Australian Government
Department of Defence
Science and Technology

DST Summer Vacation Placement Program

2020 - 2021

Potential Summer Vacation Placement Projects

List of Abbreviations

Division	Abbreviation
Air Division	AD
Joint Operational and Analysis Division	JOAD
Land Division	LD
Maritime Division	MD
Research Services Division	RSD
Science Engagement and Impact Division	SEID
Weapons and Combat Systems Division	WCSD

Research Stream	Abbreviation
Aerospace / Aeronautical Engineering, Naval Architecture Stream	AAENA
Chemical, Radiological, Biological, Food Sciences Stream	CRBFS
Computer Sciences, IT, Software Engineering, Telecommunications Stream	CSITSET
Electronic / Electrical Engineering Stream	EEE
Materials Science Stream	MS
Mathematics and Physics Stream	MP
Mechanical and Mechatronic Engineering (including Robotics) Stream	MMER
Psychology and Social Sciences Stream	PSS

Potential Summer Vacation Placement Projects - 2020/21

Division	**Location** Multiple locations may be listed	Project Title	Project description	Desirable Skills	Research Streams							
					AAENA	CRBFS	CSITSET	EEE	MS	MP	MMER	PSS
AD	Fishermans Bend, Victoria	Supportable Low Observable Coatings for Composite Airframes	This project will involve the manufacture, electromagnetic characterisation and data analysis of low observable coating technologies for composite airframes. The project will develop skills in composite manufacture (lay-up and CNC machining), microwave measurement (anechoic chamber and network analyser) and complex data processing (MATLAB).	• Experience with MATLAB • Experience with CAD, preferably NX • Experience with hand tools (workshop skills) is desirable but not necessary	**X**			**X**		**X**		
AD	Fishermans Bend, Victoria	Topology Optimisation for Additive Manufacturing	This project will develop and asses topology optimisation methods to be used for designing aircraft components to be built using additive manufacturing techniques.	• Experience in coding, with a preference for Python language. MATLAB may also be beneficial. Experience in Finite Element Analysis.	**X**					**X**	**X**	
AD	Fishermans Bend, Victoria	Assessment of Overset Meshing for Computational Fluid Dynamics Simulation of Multiple Aerodynamic Bodies in Relative Motion	Mesh generation for Computational Fluid Dynamics remains a significant challenge and remains a bottleneck in the generation of aerodynamic datasets. This is particularly the case when aerodynamic data is required for bodies with moving parts or bodies moving relative to each other. Examples include the modelling of moving control surfaces on an aircraft or the jettison of a booster from a multi-stage rocket. Overset meshing has the potential to reduce the meshing overhead in these situations. In this project overset meshing within a commercial CFD solver will initially be applied to a number of simple 2-D test cases and compared with more traditional single mesh approaches. The outcomes of this work will then be used to inform overset meshing for a 3D test case.	• Experience with the use of Computational Fluid Dynamics solvers, with an understanding of the underlying theory being desirable. • Experience with Linux OS and programming/scripting language(s) such as C, bash, and Python highly desirable • A background in fluid dynamics and flight mechanics highly desirable • Demonstrated ability to work with autonomy and in a team environment	**X**					**X**	**X**	
AD	Fishermans Bend, Victoria	Application of Conceptual Design Tools in the Identification of New and Novel Aerospace Capabilities	There are a range of conceptual design tools available for the development of new aerospace design concepts. This project will provide the student with a set of mission requirements, which will then require the student to exercise such tools in order to develop potentially new and novel configurations that may provide the ADF with new capabilities and support the development of new operational paradigms. A key outcome of this project will be an assessment of the conceptual design tools.	• Successful completion (by the commencement of the placement) of the following subjects to third year engineering level is highly desirable: preliminary aircraft design, aircraft performance, aerodynamics, propulsion. • Computational programming skills, MATLAB, C or C++, Python, etc., are highly desirable • Excellent communication skills • Ability to work independently and integrate into a small team	**X**							
AD	Fishermans Bend, Victoria	Environmental Degradation of Aerospace Composite Materials	Environmental degradation of Aerospace composite materials is a fundamental research field for DST. As the use of composite materials in primary structure becomes increasingly widespread with the introduction of advanced platforms into ADF service, the impact of the service environment on the materials properties and possible effect on structural performance needs to be well understood. This program will use current composite materials to conduct testing and analysis of the effect that key environmental factors has on the structural performance of the composite material.	• Background knowledge in engineering and composite materials • Experience with laying up composites would be useful but not essential • Ability to work in teams as well as self-motivation to progress tasks individually • Enjoys hands on work and is eager to learn	**X**							
AD	Fishermans Bend, Victoria	Distributed Debrief and Control Architecture Test Implementation	The project aims to create a test implementation of the Distributed Debrief and Control Architecture.	• General software development skills, source control configuration management • Experience in Java development • Experience or interest in network protocols			**X**					
JOAD	Fishermans Bend, Victoria	Visualization for Force Design	The ADF's force structure is constantly changing due to emerging threats, development of new technology and changes to Government policy. To keep track of these changes and to make further changes, the ADF has a deliberate and rigorous process to understand the operation, organisation and design of the force. As such, there is a lot of data collected relating to the ADF platforms, systems, capabilities and their performance that span multiple databases. This project will contribute to web-based visualization of the ADF's force structure and aerospace capabilities to enable users to navigate and comprehend the data. Project options include designing a set of icon and vignette visualizations, or creating novel animated transitions between different views to improve user interaction with and understanding of the data.	• General coding skills, with a preference for JavaScript • Skills in one or more of the following: Human Computer Interaction, Design, Visualization or Computer Game Design • Interest in User Experience • Ability to work in teams	**X**		**X**			**X**		**X**
JOAD	Fishermans Bend, Victoria	Updating Knowledge Representation and Organisation with New Information	The ADF's force structure is constantly changing due to emerging threats, development of new technology and changes to Government policy. Our understanding of the performance of the evolving force structure is also changing as new experiments and studies are conducted and aircraft, bases, tactics and threat systems change over time. Sometimes the new information supersedes the old information, and sometimes the conclusions from previous studies remain valid and can be retained. This project is about solving the problems of maintaining a body of knowledge that accumulates over a number of years so as to allow algorithmic re-evaluation and reorganisation of answers to old questions to provide answers to new questions. For example, we may like to understand the effect of upgrading a sensor on a platform and the implications of this upgrade for previous studies on the platform of interest. We want to understand how we can use data and algorithms to facilitate the re-use of knowledge while it is reliable and to know when and how it becomes outdated. Project options will include exploring the literature for approaches to solve this problem, and may include writing code to automate this process.	• General coding skills, with a preference for JavaScript, Python, DJANGO, D3 • Skills in one or more of the following: Human Computer Interaction, Visualization or Computer Game Design, Data visualisation • Interest in coding • Ability to work in teams	**X**		**X**			**X**		**X**

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JOAD	Fishermans Bend, Victoria	Compassionate Artificial Intelligence: Empathy Training as a Future Work Possibility	The authors of "Human + Machine: Reimagining Work in the Age of AI" (artificial intelligence) describe an empathy trainer as '…an individual who will teach AI systems to display compassion'. What could be involved in the work of an empathy trainer for the Royal Australian Air Force (RAAF)? The aim of this project is to develop background knowledge that may eventually help the RAAF to imagine such a role. The successful applicant will survey the published literature on artificial empathy, i.e. empathy and artificial agents. If there is a need or opportunity, they may extend the project to include models or theories of empathy, a critique of the concept of empathy training for AI, or the topic of collaborative robots.	• Interest in pursuing further studies in research and designing experiments	**X**		**X**			**X**		**X**
JOAD	Fishermans Bend, Victoria	Bias in Knowledge Elicitation Activities	In ACA, we often call on subject matter experts (SMEs) to make judgements such as: the performance of a weapon or sensor; the outcome of a military engagement; or number of aircraft required to complete a mission. The main reason for relying mostly on SME judgement is that the problem is too complex to model using traditional modelling methods. However, SME judgements are clouded by personal, cognitive and other biases. Further, there is a poor correlation between the quality of the SMEs response to their perceived confidence or experience in the question of interest. There are a range of techniques that can be used to reduce and control for these biases including: using neutral language, specific ordering of questions, seeking rationale for responses, training SMEs to de-bias their responses, peer reviewing responses and aggregating responses from experts. This project will investigate the range of techniques available as well as designing and conducting experiments to investigate one aspect of bias relevant to this task. Outcomes of this project may include development of a set of best practice guidelines for the practitioner, or improve the available data collection tools including writing code to implement an aspect of this research.	• Interest in pursuing further studies in research and designing experiments • Project may be extended to include coding for proposed experiment design • If coding, prefer knowledge and experience in Python, DJANGO (but not essential). • This project is flexible and can be adapted to suit the students' aptitude towards coding.	**X**		**X**			**X**		**X**
JOAD	Edinburgh, South Australia	Reducing Vulnerability Through Social Resilience	Discuss the potential protective function of social and cultural mechanisms to reducing vulnerability to external perturbations and/or influence. Including: (i) defining and dimensionalising vulnerability; (ii) defining social resilience and identifying sources of social resilience in the Pacific; (iii) identifying local perspectives on vulnerability and social resilience via secondary sources; and (iv) investigating the flipside downsides of these social and cultural mechanisms.	• Skills in qualitative research methods in the social sciences. • Preference for students with a background in sociology or anthropology.								**X**
JOAD	Fairbairn, ACT	Groupthink in Operational Headquarters	Groupthink is the psychological phenomenon where the desire for conformity in a group results in suboptimal decision making. DST is interested in exploring the influence of groupthink within operational headquarters, understanding its causal factors, and how to reduce its impact or leverage the benefits that groupthink brings. This project will provide students the experience of operations analysis in a real-world military environment and the opportunity to improve current decision-making practices within operational headquarters.	• Preference for students with a background in psychology with strong qualitative research skills • Have an interest in the application of cognitive bias research in military environments								**X**
JOAD	Edinburgh, South Australia	Future Technology Concept Exploration (FTCE) Evaluation Framework – Investigating the Feasibility of Quantitative System Dynamics Modelling Techniques for Military Utility Assessment of FTCE	Future technologies are expected to have a profound effect on Army's future capabilities and the way they are operated and used to achieve their designated goals. These emerging technologies may not have shown their potential yet, just as well the time until their maturity is uncertain. Army and Industry need analysis-based, solid evidence in order to make their investment decisions. The focus of the project will be investigating the feasibility of quantitative system dynamics modelling techniques for military utility assessment of FTCE which enable the rigorous evaluation of these technologies and the corresponding concepts for utilisation for military operations.	• Mathematics and statistics abilities, in particular operations research and optimisation. • Coding ability also useful						**X**		
JOAD	Edinburgh, South Australia	Combat Performance Visualisation	Combined Arms Simulation use a suite of data generation tools which model the combat performance of platforms, sensors and soldiers. The student will develop advanced visualisation tools to improve the ability to interrogate and detect errors within our performance data, such as interactive graphs, 3D visualisation and graphing and data comparison techniques. The student will build on our existing technology, which includes Java, Vue.js, TypeScript, NPM, Spring Boot and Play Framework.	• Software development, in particular Java Web frameworks, such as Vue.js, TypeScript, NPM • Experience with or knowledge of version control			**X**					
JOAD	Edinburgh, South Australia	Mathematical Modelling of Land Combat	Equation-based models of warfare are desirable, as they are computationally less expensive to solve and depending on the equations may be solved analytically. The famous Lanchester equations are such an example, whereby the analytical solutions permit the discovery of relationships between input factors which govern the boundary between success and failure (i.e. the Linear Law and the Square Law relationships between quality and quantity factors). However the Lanchester equations are not well-suited to modern land combat. For example, a simple extension that models the gaining of situational awareness during an ambush scenario can be easily posited. The student will (1) initially investigate if particular forms of the situational awareness function exist which retain analytical tractability, and thus deduce the relationship between quantity and quality in a more modern ambush scenario. If no such form exist, the student will (2) numerically solve the equations and empirically infer the relationship. Finally, the student will (3) explore if simple extensions to model other modern land combat scenarios exist.	• Mathematical modelling. • In particular differential equations and numerical analysis. • Some coding experience would be useful.						**X**		

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JOAD	Edinburgh, South Australia	Wargame Data Analysis Tools	Analytical Wargaming uses many tools including constructive simulation. This is a computer simulation of battle forces that generates time series data regarding the events in the game. The student will help to extract the raw data, and develop queries over it to produce metrics regarding mission success and other militarily relevant measures that are semantically well defined. Many measures will need to be visualised and the steps of data extraction, ingestion, querying and visualisation need to be automated in a way that continues to operate despite occasional errors. Once measures are available automated anomaly detection would be the next goal.	• Software development particularly in Python, SQL. • Basic mathematical understanding of statistics. • Basic understanding of data validity and validity of measures derived from them. • Conceptual knowledge of data visualisation tools, preferably with experience in R. • Working knowledge of scripting languages to control other programs based on success or failure of previous operations. • Experience with or knowledge of version control and backing up/archiving data. • Ability to write clear and concise internal documentation and user guides. • Experience with wargaming would make this project more interesting for the student.			**X**					
JOAD	Edinburgh, South Australia	Historical Analogues for Land Warfare	This project will explore the use of historical analogues to support the development of concepts for future land warfare. This will involve analysis of historical examples of warfare involving significant changes in ways of operating and using these to inform how similar changes may occur in the future due to changes in the operating environment.	• Literature review, historical analysis, ability to analyse/synthesise qualitative data; interest and knowledge in warfare (historical, contemporary and future).								
JOAD	Edinburgh, South Australia	Analysis of Trends in Land Force Design	This project will examine how land force structures have evolved over time. Specifically, the project will analyse the evolution of Battle Group and Combat Team structures in contemporary land forces	• Literature review, historical analysis, ability to analyse/synthesise qualitative data; interest and knowledge in warfare (historical, contemporary and future).								**X**
JOAD	Edinburgh, South Australia	Terrain Processing for Simulation	Several combat simulation tools are used in the Land Capability Analysis (LCA) branch for Operations Research. These simulation tools each have unique requirements with regards to the format of their simulated terrain environments. While LCA have a working set of processes for generating these environments, it is desirable to investigate alternative options with regards to software and tools. The objective of this project is to produce a working, proof-of-concept, automated processes to generate virtual environments for a variety of specified formats, from a combination of government and open source terrain data. The student will be provided access to all the required software and data, and technical guidance on the end formats and source formats. This project is an exploratory and learning process; prior familiarity with virtual terrain software and data is not a requirement, although it is desirable.	• General software development skills and familiarity with scripting languages • Highly desirable skills include: ○ Familiarity with Geospatial Information Systems (GIS) ○ Aptitude for coding, particularly in Python • Desirable skills include: ○ Familiarity with Simulation ○ Aptitude for GIS software, particularly QGIS and / or ArcGIS			**X**			**X**	**X**	
JOAD	Fairbairn, ACT	Analysis of Modelling and Simulation Trials.	This project will analyse modelling and simulation trials. The analysis is to focus on the output of multiple modelling and simulation trials, using statistical techniques and/or visualisations to identify insights within the existing dataset.	• There is scope in this project for the student to shape the direction based on their interest and experience (i.e. focus on statistical analysis and/ or visualisation). • Desired skills include: ○ Experience in Python and/or R software; ○ Understanding of statistics with regards to the experiment design; ○ Knowledge of visualisation techniques. • Experience in modelling and simulation and/or statistical approaches to support analysis would be of benefit						**X**		**X**
JOAD	Fairbairn, ACT	Modelling and Simulation for Analysis of Military Communication and Information Networks	This project explores how simulation based analysis can support military network design by quantifying relative utility value of capability options.	• Modelling and simulation skills, Software development • Verbal and written communications skills • Ability to work in teams • Motivated.			**X**	**X**		**X**		
LD	Fishermans Bend, Victoria	Synthetic Environments for Standoff Imaging of Ionising Radiation	DST is developing radiation simulation environments to enhance Defence's ability to detect and identify hazardous radiation sources. This project will develop and assess imaging systems for standoff radiation detection within the Geant4 simulation environment. Computer models of gamma-ray imaging systems will be developed, simulated and analysed for performance in standoff imaging scenarios.	• An understanding of the physics of high energy (gamma) ionising radiation. • Computational experience in Linux environments. • Knowledge/experience in coding with a preference for C/C++. • Experience using scientific software toolchains for analysis and graphical output • Ability to work independently and as part of a team.		**X**	**X**			**X**		
LD	Fishermans Bend, Victoria	Image Reconstruction and Sensor Data Fusion for Standoff Imaging of Ionising Radiation	DST is developing radiation imaging systems to enhance Defence's ability to find dangerous sources of radiation. This project will develop and assess gamma-ray image reconstruction techniques from single and multiple imaging systems for standoff detection systems. Image reconstruction algorithms will be developed and assessed in the context of either distributed or compact source search. Performance metrics will be developed and used to compare different approaches and methods of image reconstruction.	• Knowledge or interest in mathematical transforms and analysis of scientific data. • Computational experience, preferably in a Linux environment. • Knowledge or experience in coding with a preference for Python and C/C++. • Knowledge or experience using scientific software toolchains (such as python/numpy/scipy/matplotlib. • Ability to work independently or as part of a team.			**X**			**X**		

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LD	Fishermans Bend, Victoria	Background Estimation and Modelling for Standoff Imaging of Ionising Radiation	Defence has capabilities to survey areas for the presence of radiation sources. Natural fluctuations in background radiation can inhibit an operator's ability to identify possible dangerous radiation sources. This project will develop and deploy a system to measure the spatial variability in the ionising radiation background. The project will involve the development of a mobile spectroscopic measurement system that will allow detailed radiation spectral data to be acquired during motion. The acquired data will be analysed to characterise, and possibly model, background radiation variability that can confound the search for radiation sources in complex environments.	• Experimental skills, preferably in the development of measurement systems for ionising radiation or using inertial navigation systems. • Computational experience or knowledge of Linux environments. • Experience in coding with a preference for C/C++. • Experience using scientific software toolchains to develop analysis pipelines. • Ability to work independently or as part of a team.		**X**		**X**		**X**	**X**	
LD	Fishermans Bend, Victoria	Modelling Complex Object and Background Using Maxwell Render	Making a realistic and believable virtual environment is a not easy and making one which camouflage assessment can be conducted, even harder. One of the approaches we are exploring is using commercial ray-tracing software used for in animation/rendering industry, Maxwell studio/render, to create suitable background for future camouflage assessments. You aim during this Summer Vacation Project will be to create a realistic environment which can be used for as a background to look at the effectiveness of soldier camouflage assessment. As part of the project, you will be: 1. using and adapting existing 3D models as well be creating new 3D models for the scene; 2. employing these assets in recreating a real world environment – Australian bushland; 3. develop a methodological approach that may be used in creation of additional scene in the future You will also see the models and scenes you generated used across a spectrum of other rendering and simulations engines ranging from FPS game engines to detailed physics based simulations.	• Skills in 3D object creation, rendering and animation are highly desirable, as are specific experience with using Maxwell render or similar ray tracing software. • Software programing skills also useful but not essential. • 3D animation, game design			**X**				
LD	Fishermans Bend, Victoria	Develop an Eye Tracking Control System for Controlling a Video Camera	This project will develop an interface between an eye tracking headset and a video camera mounted on a 2D gimble. The interface will allow a user to control the movements of the camera via the gimble to search left, right, up and down based on the direction in which the user's eyes are looking. Additional functionality if time permitted would also allow the camera to zoom in or out, or take a snap shot, based on eye movements such as blinking.	• Skills in software engineering and electro-mechanical system design are highly desirable.			**X**					
LD	Fishermans Bend, Victoria	Flocking Control Using Deep Reinforcement Learning	Advanced Vehicle Systems conducts research and innovates in the multi-disciplinary field of self-managing vehicle-hosted mission systems. Our focus is on contextually aware distributed autonomic control of land vehicle fleets and their networked components, such as the coordination of the behaviours of multiple vehicles and their networked systems which are adaptive to changes in the environment. In swarm robotics one wishes to use a number of robots to achieve a desired collective behaviour, via interactions of the robots with each other and the environment. Swarming and flocking behaviour [1, 2] can be achieved by designing some simple rules that the robots should follow. However, coming up with the right rules is in general task specific and time consuming. An alternative approach is to try to learn the rules required to achieve a certain desired behaviour, by e.g. posing a reward function and using machine learning techniques to optimize this reward function. Project: A recent approach to flocking control using deep reinforcement learning was proposed in [3]. Deep reinforcement learning refers to reinforcement learning using deep neural networks as function approximators, and has enabled key breakthroughs in AI research such as in the playing of Go. This project will involve implementing the proposed algorithm of [3] in Python. Time permitting, modifications to the proposed approach to allow learning to be carried out in a distributed manner will also be investigated. [1] R. Olfati-Saber, "Flocking for multi-agent dynamic systems: Algorithms and theory, "IEEE Trans. Autom. Control, vol. 51, no. 3, pp. 401–420, Mar. 2006. [2] R. Lodge, M. Zamani, L. Marsh, B. Sims, and R. Hunjet, "A hybrid multi-modal approach for flocking," inProc. Asian Control Conf., Kitakyushu, Japan, Jun. 2019, pp. 126–131. [3] Z. Xu, Y. Lyu, Q. Pan, J. Hu, C. Zhao, and S. Liu, "Multi-vehicle flocking control with deep deterministic policy gradient method," inProc. Int. Conf. Control and Automation, Anchorage, USA, Jun. 2018, pp. 306–311.	• Knowledge of control theory and/or reinforcement learning. • Experience with Python programming and/or deep learning libraries such as TensorFlow.			**X**	**X**		**X**	**X**	

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LD	Fishermans Bend, Victoria	Swarm Collaboration Environment Classification	Background: Advanced Vehicle Systems conducts research and innovates in the multi-disciplinary field of self-managing vehicle-hosted mission systems. Our focus is on contextually aware distributed autonomic control of land vehicle fleets and their networked components, such as the coordination of the behaviours of multiple vehicles and their networked systems which are adaptive to changes in the environment. A subcategory of multi-agent control which we explore is Swarm Robotics. Swarms are built on the idea of many simple robots working together to solve a complex task; similar to swarms of ants being able to build immensely elaborate hives and to effectively forage for food. One ability of interest in swarms is the sharing of environmental data between swarm members to allow collective decision making and situational awareness [1, 2]. Project: This project will utilise a distributed swarm classification system we have recently implemented [3]. The aim is to explore distributed information sharing and distributed prediction algorithms that can improve the classification performance. Specifically, the candidate will have the opportunity to implement the scientific method on a range of swarm data-sharing techniques. Additionally, the candidate will gain experience in academic writing and the academic publication process. [1] V. Trianni, D. De Simone, A. Reina, and A. Baronchelli, "Emergence of consensus in a multi-robot network: From abstract models to empirical validation," IEEE Robotics and Automation Letters, vol. 1, no. 1, pp. 348{353, 2016. [2] R. Hunjet, B. Fraser, T. Stevens, L. Hodges, K. Mayen, J. C. Barca, M. Cochrane, R. Cannizzaro, and J. L. Palmer, "Data ferrying with swarming UAS in tactical defence networks," in 2018 IEEE International Conference on Robotics and Automation (ICRA). IEEE, 2018, pp. 6381-6388. [3] P. Smith, A. Aleti, V. C. S. Lee, R. Hunjet, and A. Khan, "Robotic hierarchical graph neurons. a novel implementation of hgn for swarm robotic behaviour control," 2019.	• We are looking for a candidate from a computer science background with interest in machine learning			X	X		X	X	
LD	Edinburgh, South Australia	Target Tracking for Vehicle Protection	This project explores the filtering and tracking algorithms in theory and in Python for implementation. Students will work with a PhD Intern who will provide the MATLAB algorithms and collaborate in Python programming.	• General programming skills and Python basics • MATLAB basics preferable, but not compulsory. • Advanced calculus understanding (first year maths for engineers) is needed.	X		X	X		X	X	
LD	Edinburgh, South Australia	Defending Vehicles Against Swarms of Drones	A swarm of unmanned aerial vehicles (UAVs) has the potential to pose a serious threat on the battlefield. The Advanced Vehicle Systems Group (AVS) of Land Division is developing algorithms to recommend appropriate countermeasures to soldiers. In this project, you will extend a pre-existing simulation environment developed with the Open AI Gym toolkit (https://gym.openai.com/). The environment simulates an attack on a group of land vehicles. Your job will be to add additional features to the environment to make the simulation more realistic and work with researchers to analyse the performance of different algorithms in this setting.	• Programming experience, preferably in Python • Software development skills			X					
LD	Edinburgh, South Australia	Decision Making for Distributed Autonomous Vehicles	The Advanced Vehicle Systems (AVS) group of Land Division at DST is undertaking research and development of a distributed control system for military land vehicles called Ravos. The goal of Ravos is to realise automated reconfiguration, healing and optimisation of mission systems on these vehicles and between groups of vehicles. Ravos exploits contextual awareness of the environment in order to adapt in response to dynamic situations, such as adversarial actions and changing mission priorities. A core element of Ravos is its distributed decision making capability, which provides Ravos with the ability to coordinate control between different vehicles and efficiently reach decisions relating to key control aspects. This capability is being applied in a number of Ravos applications including recommendations for countermeasure deployment by vehicles against unmanned aerial threats (drones) in order to maximise survivability and management of communication network links in scenarios where vehicles are trying to avoid detection. The AVS group has considered a number of market-based distributed decision making algorithms as part of Ravos, such as the Consensus Based Bundle Algorithm [1]. The aim of this project is to analyse and compare these algorithms in simulation and to propose and implement enhancements in order to improve the performance of Ravos. Current algorithms have been implemented in Python and it is expected that Python will also be used for this project. [1] Choi, H.L., Brunet, L. and How, J.P., 2009. Consensus-based decentralized auctions for robust task allocation. IEEE transactions on robotics, 25(4), pp.912-926.	• General software development skills • Experience in coding, with a preference for the Python language • Ability to work in teams			X	X			X	
LD	Edinburgh, South Australia	Robot Vision for Vehicle Protection	AVS operates several Clearpath Jackal robots running the Robot Operating System (ROS) to provide an experimental capability. The aim of this project is to enable collaboration between robots using our Ravos architecture. This project will integrate a depth camera (Zed min) on our Clearpath Jackal Robot. Object detection and classification data will be shared between Robots using Ravos; AVS' autonomic control system.	• Familiarity with Java and Python • Basic software engineering skills • Mechatronics, with some familiarity with ROS			X				X	

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LD	Edinburgh, South Australia	Drone Detection Sense-Compute-Act	The Advanced Vehicle Systems (AVS) Group of Land Division in DST utilises Unmanned Aerial Systems (UAS) or drones for research purposes. To support the ongoing research work in AVS, drone position and orientation data needs to be sensed, computations and predictions need to be performed, and decisions about the drones need to be made. Commercial systems exist to monitor the activity of consumer or commercial off the shelf drones. This data needs to be converted from the format used by the drone monitoring system into an open standard for use in decision-making system being developed by DST. An application programming interface (API) exists to support the production of software applications that can embody the Sense-Decide-Act concept. This enables an application to receive data from drones from the radio receiver on the detection system (Sense) process the data according to rules or requirements (Decide) and trigger events, actions or behaviours (Act). This project will produce software artefacts demonstrating aspects of the Sense-Decide-Act paradigm for drone detection with the software managed though an appropriate version control system. Mandatory deliverable: Written Project brief/report and presentation at DST student conference This report will describe: • The software functions desired • An assessment of the performance of the software • Evaluation of the software artefacts for ongoing use.	• Experimental skills, modelling skills, software development • Excellent computer, verbal and written communications skills are required to undertake this project. • General software development skills, scripting, source control configuration management. • Good communication skills, Ability to work in teams, Motivated and goal-focussed			**X**	**X**		**X**	**X**	
LD	Edinburgh, South Australia	Distributed RF Signature Management	The Advanced Vehicle Systems (AVS) team is developing a distributed autonomic mission system manager (Ravos) for the coordinated management of mission systems across a federation of vehicles. This includes the creation of a low probability of detection (LPD) communication application which will function as part of the Ravos system. The LPD application utilizes distributed context awareness and distributed control to minimize the RF signature of radio systems through the automatic adjustment of transmission power. A student working on this project would contribute to the transition of LPD algorithms from hardware in the loop simulation to robot land platforms. Software development to implement lessons learned in the hardware in the loop phase in the LPD algorithms • Planning and conducting experiments to validate the algorithms on hardware • Documenting and publishing results in a scientific publication	• Experimental skills, modelling skills, software development • Excellent computer, verbal and written communications skills are required to undertake this project. • General software development skills, scripting, source control configuration management. Python programming experience required • Good communication skills • Ability to work in teams • Motivated and goal-focussed			**X**	**X**		**X**	**X**	
LD	Fishermans Bend, Victoria	Examination of Results for Virtual Reality Target Detection Study with Soldiers	This project will involve a detailed analysis of the human performance results of a study conducted in FEB 2020. The study evaluated human factors issues associated with the use of virtual reality as a means to assess future tools a soldier might use to detect targets. Suitable for a behavioural science, human factors student.	• Familiar with experimental design • Comfortable with multivariate statistics • Competent with SPSS and/or Jamovi • Work as part of a small team • Some familiarity with PC and VR technology a plus								**X**
LD	Fishermans Bend, Victoria	Adsorbent Polymers Dosimeters	This project seeks to find a suitable adsorbent polymer dosimeters that can be used to trap and subsequently measure certain chemicals during testing of protective suits. The dosimeters would be used on either the DST articulated mannequin or on humans in the man-in-simulant test (MIST) for assessing chemical protective ensembles.	• Ability to work autonomously and in teams • Familiarity with chemical laboratory safety • Wet chemistry skills • Good written and verbal communication		**X**			**X**			
LD	Fishermans Bend, Victoria	Modelling the Blast and Ballistic Response of Composite Armour systems	This project will focus on exploring the level of complexity required to effectively model the response of a composite armour system under blast and/or ballistic loading conditions. While composite materials provide the potential for weight savings on armoured vehicles due to their high strength to weight ratio, the effective design of structures using these materials requires detailed knowledge of the material behaviour under high strain rate loading. Mechanical characterisation test programs for composites are both time-consuming and expensive to fully capture the materials behaviour due to their orthotropic nature and large number of failure modes. Using a previously obtained mechanical test data, the student will evaluate the use of a range of different composite material models using the same test data. The goal of the project is to determine the best model for blast and/or ballistic applications to both streamline the characterisation of these materials as well as validation and use of these materials in blast and ballistic models in the future.	• Mechanical/Aerospace/Mechatronics Engineering or Physics. • While some experience with commercial Finite Element Analysis (FEA) or Computational Fluid Dynamics (CFD) packages is beneficial, training will be provided as part of the project.	**X**				**X**	**X**		
MD	Fishermans Bend, Victoria	Characterisation of Carbon Based Materials Used in Defence with Raman Spectroscopy	Carbon based materials, such as graphene, carbon nanotubes and diamond like coatings are of increasing interest to Defence due to their excellent mechanical, electrical and thermal properties. This project will look at a range of such materials used in current and developing Defence applications using Raman spectroscopy which is an established, non-destructive analysis technique. Raman spectral bands correspond to the specific vibrational frequencies of bonds within a molecule which can reveal a great deal about its carbon nanostructure, structural disorder, state of dispersion and orientation. This project aims to build a comprehensive spectral library and explore innovative approaches to identify the carbon form in a material.	• Experimental skills, preferably in spectroscopy. • Good scientific writing and communication skills. • Ability to work in teams. Good time management skills.		**X**			**X**			
MD	Eveleigh, NSW or Fishermans Bend, Victoria	High Fidelity Flow Generated Noise Prediction	This project will investigate the coupling of a computational fluid dynamics solver (OpenFOAM) with a spectral element package (Nektar++) to predict the generation and propagation of flow generated noise. The coupled codes will be used to study the noise produced by flow over a range of structures of practical interest to the Maritime Division.	• Experience in coding, with a preference for the C++ language • Demonstrated skills with development and implementation of numerical techniques, such as Finite Difference or Finite Volume techniques • Skilled in computational fluid dynamics	**X**					**X**		

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Division	**Location** Multiple locations may be listed	Project Title	Project description	Desirable Skills	Research Streams							
					AAENA	CRBFS	CSITSET	EEE	MS	MP	MMER	PSS
MD	Eveleigh, NSW	Dynamic Path Adaptation for an Autonomous Underwater Vehicle (Underwater Robot)	Autonomous underwater vehicles (AUVs) are well suited to surveying underwater environments to determine navigability (surveying water depth and obstacles) and environmental conditions (temperature, salinity, turbidity and other factors that can affect sensor performance). This project will test techniques for dynamic path adaptation so that an AUV with limited sensing ability can avoid collisions with static obstacles such as channel markers and moving obstacles such as vessels. The algorithms will be developed and tested using small ground robots and if time and conditions allow, they will be tested on an AUV at sea.	• Experience with software development in C++ or Python is mandatory. • Experience with mobile robots would be highly advantageous. • Completion of at least one course in algorithms would be advantageous. • This project would suit a student who has completed three years of engineering or computer science and who has an interest in robotics and algorithms.	X		X	X			X	
MD	Eveleigh, NSW	Collaborative Autonomy using Robot Operating System on Turtlebot3	Objective: To use a number of small robots to demonstrate collaborative autonomy behaviours. Apparatus: Turtlebot3 Burger and Waffle - http://en.robotis.com/model/page.php?co_id=prd_turtlebot3 Method: Develop behaviours under the Robot Operating System (https://www.ros.org) to: 1. Allow one robot to follow the other, keeping a set distance from each other as they travel around a room avoiding objects; and 2. (stretch) for one robot to use its sensors to conduct a search to identify an object of interest and then call in its companion to take an image of the object 3. (stretch) integrate more sensors, develop behaviours including navigation.	• Experience with software development in C++ or Python is mandatory. • Experience with mobile robots would be highly advantageous. • Completion of at least one course in algorithms would be advantageous. • Value to Defence. The development of complex behaviours is a key enabler in many autonomy programs. The ability for more than one robot to work collaboratively with others to perform a given task lends itself to economies of scale but also adds to increased complexity. Through this activity the student will gain familiarity in ROS and develop an understanding of some of the challenges that can be experienced when robots work collaboratively.	X		X	X			X	
MD	Edinburgh, South Australia	Underwater Object Classification Using Clean Training Data	The most common approach to classify underwater objects using sonar is to separate the sonar returns into two classes: those which contain the target echo, and those that do not. When using real data, this process is complicated by the fact that the target echoes are often distorted by undesirable underwater channel propagation effects, such as multipath and reverberation. In order to overcome this issue, we investigate an approach of training classifiers on the echoes obtained from underwater objects in free-field, noiseless conditions and combining them with known models of the underwater environment	• Knowledge of digital filtering, correlation techniques and Fourier Transforms. • Ability in software coding, with a preference for MATLAB. • Ability to work in teams.			X	X		X		
MD	Edinburgh, South Australia	Sonobuoy Waveform Generator	The Directional Frequency Analysis and Recording (DIFAR) sonobuoy is a passive ASW detection unit. Testing of signal processing in the Airborne lab requires the generation of synthetic waveforms. The project is to build a DIFAR signal in MATLAB that has an isotropic noise field and a randomly generated number of tonals with known SNR. The application will generate the WAV files, display the results in a waterfall display and provide a web interface that is locally hosted to store both the Wav and the metadata for the file.	• Knowledge of programming structures, configuration control and some experience with MATLAB and/or C++. • An ability to work in a small team and has good time management skills.			X	X				
RSD	Edinburgh, South Australia	Flight Vehicle Joint Testing	In the development of aerospace vehicles, the ability to design and analyse bolted connections is of critical importance to the structural integrity of the entire vehicle. This project will investigate the strength of various mechanical joints to determine the loading experienced by fasteners within each joint. Fastener shear and tensile loads will be determined experimentally and compared against finite element models and hand calculations developed by flight vehicle engineers within our team.	• Experimental skills, preferably in a mechanical engineering related discipline. • Experience in finite element modelling and engineering calculations.	X						X	
RSD	Edinburgh, South Australia	Spacecraft Thermal Testing	In the development of space platforms, knowledge of the steady-state and transient thermal performance of the space structures is required in order to design high performance payloads. This project will involve thermal testing in a vacuum chamber of various supplied systems to determine their steady state and transient performance. The thermal performance derived experimentally will be compared against and used to validate finite element models and calculations developed by engineers within our team.	• Experimental skills, preferably in a mechanical engineering related discipline. • Experience in finite element modelling and engineering calculations (particularly thermal analysis).	X						X	
RSD	Edinburgh, South Australia	Motion Control in Space Robotic Applications	Multiple feedback intelligent field oriented control of BLDC motors for Space Robotics Applications - Field Oriented Control of Brushless DC motors provide promise in Space Robotic applications due to its independence from magnetic type sensors which are unreliable in space. The main objective of this study is to investigate novel algorithms to automatically tune multiple feedback brushless DC motor controllers in robotic applications. Initial models of the control system can be simulated in MATLAB Simulink environment and a reusable code library will be developed based on C/C++.	• -Embedded Firmware Development for ARM Processors in C/C++ • Digital and analogue Electronic circuit design • MATLAB Simulink • Digital control systems design • Robotics			X	X				
SEID	Adelaide, South Australia	Capturing Emission Spectra Using Upconversion Fluorescence	Two photon upconversion will be used to determine the emission spectra for a number of candidate materials. The experiments will collect spectra over a broader range than currently available (~200-2500nm) and use that information to find unique signatures or patterns that can be used to identify the materials. The student will help prepare samples, test setup, measure background signals, conduct scans, analyse data, and report on findings.	• Chemistry, Physics, materials science, Experimental skills • Familiarity with laser and programming skills would all be useful. • Experiments will be conducted at Adelaide University. Attendance at DST Edinburgh will be limited.		X			X	X		
WCSD	Edinburgh, South Australia	Human Factors of Advanced Technology	The student will work as part of the Human Systems Discipline on a psychology/human factors research topic of relevance to the team. This research may be on topics such as the effect of mix reality technology on physically separated teams, or how users interact with autonomous systems such as drones. There is potential for the student to undertake a number of tasks, including a literature review, contributing to and helping conduct a human-in-the-loop experiment and report write up of study findings.	• The design, conduct, analysis and write up of human experiments. • Good communication skills, ability to work in teams, and a keen interest in cognitive and experimental psychology and Human Factors. • Motivated and goal-focussed, and interested in working in a defence environment.								X

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Division	**Location** Multiple locations may be listed	Project Title	Project description	Desirable Skills	Research Streams							
					AAENA	CRBFS	CSITSET	EEE	MS	MP	MMER	PSS
WCSD	Edinburgh, South Australia	Tactical Decision Modelling Research Environment	Decision Sciences undertakes cutting edge research into the science of Decision Making across Human-Autonomous Tactical Mission Systems to ensure our Defence capability delivers superior decisions and outcomes. Our research is looking into the future where advanced autonomous systems powered by Artificial Intelligence and the latest emerging technologies to deliver the tactical edge. This project will provide real-world software engineering experience, undertaking development and enhancement of an existing suite of scientific research simulation software used to support research in decision making within distributed human and autonomous (AI) tactical systems. You will gain experience with agile software development practices across various aspects of the software development process from requirements and development through to test and release. The objective is to increase the effectiveness of our research, by continuing to develop human and AI decision models from a series of functions into individual micro-services which could then be adapted and plugged into other projects within a local testing environment. In addition to transforming the models into a more versatile micro-service structure, the project will also look into upgrading the current simulation suite to tackle more complex scenarios.	• Software & Systems Engineering. Requirements development, Software interface design, Software Design principals and Design Patterns. • Software Configuration Management, Software Documentation. • Team-based work environment.			**X**			**X**		
WCSD	Edinburgh, South Australia	Investigating Artificial Intelligence and Machine Learning (AI/ML) Techniques to Enhance Information Fusion using Combat Information Systems	This project will develop and test AI/ML techniques capable of enhancing Information Fusion using tactical information systems. The project will promote the use of machine learning to generate fused meta-data from unstructured sources. The application space could be tested using the information feed from representative data captured during the Heimdall trail.	• Software Development, Object Orientated Programming (such as Python, Java, MATLAB) • Ability to work in teams.			**X**					
WCSD	Edinburgh, South Australia	Investigating Artificial Intelligence and Machine Learning (AI/ML) Techniques to Enhance Tactical Situation Understanding Using Combat Information Systems	This project will develop and test AI/ML techniques capable of enhancing tactical situation understanding using tactical information systems. The project will promote the use of machine learning to generate meta-data that will enhance situation awareness within the combat or mission system. The application space could be tested using the information feed from a UAV ISR operations scenario.	• Software Development, Object Orientated Programming (such as Python, Java, MATLAB) • Ability to work in teams.			**X**					
WCSD	Edinburgh, South Australia	Internet of Things Trustworthiness	The Internet of Things (IoT) is a term used to describe a recent trend in adding internet connectivity to common household devices. Each IoT device can be uniquely identified and controlled over the internet. However, the act of connecting IoT devices to the internet opens up trustworthiness concerns if they are not properly protected. Trustworthiness in IoT is about managing the following system qualities: safety, reliability, security, privacy and resilience. The aim of this project is to investigate the current landscape and challenges in IoT trustworthiness. The deliverables of this project are: a) Research in IoT trustworthiness b) Development of a simple IoT testbed using commercial IoT devices c) Demonstration of trustworthiness considerations in the IoT testbed d) Report describing the work conducted in the project	• Ability to search for, review, and summarize literature • Software development skills (coding and source code management) • Knowledge of JavaScript language and development with web APIs and frameworks (preferably specific to IoT) • Interest in thinking creatively about and investigating trustworthiness concerns • Ability to work in a team environment • Ability to document and present on findings			**X**					
WCSD	Edinburgh, South Australia	Complex Battlespace Visualisation	Summary: Work closely with researchers to develop concepts and techniques to clearly and dramatically represent the physical and cyber interaction between advanced defence platforms in a complex, modern battlespace. Background: The complexity of the modern tactical battlespace requires new tools to better visualise and quickly make sense of the complex interactions taking place between different entities. Augmented reality (and virtual reality) offer possible candidates for providing increased insight and ease of manipulation. Previous work by DST and students has resulted in the development of frameworks to visualise and manipulate pre-existing data in a 3D framework (Unity), while present ongoing work is translating and testing these frameworks into HoloLens 2. This project will investigate the addition of real-time data analytics visualisation and real-time data ingestion into the present frameworks.	• 3D modelling and timeline-based modelling • Knowledge/experience with Python would be an advantage • Understanding/knowledge of Data Analytics and/or data visualisation			**X**			**X**		
WCSD	Edinburgh, South Australia	Future Tactical Management System	Summary: Work with a DST team in developing advanced software components as part of a future Combat Management Systems research testbed. Background: A Combat Management System (CMS) is the software that enables advanced functionality within our military vehicles – such as ships, planes, and tanks – and critically supports military personnel in defending themselves and others against hostile intent. The Future Tactical Management System (fTMS) is a distributed, software-based research platform, backed by constructive and virtual simulation that enables future CMS concepts and functionality to be explored, analysed and experienced. It is envisioned that fTMS be capable of being deployed in different configurations, ranging from the desktop to the human-in-the-loop experimentation. Present research and development work includes the investigation of Microsoft HoloLens (mixed reality smart-glasses) as a visualisation tool, and both machine-learning- and simulation-in-the-loop. This project will investigate and develop software components for integration into the fTMS. These software components may represent core and new CMS functionality, including: User Interface components; simulation capabilities; and infrastructural elements.	• General software development skills, scripting, source control configuration management • Experience in coding. (familiarity with Java and JavaScript would be advantageous) • Ability to work in teams • Knowledge of Distributed Systems			**X**					

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					AAENA	CRBFS	CSITSET	EEE	MS	MP	MMER	PSS
WCSD	Brisbane, Queensland	Separation Modelling	This project will look into modelling separation of two bodies during hypersonic flight. Specifically, a 6dof MATLAB model has been developed to use a coefficient build up method and investigation is required into the scope and fidelity of the required aerodatabase (generated in CFD). Other areas of effort may include improvements in modelling techniques and studying how the bodies behave in different scenarios.	• Good understanding of fluid dynamics • Experience with MATLAB and object oriented programing • Experienced in CFD modelling	**X**							
WCSD	Brisbane, Queensland	Experimental Flight Vehicle Electrical System Design and Evaluation	This project will explore and evaluate new ways of designing the electrical system for experimental flight vehicles. The aim of the project is to recommend a tool and methodology to design and route harnesses in complex assemblies with rules based optimisation. The project will include use of CAD software and practical work in the electronics laboratory.	• Ability to read and understand electrical wiring diagrams (e.g. pin connections, wire gauge, electrical symbols) • Experience with CAD programs would be advantageous but not required (e.g. Siemens NX) • A practical sense of where to route and place wiring looms and harnesses • Good analysis skills • Good communication skills • Ability to work in a team environment • Motivated and goal focused			**X**	**X**				
WCSD	Brisbane, Queensland	Antenna Modelling and Analysis	This project will assess the performance of patch antennas for flight test vehicles. The candidate will become familiar with antenna radiation modelling software to investigate optimal configurations. Verification and validation will then be conducted with the appropriate hardware set up.	• Basic understanding of fundamental antenna theory • General software development skills (i.e. scripting, source control, configuration management) • Experience with antenna modelling software • Data analysis skills in MATLAB or Python • Good written and verbal communication skills • Ability to work in a team environment • Ability to be proactive			**X**	**X**				
WCSD	Edinburgh, South Australia	Collaborative Weapon Technologies Demonstration Environment	The Collaborative Weapons Technologies (CWT) group conducts research on multi-agent guidance, control and decision-making applied to teams or swarms of autonomous systems. CWT is using the multi-agent simulation environment SCRIMMAGE to develop these technologies and demonstrate their value to stakeholders. We are looking for a motivated and team-focused student to work in our team to develop new models, scenarios and visualisation tools to enhance our simulation capability and our ability to communicate our research.	• General software development skills, scripting, source control configuration management • Experience in coding, with a preference for C++ and/or Python languages • Ability to work in teams • Any experience in simulation and/or modelling dynamics of rigid bodies using differential equations would be highly valued	**X**		**X**			**X**	**X**	