing the level of “silent” tracks on the record to the 1 kHz tones cut to the vinyl. By establishing a way to quantitatively assess a vinyl record’s quality in the context of manufacturing, this project also has the opportunity to serve as the springboard for further innovation in the field. Previous study into the manufacture of phonographic records had focused on the quality of the stampers used in the press, considering them the key to the problem.[11]

Broadly speaking, there are two main aspects that affect vinyl record quality:

1. Cosmetic defects, not all of which impact audio quality (macroscopic physical defects)
2. Audio defects during playback that manifest as a result of poor formation of the physical grooves (can be micro- or macroscopic physical defects)

This research project will focus solely on studying the defects that occur in the audio playback. Given the tools readily at our disposal and Viryl’s involvement in this project, our interest would be in examining audio defects related to and caused by the pressing stage of manufacturing.

Some common audio defects that Viryl are aware of and wish to be examined in this research are:

* Random audio artifacts like pop/clicks. Pops and clicks that are not in the same place from record to record indicate poor filling of grooves and almost always attributed to the pressing process.
* An audio artifact in the exact same spot of the record on multiple copies indicates either poor setup of the stamper mounting (e.g. debris underneath the stamper that dents the stamper) or a flaw in the stamper itself due to issue with plating or lacquer cut.
* Up/down movement of the needle is due to warp of the record during the pressing process. Warp or lack of flatness is due to several thermal and/or flow characteristics of the plastic during pressing, which can be influenced by imbalance between heating and cooling of the moulds.
* Left/right sway of turntable needle (phasing effect) is due to eccentricity between the top and bottom grooves. Usually because either the top or bottom stamper was mounted off-centre relative the record centre hole. This misalignment is very unlikely on the WarmTone compared to older machines due to setup workflow. More often this issue is caused by bad stamper “coining”, punching the center hole of the record to suit the mounting features on the pressing machine.
* Turntable needle skips can be due to extreme non-fill of grooves, but when it is consistently on the same spot of the record then it is a result of poor mastering (e.g. grooves are spaced too closely together and intersect).

Creating a vinyl record is a many stage process. Mastering, lacquer cutting, plating and stamper moulding all occur before a record press operates and each stage will have its own effect on the resulting audio signal. By creating a test record with known signals, having control over the record press and analyzing the variation in audio quality from record to record during pressing we hope to isolate the effect that the press has on audio. The records contain quiet tracks, a series of pure sine tones and a logarithmic sweep of frequencies from 10 Hz up to 16 kHz. The signals have been cut traditionally as a stereo signal, in either the left or right channel and vertically. The records will contain this exact series of signals at both the beginning and end of the record, as well as on both sides of the record. That way the bottom and top pressings can be measured against one another, as well as signals pressed to the edge and centre of a vinyl record.

* 1. **General objective** of the research project broken down into sub-objectives, activities, themes, or subprojects, as applicable:

The general objective of this research is to establish a quantitative measure of a vinyl record’s audio quality, study the impact that surface features on the record have on noise and other audible defects and lastly use these measurements and physical models along with a large sample of records to optimize the quality achieved during the pressing stage of manufacturing a vinyl record. This research will produce a masters thesis from the intern, and give Viryl Technologies the knowledge and analytical tools to produce records of optimal audio quality.

The three main aspects to this research are, measurement, understanding and study. This research will establish measurements that can quantitatively assess the audio quality of a vinyl record. It will seek to better understand the underlying physics that cause vinyl surface noise, pops and clicks, distortion and other unwanted audio defects. Lastly it will study how the conditions under which a vinyl press operates affects the final audio of a record.

Although the optimization of a record press will largely be a regressive statistical study, an attempt will also be made to study the underlying physics of record surface noise.  Preliminary results have shown variation of the noise with groove tracking speed, modulation amplitude and both stylus and antiskating force magnitudes.  We intend to determine if models of friction and surface conditions can account for some of this data.  It may be necessary to make some alterations or additional sensing of the stylus/record-surface interaction for such studies.

**2.4.1: Produce a control group of test records with which to conduct measurement and develop analytical techniques**

**2.4.2: Develop software tools for analyzing the digital recordings**

**2.4.3: Decide upon manufacturing parameters to be tested and number of records required**

**2.4.4: Complete pressing and recording of the records**

**2.4.5: Complete analysis and write the final reports**

* 1. **Details of internships or subprojects:**

**For each intern or subproject, provide the following mandatory information:**

* + 1. **Name of intern.**

Christopher Zaworski

* + 1. **Specific objectives of the internship or subproject**. Clearly state your [sub-] objectives so reviewers can assess if they are achievable.

Refer to section 2.4.

* + 1. **Methodologies**. Provide enough detail so reviewers can determine if the proposed methodology is appropriate and sufficient to achieve the [sub-] objectives.

The primary assumption of this project is that a record’s audio quality can be judged from digital recordings. Currently a record’s audio quality is assessed manually, requiring an operator to be trained to spot audio defects and irregularities. To achieve this goal every record produced for this test will be recorded under identical conditions on the same setup. This setup consists of a high quality turntable, RIAA phono preamplifier and a USB audio interface. Consumer vinyl listening setups vary greatly and any attempts to emulate or test the different listening setups are well outside the scope of this project. The components of this listening setup have all been chosen to be of high enough quality as to not influence any measurement made on the digital recording. The signal to noise ratio of the USB interface, the preamps adherence to the RIAA standard equalizer curve and any rumble noise caused by the turntable will all be measured to ensure that they do not influence any measurement of audio quality of the recordings. Preliminary measurements of the equipment and vinyl records at the university show that achieving a digital recording that meets these requirements will be straightforward with equipment on hand.

Since this study is comparing records, recording each record under identical conditions will ensure that the differences in each recording can only be caused by differences present in the individual vinyl records being played. This should eliminate any effects that the equipment used would have on the measurements of audio quality. This comparative analysis can also help to reduce the effect that the other stages of vinyl record production have on audio quality.

While the signals on these records have been designed by the researchers and produced under controlled conditions at Viryl, there are still factors that will affect the audio quality that cannot be predicted or controlled. The mastering, lacquer cutting, plating and stamper production must all be done by external parties. As with the recording equipment, focusing on comparing the differences between records as press parameters change is expected to diminish the effects that any irregularities or audio defects present in the stamper from either mastering, lacquer or stamper production will have on the quality being measured.

Many listeners praise vinyl for its trademark sound, however much of this appeal is subjective. The signals present on these records have been designed such that this project can focus on measurements of audio quality that can be made quantitatively. There are five primary measurements that will be used in this project: signal to noise, distortion, stereo separation and frequency response. Each of this measurements have been designed to use the signals present on the test records in this project:

* To measure the signal to noise of the record the level of several quiet tracks, grooves that contain no signal, are present in the record and will be compared against the level of a 1 kHz reference track
* Several pure tones have been included on the record at 100 Hz, 1000 Hz, 3150 Hz and 10000 Hz and will be used to measure the level of harmonics present in the signal, and assess wow and flutter.
* The tones listed above and the logarithmic sweep have been cut to the record in various stereo configurations: as a traditional mono signal, only the left channel, only the right channel and vertically. These signals will be used to measure the stereo separation of the record.
* A logarithmic sweep of frequencies up to 16000 Hz is included to measure the record’s frequency response.

It is important to note that currently there are no predefined optimal parameters to manufacture records within the press. As such, the initial run of records will be manufactured by Viryl using their current manual quality assessment methods and will then serve as the baseline against which to compare the following records.

A final concern for this project is how long parameter changes within the press will need to take full effect. Each of the above measurements will be made on a set of approximately 15 records per setting change—however changing parameters within the WarmTone is not instantaneous, and it may take several tens of records before the press reaches a steady and consistent state per each parameter change. One run of records that is considerably larger, approximately 100 records, holding the manufacturing parameters constant will make it possible to measure how long it takes the WarmTone to reach a steady state after a full stop and start. This baseline test will then be used to ensure that for each measured parameter change the WarmTone has completed its parameter adjustment and is producing records of similar properties.

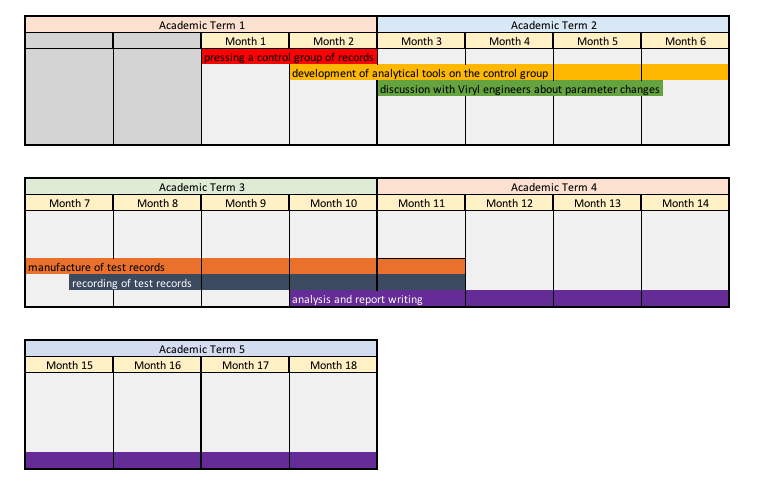
There are several parameters within the WarmTone press that are adjusted regularly to achieve optimal record quality and will have an effect on the measured audio quality. The most prominent of these are the temperature of the vinyl, the kind of vinyl used (coloured, patterned, weight, recycled or new material etc.), the time spend under pressure or the press’s cycle time, and the force of the press. There is currently no handbook or formal process for how changes of the press parameters will affect the final audio quality of the record, however there is much expertise at Viryl with regards to the WarmTone’s operation and parameters. Recommendations from Viryl engineers will drive the manufacturing parameter changes and the measurements developed for this study will help to formalize their expertise into a consistent and qualitative analysis of record quality from the WarmTone.

In addition to testing and measuring audio artifacts, a secondary goal of this project is to use data collected from these records to explore physical models of vinyl distortion, surface noise and audio defects such as pops and clicks. Preliminary results have shown variation of noise with groove tracking speed, modulation amplitude, and both stylus and antiskating force magnitudes.  We intend to determine if models of friction and surface conditions can account for some of this data.  It may be necessary to make some alterations or additional sensing of the stylus/record-surface interaction for this purpose. While a full exploration of physical models of phonographic records is most likely outside the scope of this project, comparing our observations with these models will help researchers to interpret the causes and effects that press parameters have on the measurements made in this study.

* + 1. **Timeline**. We suggest using a Gantt chart to provide a timeline showing which task will be done when to achieve each objective.

A projected timeline is provided below. It is worth noting that many of these tasks can be completed concurrently. As outlined in Section 2.4 the key milestones of the project are:

* **2.4.1 Pressing of a control group of test records**
* **2.4.2 Development of software tools to analyze the digital recordings**
* **2.4.3 Decide upon what manufacturing parameters will be explored and schedule when the records will be pressed will those parameters alongside Viryl engineers**
* **2.4.4 Complete pressing, recording of the records and refinement of software tools**
* **2.4.5 Analyze the data and produce the final reports and masters thesis**

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* + 1. **Expected deliverables.** Each project requires the submission of a completed Mitacs Final Report and Mitacs survey at the end of the project**.** Please describe the additional expected deliverables of the project i.e. expected outcomes, results, documents (intern’s thesis, peer-reviewed journal, conference presentation).

In addition to the Mitacs Final Report and Mitacs survey, this project will culminate in a Master’s thesis from the intern. The measurement techniques used in this project will also be used to inform any future attempts at Viryl to automate their quality assessments or improve their pressing process.

* + 1. **Benefit to the intern.**

In addition to completing a masters project, the intern will gain valuable experience working with the equipment and techniques already being used by the record industry. The intern will directly see the industrial applications of his research and will be at the forefront of innovation in the field.

* + 1. **Interaction**. Indicate the percentage (%) of time during the project that the intern will spend on-site at the partner’s location and at the academic institution. Research should be carried out equally (50%) in the premises of the partner and the academic institution, if different, please include a **justification**. NOTE: Theminimum interaction at either site is 25% with a maximum of 75%.

% of partner interaction: \_\_50\_\_ % **+** % of academic interaction: \_\_50\_\_ % = 100%

* + 1. **Justification** for an interaction other than 50/50
    2. **Partner Interaction.** 
       1. Provide a detailed description of the activities that will be performed on-site at the partner organization and the expected interaction with and supervision by employees of the partner organization.

The intern will oversee the production of the test records, gain immediate knowledge of the operation of a records press and what parameters control the final product. Production of records will be completed at Viryl.

Viryl has several WarmTone presses in operation at their facility and will use these presses to manufacture the test records for study. Here the intern will meet with Viryl engineers and develop a plan for parameters that will be tested over the course of the project. The time spent at Viryl will be crucial for the research goals of this project, as having direct access to a record press and its designers and operators will allow the researchers to explore the properties of vinyl records.

* + - 1. Indicate the resources the partner organization will be providing to support the intern’s work at their premises. Include information about space, resources and expertise that will be provided by the organization to the intern.

The intern will be given a desk at Vinyl’s office and manufacturing facility in Toronto from which to work. A playback and recording setup very similar or identical to the one at the University of Waterloo will be set up in the office to allow the intern to take preliminary measurements of record pressings at Viryl. While at Viryl the intern will have direct access to the designers and operators of the vinyl presses at Viryl.

Viryl is one of the only manufacturers of a new record press. Their WarmTone press is at the cutting edge of innovation and is operating in record plants all around the world.

* 1. **Relevance to the partner organization and to Canada**:  
     Describe the partner’s proposed role in the project, how the partner will benefit from participating, and how the Canadian community will benefit from this research.

Current methods for verifying record quality from a press is time consuming, requires specialized training and lacks any consistent or formal analysis techniques. The techniques developed in this project will directly benefit and inform Viryl’s ability to assess record quality. Currently, audio defects and quality need to be detected manually. Press operators must spend a considerable amount of time to listen to records and determine if they are fit for sale. Additionally, there is extensive training and expertise required to detect these defects—all of which adds up to a very laborious process. Record runs are approved based from a customer’s evaluation of a test pressing, there is no consistent or formal analysis of quality.

This project’s main focus is to gain a better fundamental understanding of how to quantitively assess the audio quality of a vinyl record and the physical processes involved, using Viryl’s own WarmTone press. The development of tests of vinyl record quality based on digital recordings will pave the way for Viryl to automate quality checks.

The sort of analysis techniques required to be developed during this project will also serve as the backbone to any future attempts at improving the vinyl record medium as a whole. This method of assessing a record’s quality will also prove extremely valuable as a benchmark of audio quality against future phonographic records. The record manufacturing industry is striving to find more environmentally friendly materials and processes for manufacturing records[12]. The measurements of audio quality developed in this project can be used to evaluate any new sustainable methods or materials developed, and help the industry create a better sounding, greener and more sustainable phonographic record. The WarmTone press has already made its impression worldwide, operating in record plants around the world. This project will ensure that Canadian innovation is at the forefront of the current Vinyl renaissance.

* 1. **Project economic orientation (for submissions with a NFP organization ONLY):**Describe the economic or productivity orientation of the project. NOTE: if any partner listed in this proposal is a not-for profit (NFP) organization, please contact a [Mitacs Business Development representative](https://www.mitacs.ca/contact-us/business-development) to discuss its eligibility before proceeding with your proposal submission.

Not applicable.

* 1. **Relationship (if any) to past/other Mitacs Accelerate internships, Mitacs Elevate fellowships, or current applications in submission to any Mitacs program:**   
     Describe whether or not the current project is related AND provide specifics about the relationship (e.g. not related because it refers to a different research area OR if related: provide information about what has been achieved in past projects and how the current application complements other submissions)

Not applicable.

* 1. **References:**

[1] J. Vanderkooy and S. P. Lipshitz, "Resolution Below the Least Significant Bit in Digital Systems with Dither", J. Audio Eng. Soc. vol. 32, p.106-113, March 1984.

[2] Nielson. 2017 Year-End Music Report U.S. *Nielson*. Retrieved May 1st, 2018 from: <http://www.nielsen.com/us/en/insights/reports/2018/2017-music-us-year-end-report.html>

[3] Palm M, 2017. Analog backlog: Pressing records during the vinyl revival. *J. Pop. Music Stud*. 2017;29,e12247. <https://doi.org/10.1111/jpms.12247>

[4] Sisario B, 2015. Vinyl LP frenzy brings record-pressing machines back to live. *New York Times*. Retrieved May 1st, 2018 from: <https://www.nytimes.com/2015/09/15/business/media/a-vinyl-lp-frenzy-brings-record-pressing-machines-back-to-life.html>

[5] Ulanoff L, 2013. 3D record plays like the real thing. *Mashable*. Retrieved May 1st, 2018 from: <https://mashable.com/2013/03/12/3d-printed-record-plays/#axxZhoaDUgqg>

[6] Seppala, 2018. HD vinyl is a promise, not a product. *Engadget*. Retrieved May 1st, 2018 from: <https://www.engadget.com/2018/04/26/hd-vinyl-rebeat-innovations/?guccounter=1>

[7] Various, 2010. Does a heavy weight vinyl have better sound than a standard weight LP? *Gearslutz.* Retrieved May 1st, 2018 from: <https://www.gearslutz.com/board/mastering-forum/454451-does-heavy-weight-vinyl-have-better-sound-than-standard-weight-lp.html>

[8] Kogen J, 1967. The Skating-Force Phenomenon. *Audio.* Retrieved May 1st, 2018 from: <http://www.audiomods.co.uk/papers/kogen_skatingforce.PDF>

[9] Tollerton R, 2009. Digital simulation of phonograph tracking distortion. *Audio Engineering Society.* Convention Paper 7924. October 2009.

[10] Robin M, 2005. Analog audio noise. *Broadcast Engineering.* Retrieved May 1st, 2018 from: <https://search-proquest-com.proxy.lib.uwaterloo.ca/docview/218614226/fulltextPDF/68AD1B862A254669PQ/1?accountid=14906>

[11] Max A M, 1955. Record Quality and Its Relation to Manufacturing. *Journal of the Audio Engineering Society.* Volume 3, Number 1. p 19-25, October 1955.

[12] SoLil, 2016. Injection Moulded Records – Vinyl of the Future? *Discogs Blog*. Retrieved May 1st, 2018 from: <https://blog.discogs.com/en/injection-moulded-records-vinyl-of-the-future/>

### Declarations

* 1. **Will the proposed research be taking place outside of the lab or normal business environment?**

\_\_\_No\_\_\_

**If yes*,*** please complete the following section to indicate what (if any) impact there may be on the environment.

1. Main characteristics of the location (i.e. physical description & coordinates).
2. Principal activity(ies): for each activity, list the environmental elements affected.
3. Are authorizations, permits, or licenses required to undertake any activity during the internship?

\_\_\_No\_\_\_

**If yes**, please list and include copies with your application.

* 1. **Does the proposed research involve living human subjects (including conducting interviews) or human remains, cadavers, tissues, biological fluids, embryos, or fetuses?**

\_\_\_No\_\_\_

**If yes,** the proposal must be approved by the participating academic institution’s Research Ethics Board\*, and a valid Ethics approval is required for the duration of the research project. Access to funding may be denied for projects that do not have ethical approval.

Please note: Mitacs may request a copy of the report to ensure compliance.

* 1. **Does the proposed research involve animal subjects?**

\_\_\_No\_\_\_

**If yes**, the proposal must be approved by the participating Institution’s Animal Care Committee\*, and a valid approval from the committee is required for the duration of the research project.

Please note: Mitacs may request a copy of the report to ensure compliance.

* 1. **Is a biohazards review required?**

\_\_\_No\_\_\_

**If yes**, the necessary review/report must be conducted in accordance with your academic institution’s policies\*, and a valid biohazards approval is required for the duration of the research project.

Please note: Mitacs may request a copy of the report to ensure compliance.

* 1. **Have any participants declared a Conflict of Interest (COI)\* as part of this application?**

\_\_\_No\_\_\_

**If yes,** please attach the signed conflict resolution letter.

*\* if you have any questions about the requirement for Research Ethics/Animal Care/Biohazards review or academic institution/Conflict of Interest Policies at your institution, please contact your corresponding institution's research office.*

### Participants Duplicate relevant section(s) as needed for multiple interns or supervisors.

**4.1. Academic supervisor:**

|  |  |
| --- | --- |
| Name: | John Vanderkooy |
| Academic Institution: | University of Waterloo |
| Department: | Physics and Astronomy |
| Address (at academic institution): | 200 University Ave W |
| City, Province, Postal Code: | Waterloo, ON, N2L 3G1 |
| Phone: | 519-888-4567 x 3222 |
| Permanent Email: | jv@uwaterloo.ca |
| Alternative E-mail: |  |

**4.1.1. Is the academic supervisor\*\*:**

1. An owner or a co-owner of the partner organization: \_\_\_No\_\_\_
2. A relative of an owner or co-owner of the partner organization: \_\_\_No\_\_\_
3. An employee of and/or a participant in the day-to-day management of the partner organization: \_\_\_No\_\_\_
4. A relative of the intern and/or partner supervisors of the proposed project: \_\_\_No\_\_\_

**If yes** to any of the above, please [click here](https://www.mitacs.ca/sites/default/files/uploads/page/mitacs_conflict_of_interest_declaration_july2016.docx) to complete the **Conflict of Interest Declaration** and send it to [accelerate@mitacs.ca](mailto:accelerate@mitacs.ca) **BEFORE** submitting your application.\*\*

**For any additional academic supervisors copy and paste Section 4.1. below:**

**4.1. Academic supervisor:**

|  |  |
| --- | --- |
| Name: | James Martin |
| Academic Institution: | University of Waterloo |
| Department: | Physics and Astronomy |
| Address (at academic institution): | 200 University Ave W |
| City, Province, Postal Code: | Waterloo, ON, N2L 3G1 |
| Phone: | 519-888-4567 x 33201 |
| Permanent Email: | jddmartin@uwaterloo.ca |
| Alternative E-mail: |  |

**4.1.1. Is the academic supervisor\*\*:**

1. An owner or a co-owner of the partner organization: \_\_\_No\_\_\_
2. A relative of an owner or co-owner of the partner organization: \_\_\_No\_\_\_
3. An employee of and/or a participant in the day-to-day management of the partner organization: \_\_\_No\_\_\_
4. A relative of the intern and/or partner supervisors of the proposed project: \_\_\_No\_\_\_

**4.2. Partner organization:**

|  |  |  |  |
| --- | --- | --- | --- |
| Legal name: | Viryl Technologies Corp. | | |
| Operating name (if different): |  | | |
| Contact name: | James Hashmi | | |
| Position: | CTO | | |
| Department: | Engineering | | |
| Address: | 16 Goodrich Rd, Unit D | | |
| City, Province, Postal code: | Toronto, Ontario, M8Z 4Z8 | | |
| Phone: | 1.844.468.4795 | | |
| Email: | [james@viryltech.com](mailto:james@viryltech.com) | | |
| Website: | [www.viryltech.com](http://www.viryltech.com) | | |
| Partner size (number of employees): | 1-49 |  | |
| Legal status: | For Profit Canadian Private Corporation |  | |
| If Not for profit Canadian Corporation | Select NFP Type |  | |
| **NAICS Code** (First three digits)\*: | 333 | | |
| \* [Click here for a list of North American Industry Classification System codes.](http://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVDPage1&db=imdb&dis=2&adm=8&TVD=118464) | | | |
| Is this the **first time** the partner has collaborated with the academic institution? : | | Yes |  |

**For any additional partner organization copy and paste Section 4.2. below:**

* + 1. **Invoicing Partner Contact**

Partner contributions must be received by Mitacs BEFORE any funds are awarded to the academic institution. **Costs can only be incurred after research approval of the proposal** and the **receipt** of the partner funds at Mitacs**.**

Please describe any applicable **invoicing requirements** (vendor setup, PO, etc.):

|  |  |
| --- | --- |
| Invoicing contact name: | Sharda Gonsalves |
| Email: | accounting@viryltech.com |

**Invoicing Partner address**:

|  |  |
| --- | --- |
|  | Address same as filled in Section 4.2. |
| X | If invoicing address different than Section 4.2, please fill out the following: |

|  |  |
| --- | --- |
| Legal name: | Viryl Technologies, Corp. |
| Address: | 212 Norseman Street |
| City, Province, Postal code: | Toronto, Ontario, M8Z 2R4 |
| Name of contact: | Sharda Gonsalves |
| Phone: | 1.844.468.4795 |
| Email: | accounting@viryltech.com |

Have these funds been leveraged against other federal or provincial programs? \_\_\_No\_\_\_

**If yes,** please provide details:

* + 1. **Partner Funds at academic institution. *IF APPLICABLE***

To be completed only if Partner funds were sent as an exception to the academic institution**. If no** please proceed to section 4.3.:

1. Is there a **research agreement** in place with the academic institution that governs the use of these partner funds?

Yes\_\_\_ No\_\_\_

**If yes** please speak with your BD representative, fill out the *addendum to research agreement document*, and submit that document with your completed application.

**If no** pleasecomplete the following:

1. ORS/UILO or equivalent agrees to send these funds to Mitacs: Yes\_\_\_ No\_\_\_

**If yes**, please provide:

|  |  |
| --- | --- |
| Academic institution account number: |  |

1. The partner agrees by signing this application that the funds can be forwarded: Yes\_\_\_ No\_\_\_

**If yes**, please provide:

|  |  |
| --- | --- |
| Name of the consenting partner representative |  |

1. **Invoicing academic institution contact** to receive Mitacs invoice:

|  |  |
| --- | --- |
| Name: |  |
| Department: |  |
| Email: |  |

1. Is the GST or HST, and QST (if applicable) to be included with invoice to academic institution? Yes\_\_\_ No\_\_\_

**If no**, tax(es) will be invoiced directly to the industry partner.

**4.3. Intern(s) identified:**

**4.3.1. Intern #1 information *\* MANDATORY \****

|  |  |  |  |
| --- | --- | --- | --- |
| Name: | Christopher Zaworski | | |
| Degree program during internship (college/masters/PhD/PDF): | masters | | |
| Expected year of graduation: | 04 | | 2020 |
| If PDF, indicate month/year PhD received: | -- | | -- |
| Academic institution: | University of Waterloo | | |
| Department: | Physics and Astronomy | | |
| Address at academic institution: | 200 University Ave W | | |
| City, Province, Postal code: | Waterloo, ON, N2L 3G1 | | |
| Phone: | 647-463-3342 | | |
| Permanent phone or Cell phone |  | | |
| Permanent email: | [cjzawors@uwaterloo.ca](mailto:cjzawors@uwaterloo.ca) | | |
| Alternative email: | christopherzaworski@gmail.com | | |
| Citizenship: | **Canadian** |  | |
| Gender: | **Male** |  | |

**4.3.2. Conflict of interest. Is the intern:**

1. An owner or a co-owner of the partner organization: \_\_\_No\_\_\_
2. A relative of an owner or co-owner of the partner organization \_\_\_No\_\_\_
3. An employee of and/or a participant in the day-to-day management of the partner organization:

\_\_\_No\_\_\_

1. A relative of the academic and/or partner supervisors of the proposed project: \_\_\_No\_\_\_

**If yes** to any of the above, please [click here](https://www.mitacs.ca/sites/default/files/uploads/page/mitacs_conflict_of_interest_declaration_july2016.docx) to complete the **Conflict of Interest Declaration** and send it to [accelerate@mitacs.ca](mailto:accelerate@mitacs.ca) **BEFORE** submitting your application.

**4.3.3. Demographic information. *\*OPTIONAL\****

**Please indicate (x) if you are:**

|  |  |  |  |
| --- | --- | --- | --- |
| Francophone: | (\_) | A person with a disability: | (\_) |
| Indigenous: | (\_) | First in your family to attend college or university: | (\_) |
| Member of a visible minority group - *includes persons who are non-Caucasian in race or  non-white in colour and who do not report being Indigenous* | | | (\_) |

**Social Media: Please provide usernames if you wish to connect with Mitacs by social media:**

|  |  |
| --- | --- |
| LinkedIn: | https://www.linkedin.com/in/chriszaw/ |
| Twitter: | n/a |
| Facebook: | n/a |

**For any additional interns copy and paste Section 4.3. below:**

**4.4. Intern(s) to be determined (TBD):**

**4.4.1. TBD#1**

|  |  |
| --- | --- |
| Degree program during internship  (college/masters/PhD/PDF): | n/a |
| academic institution: | n/a |
| Department: | n/a |

**For any additional TBD interns, copy and paste Section 4.4. below:**

### Resource Plan and Invoicing

All Accelerate projects are required to complete the Accelerate Resource Plan and confirm the Invoicing schedule on the Excel Budget spreadsheet template. Please refer to the [**Accelerate Guide: Writing your proposal**](http://www.mitacs.ca/sites/default/files/uploads/page/writing_your_proposal_-_accelerate_2017.pdf) to assist you

### Suggested Reviewers

* 1. **Reviewer’s comments.** Please select ONE of the following:

\_\_\_ We consent to receive reviewer’s comments in either official language (French or English).

\_X\_ We request to only receive reviewer’s comments in the language of which this proposal is submitted.

* 1. Please provide the names and contact information of at least **SIX (6)** **arms-length** reviewers.

An arms-length reviewer must:

* Be a recognized expert in the research topics and technical aspects covered by the proposal;
* NOT be from the same academic institution as the intern(s) or the academic supervisor(s); and
* NOT have had any collaboration with the intern(s) or the academic supervisor(s) or the partner(s) during the past five (5) years or planned for the near future.

Please note that neglecting to suggest reviewers who qualify as arms-length will delay the review of your application.

**Reviewer 1:**

|  |  |
| --- | --- |
| Name: | Hans-Peter Loock |
| Academic institution: | Queen’s University |
| Department: | Department of Chemistry |
| Email: | Peter.loock@chem.queensu.ca |

**Reviewer 2:**

|  |  |
| --- | --- |
| Name: | Ewan Macpherson |
| Academic institution: | University of Western Ontario |
| Department: | School of Communications Sciences and Disorders |
| Email: | Ewan.macpherson@nca.uwo.ca |

**Reviewer 3:**

|  |  |
| --- | --- |
| Name: | Vijay Parsa |
| Academic institution: | University of Western Ontario |
| Department: | School of Communications Sciences and Disorders |
| Email: | parsa@nca.uwo.ca |

**Reviewer 4:**

|  |  |
| --- | --- |
| Name: | Catherine Moore |
| Academic institution: | University of Toronto |
| Department: | Faculty of Music |
| Email: | catherinej.moore@utoronto.ca |

**Reviewer 5:**

|  |  |
| --- | --- |
| Name: | Rene Wiedner |
| Academic institution: | University of Warwick |
| Department: | Warwick Business School |
| Email: | rene.wiedner@wbs.ac.uk |

**Reviewer 6:**

|  |  |
| --- | --- |
| Name: | Chris Muth |
| Academic institution: | Taloowa – Mastering and Vinyl Cutting |
| Department: |  |
| Email: | chrispmuth@gmail.com |

**Potential conflict of interest. *\*OPTIONAL\****

Please list reviewers you would prefer Mitacs not to contact.

|  |  |
| --- | --- |
| Name: |  |
| Academic institution / Research Group: |  |

|  |  |
| --- | --- |
| Name: |  |
| Academic institution / Research Group: |  |

### Mitacs Accelerate Memorandum

The participants listed below confirm that the information presented accurately reflects their intention to apply to the Mitacs Accelerate program. The participants have also agreed to set in place an internship based upon the attached proposal. The participants acknowledge that they have read, understood and agreed to abide by and uphold the Project Responsibilities applicable to each of them, available for reference at: <http://www.mitacs.ca/en/programs/accelerate/project-responsibilities> which include and are not limited to the following: It is understood that the partner organization contribution shall be provided to Mitacs Inc. prior to commencement of the internship; in the event that the sponsor organization funds are at the academic institution, the academic institution shall forward these funds to Mitacs. Upon research approval and the reception of the partner funds at Mitacs, Mitacs shall forward the funds to the academic institution as a research grant to the supervising professor, and the internship stipend/salary will be paid to the student by the academic institution from the grant. Costs associated with this proposal as outlined in the budget can only be incurred after research approval of the proposal and the receipt of the partner funds at Mitacs.

Mitacs is unable to assume liability for any losses including—but not limited to—accidents, illness, travel, or other losses that may occur during the internship period. All undersigned parties agree that they are responsible for ensuring that they have appropriate insurance and meet any institutional policies regarding health, safety, and travel preparation requirements. All parties also agree that the intern will provide Mitacs with a final report and that all participants will complete an exit survey within one month of project completion.

All parties involved with Mitacs Accelerate are bound by the standard intellectual property (IP) terms of the academic institution where the intern is enrolled; except where intellectual property is covered by separate agreements to which the academic institution and the sponsor organization are parties and that are active during the dates of the internship. By signing this memorandum, you are acknowledging that you agree to the terms of the academic institution where the intern is enrolled. institution-specific IP policies regarding Accelerate internships can be found at [Frequently Asked Questions (FAQ)](https://www.mitacs.ca/en/programs/accelerate/faq).

The participants listed below agree that Mitacs can disclose the provided personal information included in this proposal (e-mail, LinkedIn, Twitter, Facebook, etc.) to the program’s funding partners. Mitacs can use this information for the purpose of communication and to evaluate the program and its outcomes during and after participants’ program tenure. The participants also agree that Mitacs will post the title of the project, the public project overview, the name of the partner(s) organization(s), the name of the intern(s), the name of supervisor(s) and the involved academic institution on [www.mitacs.ca/en/projects](http://www.mitacs.ca/en/projects) and may be used by Mitacs to publicize Mitacs Accelerate. Mitacs Privacy Policy can be found at [www.mitacs.ca/en/privacy-policy.](https://www.mitacs.ca/node/20705)

Internship participants (intern, supervising professor, and partner) further agree to the following addendum(s):

Mitacs does not require, inspect, or enforce any additional terms as outlined by participants in the above addendum.

**7.1. Title of the Project:**

Optimizing modern day vinyl presses

**7.2. Public Project Overview:**

Using simplified language understandable to a layperson; provide a general, one-paragraph description of the proposed research project to be undertaken by the intern(s) as well as the expected benefit to the partner organization. **(100 - 150 words)**

Viryl technologies currently manufactures one of the worlds only modern day vinyl record presses. The recent vinyl renaissance has taken the marketplace by storm. The quality of a record pressing is determined by the characteristic of the vinyl used, its temperature, the force used to stamp the record, the final thickness of the pressing, the cycle time of the press, the efficacy of the flash cooling incorporated in the press, and possibly other factors. It is the aim of this research to study the effects of such parameters on the final quality of the pressed discs. Using modern day digital signal processing analysis on the age-old analog medium in order to bring the manufacturing of vinyl records into the modern age!

### 7.3. Participant Signatures:

### Please sign, scan and save in PDF format

**7.3.1. Intern:**

|  |  |  |
| --- | --- | --- |
| Name: | Christopher Zaworski | |
| Department: | Physics and Astronomy | |
| Academic institution: | University of Waterloo | |
| Signature: |  | Date: |

7**.3.2. Academic Supervisor:**

|  |  |  |
| --- | --- | --- |
| Name: | John Vanderkooy | |
| Department: | Physics and Astronomy | |
| Academic institution: | University of Waterloo | |
| Signature: |  | Date: |
| Name: | Jim Martin | |
| Department: | Physics and Astronomy | |
| Academic institution: | University of Waterloo | |
| Signature: |  | Date: |

**7.3.3. Partner Organization:**

|  |  |  |
| --- | --- | --- |
| Name: | James Hashmi | |
| Department: | Engineering | |
| Title/Position: | CTO | |
| Organization: | Viryl Technologies Corp | |
| Financial Commitment: | $18 000 | |
|  | The partner organization commits to the funding contribution specified directly above and the payment schedules outlined in the attached *Accelerate Resource Plan and Invoicing* schedule. These are key conditions of the application and by signing below this proposal, the partner organization agrees to these conditions. | |
| Signature: |  | Date: |

**7.3.4. Office of Research Services Representative or equivalent:**

|  |  |  |
| --- | --- | --- |
| Name: | Evelyn Allen | |
| Title/Position: | Manager, Corporate Research Partnerships | |
| Academic institution: | University of Waterloo | |
| Signature: |  | Date: |

**For any additional participants include corresponding details and signature line below:**

### Appendix A – Accelerate Intern Consent Form

**USE AND DISCLOSURE OF PERSONAL INFORMATION PROVIDED TO MITACS**

1. All personal information collected is subject to privacy legislation and Mitacs Privacy Policy for Program Participants. For a description of Mitacs’ commitment to protect the personal information provided by program applicants, please see <http://www.mitacs.ca/en/privacy-policy>.
2. All the information supplied in this application will be made available to Mitacs staff responsible for managing the application, for activities including identifying appropriate peer reviewers, administering and monitoring awards, compiling statistics, and evaluating the program.
3. Information supplied in this application will be made available to internal and/or external reviewers, being composed of experts recruited from the academic, public and private sectors. All reviewers are required to commit to keep the application information confidential.
4. Contact information in this application may be used by Mitacs staff to contact you in future for:
   1. Invitations to be profiled in stories or news items, to speak at or attend events, to provide a spotlight story and/or blog post;
   2. Communications about opportunities for Mitacs alumni; and
   3. Research surveys for Mitacs alumni.

You will have the opportunity to unsubscribe from emails sent to you, once all commitments regarding the internship that is the subject of this application are complete.

1. Your name, academic institution and department, and the title of your project may be provided to the federal, provincial and academic institution funders of the Accelerate program, to:
   1. Enable Mitacs to report on funding contract commitments; and
   2. Allow the funders to evaluate the program.

Note that all Canadian provincial and federal governments, and academic institutions, are bound by privacy legislation and are therefore bound to keep your personal information confidential.

1. Your name and contact information may be provided to the academic institution at which this internship takes place to enable the academic institution to manage the award and for reporting purposes.

I, the undersigned, do hereby give CONSENT to the use and disclosure of the information contained in my application for the purposes as described above.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Intern Name Signature Date

**Appendix B** **- Drop Down - Options**

### Please delete if not applicable

Please refer to the drop down of the section, and type the corresponding answer on the space provided.

**1.5. Academic discipline:**

* Business
* Computer Science
* Earth Sciences
* Engineering
* Life Sciences
* Mathematical
* Sciences Social Sciences, Arts & Humanities
* Physical Sciences

**1.6. Project priority sectors:**

|  |  |  |
| --- | --- | --- |
| * Indigenous Affairs | * Entertainment & Media | * Natural Resources |
| * Advanced Manufacturing | * Environmental Science & Technology | * New & Digital Media |
| * Aerospace | * Finance & Insurance | * Ocean Tech |
| * Agriculture & Food | * Forestry | * Oil & Gas |
| * Aquaculture & Fishing | * Green/Alternative Energy | * Pharmaceuticals |
| * Automotive | * Health and Related Sciences & Technology | * Public Service, Policy, & Governance |
| * Biotechnology | * Information & Communications Technology | * Sustainability & the Environment |
| * Clean Technology | * Life Sciences (not health) | * Technology |
| * Commercial Services | * Manufacturing & Construction | * Tourism |
| * Construction | * Mining | * Transportation |
| * Education | * Nanotechnology | * Water |
| * Energy & Utilities | * Natural Gas | * Other (please describe) |

**1.8. List of Participants:**

**Partner Legal Status:**

* For Profit Canadian Private Corporation
* Crown Corporation
* Not for Profit Canadian Corporation

**4.2. Partner organization:**

**Partner size (No. employees):**

* 1 to 49
* 50 to 99
* 100 to 499
* 500 and higher

|  |  |
| --- | --- |
| **Legal status:** | **If NFP:** |
| * For Profit Canadian Private Corporation | * Charitable Organizations |
| * Crown Corporation | * Economic Development Organizations |
| * Not for Profit Canadian Corporation | * Health Organizations |
|  | * Industry Associations |
|  | * Social Welfare Organizations * Other |

**4.3.** **Intern(s) identified:**

**4.3.1. Citizenship**:

* Canadian:
* Permanent Resident:
* Foreign:

**Gender**

* Female
* Male
* Other gender identity