

# Theme 3: Support the Manager

The effects of maintenance planning on long-term productivity are not well-studied. Finding the right balance between the costs of preventative maintenance and the disruptions caused by on-site failures is difficult and requires an extensive, systematic exploration of all options. The potential benefits are enormous.

Initial project areas for Theme 3 include:

1

## Optimising Maintenance for Duplicate Assets

Process plants in the mining sector often contain large populations of duplicate assets – for example, precipitators in alumina production. Scheduling the periodic maintenance of these assets is a major challenge because the assets are inter-connected and there is uncertainty around their condition – often the precise maintenance requirements only become known once the asset is taken out of service.

Currently, such maintenance is manually scheduled using “rules of thumb” driven by legacy practices rather than real data or rigorous science.

The aim of this project is to develop fast optimisation algorithms for scheduling maintenance in populations of inter-related duplicate assets, taking into account the condition estimates, constraints on resource /labour availability, production needs, safety compliance, and asset inter-connections and redundancy. This will lead to automated tools for ensuring schedule compliance, cost control, and reducing unplanned maintenance work. Key challenges in the project will include developing the correct optimisation models that add value to the industry partners, and overcoming the dimensionality challenges that are common in large-scale industrial optimisation problems.

2

## Maintenance Scheduling under Plant Constraints

Maintenance plans for mining assets must adhere to numerous constraints ensuring plant integrity and safety – for example, a certain pump cannot be switched off at the same time as another pump. Existing software tools can identify constraint violations and clashes in a given maintenance schedule, but updating the schedule when clashes are detected is still a laborious manual process. Humans are unable to efficiently process the vast streams of data now available, nor can we visualise and balance the numerous competing factors necessary to determine an optimal maintenance schedule that minimises cost.

The aim of this project is to develop mathematical optimisation algorithms for automatically updating short- term and long-term maintenance schedules to avoid violations/clashes while optimising a specific performance index – for example, maximising plant throughput or minimising cost. These algorithms will incorporate tacit rules about which equipment can or cannot be repaired at the same time. Mathematical advances in optimisation theory will be required to deal with the extreme dimensions present in these scheduling problems.

3

## Optimising Maintenance Intervals

### Publications

- [A Note on the Finite Convergence of Alternating Projections \(...\)](#) —

Journal Article

Dr Hoa Bui

**Authors: Hoa Bui, Ryan Loxton, Asghar Moeini**

2021-05-09

- [An exact cutting plane method for solving p-dispersion-sum problems \(...\)](#) —

Journal Article

Sandy Spiers

**Authors: Sandy Spiers, Hoa T. Bui, Ryan Loxton**

2022-07-22

- [Approximate dynamic programming for an energy-efficient parallel machine scheduling problem \(...\)](#) —

Journal Article

Dr Mojtaba Heydar

**Authors: Dr Mojtaba Heydar, Dr Elham Mardaneh, Proj Ryan Loxton**

2022-10-01

- [Bayer digestion maintenance optimisation with lazy constraints and Benders decomposition \(...\)](#) —

Journal Article

Sandy Spiers

**Authors: Sandy Spiers, Hoa T. Bui, Ryan Loxton, Moussa Reda Mansour, Kylie Hollins, Richard Francis, Christopher**

All assets – from individual mobile assets to the entire fixed plant – consist of multiple inter-related sub- systems with different maintenance cycle times. A key challenge in maintenance planning is to align these cycle times so that maintenance tasks requiring the same resources and isolations are performed at the same time, minimising rework and disruptions to production. For example, if one component has a cycle time of 6 months and another has a cycle time of 5 months, then it may be advantageous to reduce the 6- month cycle time (effectively over-maintaining the component) so that both components are maintained at the same time. Real-life maintenance projects may involve hundreds or thousands of components, well beyond the scale that humans can comprehend and hence necessitating automated approaches.

To this end, this project will involve developing optimisation algorithms for determining maintenance cycle times in an inter-connected system to maximise synergies, minimise downtime, and minimise the probability of failures. There will be various constraints to respect - for example, in the case of mobile assets, there are typically a limited number of maintenance bays for accommodating equipment undergoing maintenance. Other considerations include sub-system redundancy, journey times, OEM recommendations, and production needs.

## **Martindale, Yogesh Pimpale**

2023-09-16

- [Branch-and-price for clash-free periodic supply vessel planning problem with split delivery and variable service time \(...\)](#) —

## **Journal Article**

[Dr Elham Mardaneh](#)

**Authors: Elham Mardaneh, Mojtaba Heydar, Ryan Loxton**

2022-09-09

- [Connectivity of cubical polytopes, Journal of Combinatorial Theory \(...\)](#) —

## **Journal Article**

[Dr Hoa Bui](#)

**Authors: Hoa Bui, Guillermo Pineda-Villavicencio, Julien Ugon**

2019-08-06

- [Cutting Plane Algorithms are Exact for Euclidean Max-Sum Problems \(...\)](#) —

## **Journal Article**

[Dr Hoa Bui](#)

**Authors: Hoa T Bui, Sandy Spiers, Ryan Loxton**

2023-09-17

- [Cutting plane algorithms for nonlinear binary optimization \(...\)](#) —

## **Journal Article**

[Dr Hoa Bui](#)

**Authors: Bui, Hoa; T Lin, Qun; Loxton, Ryan**

2022-03-18

- [Extremal Principle: Nonlinear Characterizations of Non-Intersection Properties \(...\)](#) —

## **Journal Article**

[Dr Hoa Bui](#)

**Authors: Dr Hoa  
Bui, Prof. Alex  
Kruger**

2020-06-22

- [Geometric and Metric Characterizations of Transversality Properties \(...\)](#) —

Journal Article

[Dr Hoa Bui](#)

**Authors: Hoa T. Bui,  
Nguyen Duy Cuong,  
Alexander Y. Kruger**

2020-03-05

- [Long-term maintenance optimization for integrated mining operations \(...\)](#) —

Journal Article

[Yingying Yang](#)

**Authors: Yingying  
Yang, Ryan Loxton,  
Andrew L. Rohl,  
Hoa T. Bui**

2023-11-16

- [Minimizing equipment shutdowns in oil and gas campaign maintenance \(...\)](#) —

Journal Article

[Prof Ryan Loxton](#)

**Authors: Z.Seif, R.  
Loxton, E.Mardaneh  
and A.Lockwood**

2020-06-29

- [Single-Projection Procedure for Infinite Dimensional Convex Optimization Problems \(...\)](#) —

Journal Article

[Dr Hoa Bui](#)

**Authors: Hoa T.  
Bui\* Regina S.  
Burachik† Evgeni A.  
Nurminski‡  
Matthew K. Tam**

2022-10-21

- [Some new characterizations of intrinsic transversality in Hilbert spaces \(...\)](#) —

Journal Article

[Dr Hoa Bui](#)

**Authors: Nguyen Hieu Thao, Hoa Bui, Nguyen Duy Cuong and Michel Verhaegen**

2020-02-12

- [The Impact of Changes in Resolution on the Persistent Homology of Images \(...\)](#) —

**Conference Publishing**

[Dr Hoa Bui](#)

**Authors: Teresa Heiss, Sarah Tymochko, Brittany Story, Adelie Garin, Hoa Bui, Bea Bleile, and Vanessa Robins**

2022-01-13

- [The linkedness of cubical polytopes: The cube \(...\)](#) —

**Journal Article**

[Dr Hoa Bui](#)

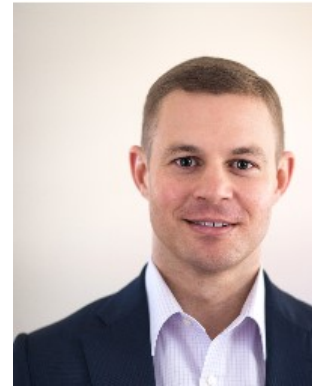
**Authors: Hoa T. Bui, Guillermo Pineda-Villavicencio, Julien Ugon**

1970-01-01

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## Presentations

- [2020 ANZIAM Early-career Workshop \(...\)](#) —



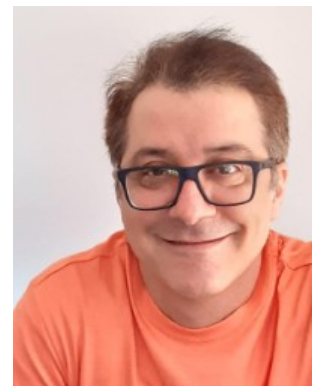
Prof Ryan Loxton

Theme Lead

### Theme 3

2020-01-31

- A stochastic model for job assignment problem with random arrivals and processing time (...) —



Dr Mojtaba Heydar

## Research Fellow

### Theme 3

2021-07-09

- [AMPeak. Annual conference put on in Perth by the Asset Management Council \(...\)](#) —



[Prof Ryan Loxton](#)

Theme Lead

### Theme 3

2019-04-08

- [An exact cutting plane algorithm for the Euclidean Max-Sum Diversity Problem \(...\)](#) —



[Sandy Spiers](#)

PhD Student

### Theme 3

2024-02-16

- [An exact cutting plane method for the Euclidean Max-Sum Diversity Problem \(...\)](#) —



[Sandy Spiers](#)

PhD Student

### Theme 3

2023-07-13

- [Connectivity and Linkedness of the Graph of Cubical Polytopes \(...\)](#) —



Dr Hoa Bui

Research Fellow

### Theme 3

2020-07-09

- [Crew Rostering Optimization in Maintenance Operations - Models and Solution Methods \(...\)](#) —



Ponpot  
Jartrillaphand

PhD Student

### Theme 3

2021-07-09

- Long-term Integrated Maintenance Scheduling Optimisation (...) —



Yingying Yang

PhD Student

### Theme 3

2023-11-17

- [Maintenance Optimisation for Network Connected Assets \(...\)](#)
- 



Sandy Spiers

PhD Student

### Theme 3

2021-08-27

- [Master Class - Solution Methods for Practical Scheduling Models \(...\)](#) —



Dr Hoa Bui

Research Fellow

### Theme 3

2021-04-15

- [Multi-skilled Workforce and Maintenance Job Scheduling in Turnaround Maintenance.](#) (.. .) —



Ponpot  
Jartnillaphand

PhD Student

**Theme 3**

2022-09-09

- [NSW ANZIAM 2021 Mid-year Conference - Optimisation Methods for Maintenance Scheduling in the Mining Industry. \(...\) —](#)



Dr Hoa Bui

Research Fellow

**Theme 3**

2021-07-09

- [On outer approximation method for nonconvex binary optimization \(...\) —](#)



Dr Hoa Bui

Research Fellow

### Theme 3

2023-07-10

- [Optimal maintenance scheduling for Alcoa digester banks \(...\)](#) —



Sandy Spiers

PhD Student

### Theme 3

2022-06-03

- [Optimal Maintenance Scheduling via Mathematical Programming \(...\) —](#)



[Yingying Yang](#)

PhD Student

### Theme 3

2021-02-12

- [Optimisation Methods for Maintenance Scheduling in the Mining industry \(...\) —](#)



Dr Hoa Bui

Research Fellow

### Theme 3

2022-07-20

- [Optimisation model for sixteen-week Maintenance Planning in Alcoa \(...\)](#) —



Dr Hoa Bui

Research Fellow

### Theme 3

2021-02-12

- [Optimisation platform for shutdown maintenance scheduling \(...\)](#) —



Dr Hoa Bui

Research Fellow

### Theme 3

2022-10-07

- [Optimising Maintenance Teams \(...\)](#) —

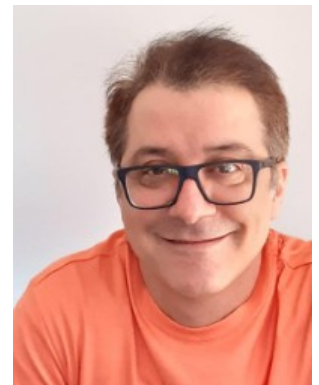


Ponpot  
Jarnillaphand

PhD Student

**Theme 3**  
2023-09-15

- [Plant shutdown planning problems. \(...\) —](#)



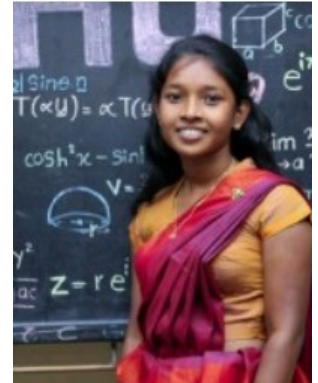
Dr Mojtaba Heydar

Research Fellow

### Theme 3

2022-08-12

- [Risk-Based Maintenance Scheduling Optimisation \(...\)](#) —



Srimali  
Gunasekara

PhD Student

### Theme 3

2023-06-16

- [Scheduling Tool for Furnace Outages at Kwinana Nickel Refinery by Hoa Bui \(...\)](#) —



Dr Hoa Bui

Research Fellow

**Theme 3**

2022-03-11

- [The International Conference on Smart Computing & Communications \(ICSCC 2019\) \(...\)](#) —



Prof Andrew Rohl

Training Centre  
Director

**Directorate**

2019-06-29

- [Understanding the Difficulties of Optimisation \(...\)](#) —



**Sandy Spiers**

PhD Student

**Theme 3**

2023-10-20

- [WOMBAT 2023 - Cutting Plane Methods are Exact for Euclidean Max-Sum Problems \(...\)](#) —



Sandy Spiers

PhD Student

### Theme 3

2023-12-11

- [WOMBAT 2023 - Parallel Machine Scheduling Problem with Flexible Resources and Shift Consideration \(...\) —](#)



Ponpot  
Jartnillaphand

PhD Student

### Theme 3

2023-12-13

- [Zero Duality Gap Conditions via Abstract Convexity \(...\)](#) —



Dr Hoa Bui

Research Fellow

### Theme 3

2020-07-08

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## Tools

- [Schedule Optimisation Tools \(..\)](#) —



2020-01-31

Tools for common  
schedule  
optimisation  
problems

## The Team

### Lead

- [Prof Ryan Loxton \(...\)](#) —



[Prof Ryan Loxton](#)

Theme Lead

### Theme 3

### Chief Investigators

- [A/Prof Mark Reynolds \(...\)](#) —



[A/Prof Mark Reynolds](#)

Chief Investigator

### Theme 3

- [Dr Elham Mardaneh \(...\)](#) —



[Dr Elham Mardaneh](#)

Chief Investigator

### Theme 3

## Partner Investigators

### Content by label

There is no content with the specified labels

## Research Fellows

- [Dr Hoa Bui](#) (...) —



[Dr Hoa Bui](#)

Research Fellow

### Theme 3

## PhD Students

- [Ponpot Jartrillaphand](#) (...) —



Ponpot Jartrillaphand

PhD Student

**Theme 3**

- [Sandy Spiers \(...\)](#) —

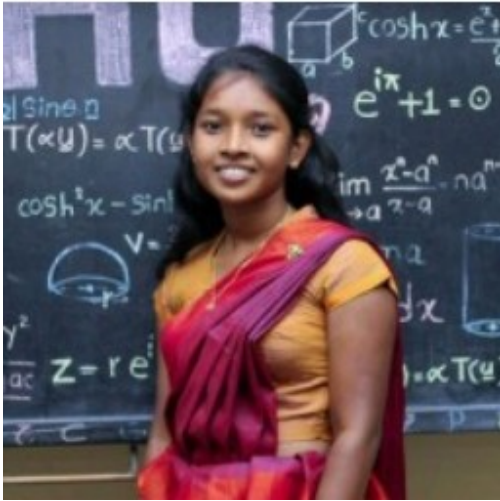


Sandy Spiers

PhD Student

**Theme 3**

- [Srimali Gunasekara \(...\)](#) —



[Srimali Gunasekara](#)

PhD Student

### Theme 3

- [Yingying Yang \(...\)](#) —



[Yingying Yang](#)

PhD Student

### Theme 3

Honours Students

Content by label

There is no content with the specified labels