Internship Position

Multiple-resource Flexible Job-shop for Remanufacturing Systems

Location	Mines Saint-Étienne, Henri Fayol Institute, Saint-Étienne, France
Supervisors	Damien Lamy (MSE), Mohammed-Amine Abdous (IMT-NE)
Keywords	Scheduling; Remanufacturing System; Multiple Resource Scheduling; Ergonomics; Metaheuristics; Sustainable Production Systems
Starting date	March/April 2026
Duration	5 or 6 months
Indemnities	Legal amount (https://www.service-public.fr/particuliers/vosdroits/F32131)
Possible continuation	PhD position available starting September 2026

Context

Due to societal challenges related to the environment, the tightening of environmental and social legislation, as well as the scarcity of resources, waste reduction and component lifecycle have become major priorities (International Energy Agency, 2024), which implies sustainable manufacturing systems. In addition, it is suggested in that a sustainable manufacturing system must possess the capabilities of 6Rs (Remanufacturing, Reuse, Redesign, Recycle, Recover, and Reduce). These contemporary societal changes are driving a significant shift from traditional linear production models to more circular and sustainable approaches. The circular economy emphasizes resource efficiency, waste reduction, and extending product life cycles through different stages. If different representations exist, they all emphasize longer product usage, reuse, remanufacturing, and recycling before final disposal if no recovery is possible. Remanufacturing plays a crucial role in this lifecycle by restoring used products to like-new condition, saving resources, reducing environmental impact, and with a strong human dimension. The ReCircle project focuses on this component of the circular economy, which implies different activities through a Remanufacturing or Reverse Supply Chain (RSC). This diversity of actors can lead to conflicting objectives and inefficiencies within this supply chain. If RSCs have received attention from a planning perspective (Suzanne et al., 2020), they lack the proper tools to manage them at an operational level. Additionally, these systems are typically manual with low levels of automation, necessitating careful consideration of human factors and ergonomics, such as operator stress and fatigue (Abdous et al., 2023; Yadegari et al., 2023). In recent years, collaborative robots (cobots) have emerged as a means of reducing human fatigue. However, the use of cobots can also lead to a different kind of fatigue, related to cognitive fatigue, particularly when humans have to adapt to certain movements of the robot or are waiting for it to perform an action. The purpose of this internship is to investigate a remanufacturing factory equipped with cobots and evaluates its performance considering ergonomics aspects.

Subject

In this research internship proposal, we are interested in the consideration of human resources and cobots who can work together to achieve different remanufacturing tasks. An operation can be assigned to an operator, and its initial duration will depend on the operator's skills. The operator will accumulate fatigue throughout the day based on the assigned operations. However, this fatigue can be partially mitigated if a cobot is assigned to the operation, which will also affect the duration of the operation at the moment it joins the processing stage. Yet, due to a limited number of workers and cobots, it is not possible to operate all tasks with several resources. In addition, working in binomen with a cobot might generate other additional cognitive fatigue, that cannot be assimilated to physical fatigue. The main objectives of the research internship are:

- Formalising and modelling the problem through mathematical programming
- Investigating a metaheuristic approach to solve the problem
- Writing a draft paper for presentation in national or international conference

Candidate Profile

French or European engineer and/or research master's degree with a focus on operational research and industrial engineering. Following skills are expected:

- Good programming skills (C++, Java, Python or Julia);

- Good knowledge of operations research and combinatorial optimization (ILP, heuristics);
- Familiarity with optimization solvers such as Cplex/Gurobi/Hexaly;
- Knowledge on machine learning methods (reinforcement learning, deep learning) is a plus;
- A good level of English is highly appreciated.

Application

To apply, candidates must send their CV and grades to Damien Lamy (damien.lamy@emse.fr) and Amine Abdous (amine.abdous@imt-nord-europe.fr)

Bibliographie

Abdous, M.-A., Delorme, X., Battini, D., Berger-Douce, S., 2023. Multi-objective collaborative assembly line design problem with the optimisation of ergonomics and economics. International Journal of Production Research 61, 7830–7845.

Suzanne, E., Absi, N., Borodin, V., 2020. Towards circular economy in production planning: Challenges and opportunities. European Journal of Operational Research 287, 168–190.

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Touzout, F.A., Ladier, A.-L., Hadj-Hamou, K., 2022. An assign-and-route matheuristic for the time-dependent inventory routing problem. European Journal of Operational Research 300, 1081–1097.