TITRE DE LA THESE: Worker centric design of flexible mixed model assembly lines

Direction de thèse :

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Co-encadrant·es :

- Serena Fincoa, University of Padova, serena.finco@unipd.it
- Simon Thevenin, IMT Atlantique, LS2N, simon.thevenin@imt-atlantique.fr

Laboratoire(s) : LS2N

Equipe(s) de recherche : MODELIS

Département(s) IMT Atlantique : DAPI

S'agit-il d'une thèse en cotutelle internationale ?
Oui
Si oui, organisme avec lequel la cotutelle est envisagée :
University of Padova
Le sujet proposé présente-il un caractère interdisciplinaire ?
Oui
Si oui, expliquer brièvement pourquoi (2 ou 3 lignes) :

University of Padova will provide skills on the social implications on workers of work on production lines
IMT Atlantique will bring its skills in optimization under uncertainty in a dynamic context.
Both partners have expertise in the optimization of flexible assembly lines.

La source du co-financement est-elle identifiée ?
Oui
Si oui, préciser quel co-financement est envisagé : Université de Padova

Autres informations :
We are submitting a second request ("*Innovative design strategies for mixed-model assembly lines in the Operator 5.0 era")* for a half-thesis on a related subject. The University of Padua operates exclusively on whole thesis funding. Consequently, the co-supervisor of the two theses (Serena Finco), has agreed to finance two half-theses if we obtain two half-fundings from our side.

Contexte ou état de l'art scientifique :

In classical assembly line, workers are fixed at station, and they perform the same set of tasks throughout the day. Opposite to such static lines, recent works (Hashemi et al 2024, Hashemi at al 2023) showed that dynamic tasks and moving workers yield more efficient assembly lines. The flexible assignment of tasks is nowadays possible thanks to the availability of new resources, such as programmable CNC machines, or programmable robots/cobots. These resources can perform different task by a simple change on the software level. While these previous works show flexible assembly lines are efficient, this paradigm imposes a change on the way workers perform their activities. In such lines, workers are moving more, and they perform a wider set of tasks. The increase in the set of tasks may have negative effects on their productivity, and the loss of regularity may generate stress. On the positive side, their dynamicity may reduce boredom, and consideration of worker diversity increases workers satisfaction and productivity (Battini et al 2022). There is a need to analyze the precise impact of these flexible lines on the well-being of workers and their productivity, and to developer approaches for managing these side effects. This research topic is fully in line with the industry 5.0 concept that require to place the human at the center of the manufacturing systems.

Objectifs de la thèse :

The thesis aims to design tools that help designing an assembly line that is flexible and accounts for human factors. The research objective is threefold. First, we will design accurate models to predict the efficiency and well-being of workers. This model will be built from data collected on a laboratory scale assembly line. This data set evaluate of the efficiency and well-being of workers when they are assigned a sequence of tasks, considering the process duration, stress level, and boredom. Second, we will incorporate this worker well-being and efficiency models into decision modules. We will develop tools to allocate workers to tasks in real-time, and a tool to design flexible production lines that can adapt to different teams of workers. The tools that assign workers to stations must provide answers in seconds to be used in practice. Designing fast and efficient optimization algorithms in this context is challenging due to the combinatorial explosion of the number of task/worker assignments with the increase in the number of tasks and workers. Finally, designing a flexible line that can provide reconfiguration for different possible teams of workers requires integrating the real-time worker assignment problem into a line balancing problem. Both problems are NP-hard, and the resulting model will likely be difficult to solve.

Compétences attendues du ou de la candidat·e :

The successful candidate must:

- Hold a Master's degree in operational research, computer science, industrial engineering, applied mathematics or in any other related field.
- Have a good knowledge of operational research (mathematical programming, stochastic optimization, metaheuristics, etc.).
- Have good computer programming skills.
- Have good organizational and communication skills (ability to speak and write in English).