## Project Interim Progress Report (Rapport d’avancement de project intérimaire) July 1, 2016 - January 31, 2017 Please submit by January 16, 2017 (Attn: Joanne O’Connor [management@nserc-canrimt.org](mailto:management@nserc-canrimt.org))

## Instructions

*This progress report, updated milestones**and the Form 300 are required as a condition of research funding support from the sponsors of the NSERC CANRIMT.* ***Please report for activity in the current reporting period only.***

**SUMMARY**

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| **THEME :** *THEME I - Digital Machining* | | | | | | **Leader/ Chef:**  *K. Erkorkmaz, Waterloo* | | |
| **PROJECT I.B.1:** *Process Modeling and Optimal Trajectory Planning for Hybrid Configuration Machining and Additive Manufacturing* | | | | | | **Leader/ Chef:**  *M. Vlasea, Waterloo (Supervisor)*  *K. Erkorkmaz, Waterloo (Co-Supervisor)* | | |
| **PROJECT DURATION/DURÉE DU PROJET : May 2017 – May 2021** | | | | | | | | |
| **STATUS/STATUT:** *(****Milestones*** *to be updated by each Project Leader)* | | | | | | | | |
| **Ahead of Schedule** |  | **On Schedule** | **X** | **Delayed** |  | | **Cancelled** |  |

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| **PROJECT DESCRIPTION/ DESCRIPTION DU PROJECT**  (*Brief description in point form, including role of project in Theme.)* |
| The goals of the research project:   * to investigate effective ways to reduce the hybrid manufacturing cycle time * while ensuring that geometric, mechanical, and physical quality specifications are met   Hybrid manufacturing in this context describes the synergy between laser powder fed fusion and machining processes in a layer intermittent fashion.  To achieve the proposed research goals, the work will focus on thermomechanical modeling of the laser-material interaction and optimal trajectory planning for layer-intermittent machining. The project is cohesive in supporting the research theme, in terms of developing virtual models of physical manufacturing processes that would enable increased efficiency and performance of hybrid manufacturing processes. |

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| **PROJECT OBJECTIVES & METHODOLOGY/ OBJECTIFS DU PROJET & MÉTHODOLOGIE**  *(Include alignment with Network objectives.)* |
| * Develop thermomechanical modeling of the laser-material interaction to accurately predict melting and solidification rates, residual stresses and deformation * Use in-process thermometry monitoring to validate models * Develop optimization algorithms for affecting layer deposition trajectory, machining toolpath, and feedrates * Process validation strategies, part manufacturing   These overall objectives are in support of the network objectives in developing virtual models and digital tools for process optimization. |
| **1. RESEARCH TEAM/ ÉQUIPE DE RECHERCHE** *(Summary for the current reporting period)* |

**1a: Research Personnel (Supervisors, Co-Supervisors, Collaborators)/   
Personnel de recherche**

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| --- | --- | --- | --- | --- |
| *Name, given name/ Nom., prénom* | *Organization/ Organisation* | *Sup./Co-Sup./*  *Collaborator* | *E-mail/Courriel* | *Phone No./ Téléphone* |
| M. Vlasea | Waterloo | Supervisor | mihaela.vlasea@uwaterloo.ca | 519-888-4567 |
| K. Erkorkmaz | Waterloo | So-Supervisor | kaane@uwaterloo.ca | 519-888-4567 |
| J. McPherson | ODG | Collaborator | jmcpherson@odg.com | 519-662-2840 |
| S. Engin | P&WC | Collaborator | serafettin.engin@pwc.ca |  |

**1b: Students, Postdoctoral Fellows, Research Assist./  
Assoc./Eng., Technical/Professional, Guests** *(from outside Québec; from outside Canada)***/  
Étudiants, Boursier de recherches postdoctorales, assistants, techniciens et invites** *(invite hors Québec; hors Canada)*

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| *Name, given name/ Nom., prénom* | *Position* | *Organization/ Organisation* | *Name/Nom. (S) or /ou (C)\** | *Start/ Début* | *End/ Fin* | *CANRIMT Salary/Mo incl ben.* | *Extern. funding amount* | *Extern funding source* |
| Sera Deniz Ertay | PhD | Waterloo | S | 05/2017 | 05/2021 | *$2125* | *$0* |  |

***\*(S) – Supervisor  
 (C) – Co-Supervisor***

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| **TOTAL #** | **BASc** | **MASc/**  **M.Eng.** | **Ph.D.** | **PDF** | **Res. Asst.** | **Res. Assoc.** | **Res. Eng.** | **Tech./ Prof.** | **Guests/ outside Québec** | **Guests/ outside Canada** |
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**1c: Partners & Contributions/   
Partenaires et Contributions**

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| --- | --- | --- | --- | --- | --- | --- |
| *Organization / Organisation* | *Acronym/ Acronyme* | *Contact* | *Cash/ Espèce* | *In-Kind/ Nature* | *Overhead/ Frais généraux* | *Total* |
| Ontario Drive and Gear | ODG | J. McPherson |  |  |  |  |
| Pratt & Whitney Canada | P&WC | S Engin |  |  |  |  |

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| **2. RESEARCH PLAN FOR THE CURRENT PERIOD/PLAN DE RECHERCHE POUR  LA PÉRIOD ACTUELLE** *(Please list both the technical objectives, methodologies and milestones as stated in the previous report.)* | |
| **Task 1** | Objective: Literature review on thermomechanical models for powder fed laser fusion.  Milestones: Deliver comprehensive overview summary of research methodologies in this domain. |
| **Task 2** | Objective: Develop appropriate physics-based model to simulate laser-material interaction. Look into lumped-parameter approaches, based on the equations of heat transfer. Investigate approaches for accelerated models based on driving process dynamics.  Milestones: Create preliminary thermomechanical model of laser powder fed material deposition process. |
| **Task 3** | Objective: Integration of thermometry sensing to collect in-process data for model refinement and experimental validation and future feedback control implementation.  Milestones: Investigate, purchase and integrate radiometric sensors into the process. Perform sensor calibration and testing. |

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| **3. ALIGNMENT OF RESEARCH PROJECT WITH NETWORK OBJECTIVES/ ALIGNEMENT DU PROJET DE RECHERCHE AVEC LES OBJECTIFS DU RÉSEAU** *( Please comment on the alignment of the research project with the overall Network objectives.)* |
| The network objectives are currently in-line with the projected outcomes from this project. The project envisions to digitize the hybrid manufacturing process by predicting the thermomechanical behavior of the deposited material layer and the layer intermittent machining process to optimize machining time and part qualities. The optimization parameters are hybrid manufacturing process time, surface quality, part dimensional accuracy. |

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| **4. PROBLEMS and RESOLUTIONS/ PROBLEMES ET SOLUTIONS PROPOSÉES** *( Please summarize any problems arising during the current reporting period and their resolution or plans for resolution.)* |
| *Problem/ Problème:* N/A  *Resolution / Résolution:* N/A |

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| **5. RESEARCH PROGRESS and RESULTS/ PROGRÈS DE LA RECHERCHE et RESULTATS:** *(Summarize progress and results below.)* |

**5a: MILESTONES/ÉTAPES**  
*Summarize progress on milestones – including % completed – as outlined in the Research Plan for the current reporting period and any modifications since the last reporting period.* *(Milestones document also to be updated for each project.)*

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| **MILESTONE/ ÉTAPE:** | |
| **Progress:**  The project is due to start in May 2017.  **Modifications:** There are currently no deviations from the currently listed milestones. | |
| **% Completed/ Rempli** | **0%** |

**5b: PUBLICATIONS and PRESENTATIONS/ PUBLICATIONS ET PRESENTATIONS**

*Please list all publications directly arising from Network-funded research during the current period. Do not include abstracts.*

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| ***A: REFEREED CONTRIBUTIONS - ARTICLES***  *Include articles in refereed publications – please specify whether the article has been submitted (S), accepted (A) or published (P).* | | | |
| Last Name, Initial | *Year* | *Title, Journal, Volume* | *Status* |
|  |  |  |  |
| ***B: REFEREED CONTRIBUTIONS - OTHER***  *Include papers in refereed conference proceedings, letters, notes, communications, review articles, monographs, books, book chapters and government publications.* | | | |
| Last Name, Initial | *Year* | *Description* | *Status* |
|  |  | Conference Title, Location and Date (Status: Invited, Not invited) |  |
|  |  | Journal/Book/Publication Title (Status: S-submitted; A-accepted; P-published) |  |
| ***C: NON-REFEREED CONTRIBUTIONS***  *Include papers in non-refereed conference proceedings, papers, letters and review articles.* | | | |
| Last Name, Initial | *Year* | *Description* | |
|  |  | Conference Title, Location and Date | |
|  |  | Journal/Book/Publication Title | |
| ***D: SPECIALIZED PUBLICATIONS - PRESENTATIONS***  *Include theses, presentations, industrial/technical reports, internal reports, discussions of abstracts and symposium records.* | | | |
| Last Name, Initial | *Year* | *Description* | |
|  |  | Thesis or Conference Title, Location and Date | |
|  |  | Journal/Book/Publication Title | |
| ***E: PUBLICATIONS –  Not originally funded by NSERC CANRIMT but continuing or completed with Network funding*** | | | |
| Last Name, Initial | *Year* | *Description/Title* ***(include start date of NSERC CANRIMT funding)*** | |
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| ***F: PUBLICATIONS – Not funded by NSERC CANRIMT but related to the Network research focus*** | | | |
| Last Name, Initial | *Year* | *Description/Title* | |
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**5c: PATENTS and LICENSES/ BREVETS ET LICENSES**

*Non-disclosure agreements signed, patent applications filed, patents issued, copyrights, licenses under negotiation, licenses granted, etc.*

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| *Category* | *Owner* | *Description* |
|  |  |  |

**5d: OTHER COMMUNICATIONS, AWARDS/ AUTRES COMMUNICATIONS, PRIX**

*Provide information on additional communications related to your work, such as awards and distinctions, news stories, interviews, public forums, press releases, etc. for the current reporting period (please provide copies or links.)*

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| *Name, given name/ Nom, prénom* | *Details* | *Date* | *Link or copy attached* |
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| **6. TRAINING/ FORMATION** *(Describe the extent of cross-network and partner involvement in training for the current reporting period.)* |
| **N/A** |

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| **7. RESEARCH PLAN FOR NEXT 6 MONTHS/ PLAN DE RECHERCHE POUR LES 6 PROCHAINS MOIS***(Describe Planned Research Activities for the next 6 month period and include any modifications made during the current reporting period.); also please list both the technical objectives and milestones.)* |
| Please see *“2. RESEARCH PLAN FOR THE CURRENT PERIOD/PLAN DE RECHERCHE POUR*  *LA PÉRIOD ACTUELLE”*  Task 1 and part of Task 2. |

**8. OPTIONAL – Comments, Questions and/or Feedback/  
OPTION – Commentaires, questions et/ou des commentaires**

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| *Include any supplemental comments or questions pertaining to the Network here.* |
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**9. NETWORK EVENTS ATTENDED or SUGGESTIONS /  
ÉVÉNEMENTS RÉSEAU ONT ASSISTÉ ou SUGGESTIONS**

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| *Please list any Network-related events attended and include comments and suggestions for events which may be helpful and informative for Network members to attend in future.* | |
| *Event* | *Comments/Suggestions* |
| **ASTM F42 Committee on AM Technologies**  (To attend) | Jan 30 - Feb 02 2017  University of Alabama School of Engineering, Tuscaloosa, AL |
| **SME AM Community Advisors – in person Strategic Development Planning Meeting**  (to attend) | Jan 19 - Jan 20 2017  SME Headquarters, Dearborn, Michigan |
| **RAPID**  (to attend) | May 8 - 11 2017  Pittsburgh, Pennsylvania |
| **SFF**  (to attend) | Aug 7 - 9 2017  Austin, Texas |
| **CMTS**  (to attend) | Sept 25 - 28 2017  Toronto, Ontario |