EPSRC Impact Acceleration Account (IAA) Project Update – May 2023

This template records information requested by the EPSRC to capture the success of IAA funding and will be used in our periodic reporting to the EPSRC.

Project Title	IAA - Smart Fluid Inertance Technology for Improving Hydraulic Energy Efficiency		**Project code (internal)**	IAA615
PI(s)	Min Pan		**Co-I(s)**	N/A
Value of the award	**IAA**	£118,451	**RA(s)**	Chenggang Yuan
	External cash	N/A	**Start date**	1/11/22
	External in-kind	£52,500	**End date**	2/11/24

Impact type (tick all that apply)	**EPSRC Capability Theme (tick all that apply)**	**External collaborators**
☒ Economic ☒ Knowledge ☒ Social (incl. political) ☐ Other – please provide details	☒ Engineering ☐ ICT ☐ Mathematical Sciences ☐ Physical Sciences ☐ Digital Economy ☐ Energy ☐ Healthcare Technologies ☐ Manufacturing the Future ☐ Non-theme Specific ☐ Other – please provide details	Domin Fluid Power Limited UK **New relationship(s) for University?** Y
Activity type		**How was your collaboration initiated?**
☒ Early stage commercialisation ☐ Business/user engagement ☐ Driving culture change ☒ Other – please provide details Prototyping		Domin Fluid Power Limited UK is my project partner for Innovate UK project SWIFT: Switch Inertance Fluid Technology (TS/V013432/1).

Secondments (if applicable) – any transfer of personnel for a day or more from one site to another	**Who was seconded and in which direction? What happened? Short description and relevant outcomes.**
PhD student	
Early career researchers/ postdocs <10yrs experience	
Established career researchers/ postdocs >10yrs experience	

*Please keep responses to the following questions to **under 200 words** each and in layman's terms for a non-expert audience.*

1. Project description and purpose

Hydraulic fluid power is used in a variety of important sectors that include aerospace, transportation, oil and gas, robotics and machinery for industry, construction, and agriculture. However, current hydraulic control simply involves using valves to throttle flow which is highly inefficient. The average efficiency of fluid power systems is only around 21%. This IAA project will build on the successful research outcomes from PI's EPSRC projects and will develop a compact and highly efficient digital hydraulic converter prototype to provide a pathway to a commercial product that can significantly improve hydraulic efficiency to 80%, which will be showcased to customers and potential investors to significantly accelerate research impact.

2. Objectives

Objective	Progress made towards objective, key activities undertaken and outcomes achieved. Include here any barriers, facilitators and changes to the original plans
1) Develop and build a compact and highly efficient digital hydraulic converter prototype that can be showcased to customers and potential investors relating to mobile hydraulic vehicles, thereby generating immediate impact. 2) Evaluating the energy efficiency and fuel reduction associated with using digital converters for generating research interest and impact. 3) Stimulating and creating pathways to impact to disseminate the research outcomes and promote exploitation of the new technology. 4) Developing a high-impact consortium with stakeholders in a wide range of industrial sectors to deliver practical digital hydraulic converter solutions to generate long-term impact.	In the last six months, progresses have been made towards Objective 1: a) The high-speed switching valve (key component) of the digital hydraulic converter has been designed, validated and quoted. b) Other components related to prototyping the digital hydraulic converter have been sized, selected, and quoted. c) A compact and highly efficient digital hydraulic converter prototype has been developed, and a 3D-printed mini prototype has been manufactured. d) Immediate impact: the 3D printed 1:1 prototype generated immediate impact; a plan has been made to demonstrate the prototype in engagement activities such as lab tours, university open day, and showcase to potential customers and investors.

3. Quantitative outputs, outcomes and impacts

Outputs	No. or Value	Outcomes	No. or Value	Impacts	No. or Value
OP1 No. outward secondments		OC1 No. partners engaging in further collaboration after end of IAA project		IM1 No. jobs created or safeguarded (including through secondments)	1 RA
OP2 No. inward secondments		OC2 No. new projects resulting from IAA funded project		IM2. All R&D expenditure resulting from IAA related activities (incl gov & 3rd sector)	

OP3 Joint academic/industry publications		OC3 Permanent employment resulting from initial IAA placements/ secondments		IM3. Value of increased turnover, profit and exports from/of new products & processes	
OP4 New records of invention		OC4 No. Spin-outs established		IM4. Cost savings for partners	
OP5a No. Patents filed		OC5 Income generated as a result of commercialisation activities (licensing, consultancy)		IM5. No. new products & processes resulting from IAA project	
OP6 /7 No..& value of licensing agreements		OC 6 Value of commercial R&D investment in the University beyond initial IAA activity		IM6. Policy changes	
OP8 Proof of concept project completed	1	OC7 Value of commercial R&D investment from SMEs alone beyond initial IAA			
OP9 No. market assessments completed		OC8 Number of PoC projects funded by others linked to IAA activity			
OP10 No. of prototypes produced	1	OC9 Investment from companies or venture capitalists in commercialisation			

4. Additional benefits not captured above. Please tick all that apply

Academic benefits – ways in which the IAA has contributed to career etc.	**Tick all that apply**	**Benefits to the external partner (tick any benefits that you have observed accruing to your partner)**	**Tick all that apply**
Contributed to relevant trade publications		New services established	
Potential REF Impact Case Study	×	New technology developed	
Opportunity for consultancy work with partner or other		Knowledge applied to service development or delivery	
Informed new teaching material	×	Knowledge applied to business process development	
Informed academic conference papers		Knowledge applied to product development process	×
Helped secure research funding		New algorithms developed	
New research projects developed	×	Technology applied to service development and /or delivery	
Increased interest in engaging with external partners	×	Provided the partner with access to potential employees	×
Enjoyment / increased job satisfaction	×	Enabled R&D capability development (e.g. partner staff have increased R&D capability)	×
Increase in research capacity (e.g. additional researchers)	×	Successful field testing	
Supported ongoing relationship for future collaborations	×	Developed network for future collaborations	×
Built networks for future collaborations	×	Increased understanding of how to apply research	×
Successful identification of pathways to impact from research	×	Other ……	

New insights into how industry might apply research	×		
Other (please specify) ……			

5. Outputs

Please provide further information about the outputs (i.e. products such as research reports, patents, journal articles) recorded in the above table and information about any other outputs not covered.

In the last six months,

A compact and highly efficient digital hydraulic converter prototype has been developed, including:

1. Key component design: a high-speed switching valve has been designed to achieve high operating pressure and flow (400 bar, 100 L/min), low leakage (<8 μm clearance), low resistance (15 bar pressure loss at 100 L/min) and better dynamic transitions (symmetric design).

2. Other components sizing and selection: the other components, including motors and drives, controllers, and accumulators in the digital hydraulic converters, have been sized and selected according to the requirement of the application.
   - According to our analysis and investigations, two servomotors with a torque of 6.36 Nm and a power of 2 kW have been selected to drive the high-speed switching valve.
   - An industrial standard PLC controller with a compact design has been selected to implement the control algorithm,
   - Four diaphragm accumulators have been selected to reduce the pressure pulsations.

3. A compact and highly efficient digital hydraulic converter prototype has been designed and developed.

4. A 3D-printed 1:1 prototype has been manufactured to validate the size and functions of the converter and will be used as a demonstrator to generate immediate impact.

6. Outcomes

Please tell us what has or is expected to happen as a result of the project and provide further information about the outcomes recorded in the above table (i.e. changes such as spin-out company, licencing, new projects or collaborations as a result of the work done on the IAA, further investment, new secondment opportunities, and employment)?

The ticked records in the above table are the outcomes we expect to happen. Since it just has been 6 months, the project is still at an early stage and in progress.

7. Impacts

Please outline any impact achieved to date and how you have been able to measure and evidence this (i.e., new jobs created, cost savings in companies, new products launched, policies changed, etc.).

- The IAA project has created a new RA job. Dr Chenggang Yuan is conducting research on the development and design of a compact and efficient digital hydraulic converter and pathway of impact activities. He is also jointly responsible for the day-to-day running of the project, which has provided excellent opportunities for him to develop his management skills and leadership.

- The 3D printed 1:1 prototype is ready to be demonstrated in lab tours, university open day, and showcase to generate immediate impact.

What plans are in place to capture any impacts arising in the future?

- Preparing a REF impact case study
- Demonstrating the real converter prototype to wider sectors and audiences, which will significantly speed up EPSRC research outcomes towards innovation across industry, business, and the public sector.
- Presenting our work at a conference or workshop for outcome and impact dissemination.
- Developing new research proposals for securing continuous research funding from UKRI, the Royal Academy of Engineering, industrial partners and investors.

8. Lessons learnt

Please outline any lessons learnt during the project that you would like to share with other IAA award holders and the Impact Assessment Group.

We are enjoying working on the IAA project, which provided us with a unique opportunity to prototype and think about the commercialisation of our research. The impact activities bring more opportunities to communicate with our industrial partners, end-users, and the public, which are very valuable to us.

9. Follow-on funding

Has your IAA award been used to align with other sources of cash and/or in-kind funding (e.g., HEIF, Innovation UK, industry or other funding sources). If so, how were they secured?

Yes, Domin Fluid Power is supporting facility access and knowledge transfer.

10. Any further comments' to add?

N/A