

Deciding the Level of Automation for Internal Transportation Activities in production systems

Keywords: internal logistic systems, Production system simulation, decision support system, human/robot cooperation strategy, industry 4.0.

Context:

Mastering the **Internal logistic system (ILS)** is of high interest for an efficient production workshop. Its importance range from 15% to 70% of total manufacturing costs depending on the kind of production (according to Hellmann et al., 2019). **Internal transportation activities** are particularly known to be painful for humans and sometimes hard to be automated. On the robots market for example, one may find numerous offers for automatic carrying systems, from point to point delivery rovers (see for example www.leo-locative.com) to fully automated stockers coupled with various kind of conveying systems (see for example www.exotecolutions.com).

The more advanced transportation/conveying systems are now implemented for logistics platform and orders preparation. Fully automated solutions for movement of goods are set up by big e-commerce companies such as Amazon, Cdiscount in France or Ocado in the UK. Their heavily automated ILS are somehow relevant since they operate on massive flows, in a controlled environment (each product has a defined place, is of medium size), with stable missions to be accomplished (e.g. bring goods to a picker preparing a pack). However, heavily automated material/part/product transfer systems in production plants are less often observed/studied. Furthermore, within one given production site, very dissimilar **level of automation (LoA)** may be observed for internal logistics activities. For example, some workstations are connected by conveyors, some parts are brought by an automatic logistics train, but some stocking operations are done manually where big batches are put on trolleys and pushed by operators.

Deciding the LoA for internal transportation activities is still an open question from a technical and strategical point of view. Additionally, with the new possibilities brought by industry 4.0 and namely by the full connectivity of production actors (Internet of Things), it is of high importance to renew the question of automating some of the transportation activities and investigate the expected benefit of deploying communicating transportation assistant in production systems.

Subject description & missions:

The level of automation of production activities has been debated for a long time (Parasuraman et al., 2000; Salmi et al., 2015). The basic question formulated by Parasuraman and Sheridan as "*Which system functions should be automated and to what extent?*" is certainly not easy to answer since many aspects shall be studied to take a fully enlighten decision. Indeed, besides the simply technical aspects of the question (ex: kind of task, weight of parts), complementary points must be analysed like economic viability, operators acceptance, system lifecycle etc. In a previous work done on our laboratory, Anas Salmi (Salmi, 2016) has shown that for assembly operations, more than 70 criteria can have a significant impact on the **decision of automation**.

The purpose of this thesis is to investigate the Level of Automation for internal transportation activities. It is clear that novel robotized solutions will bring high benefits for plants operations, but their introduction in the shop floor must be carefully prepared and analysed from a human-robot cooperation perspective. The work should aim at proposing a **multi-criteria approach** to assess the relevance of AGVs,

AIVs (Automated Intelligent Vehicle) and Material handling systems in the most effective way for real industrial case studies. To reach this goal, tasks allocation, human-robot cooperation strategies, criteria investigation and evaluation methods need to be tackled with regard to the new technologies of industry 4.0. The candidate is expected to establish a state-of-the-art study about the topic with the following main missions:

- **Criteria elicitation & problems classification:** identifying the criteria and important drivers influencing the design of an ILS, in order to provide a complete understanding of the ILS design problem and of its LoA selection.
- **Performance analysis of ILS:** this mission consists in providing evaluation techniques (such as discrete event simulation) to assess the performance of future ILS (including flexibility, productivity, adaptability to hazards...). Namely, evaluating the benefits of introducing industry 4.0 technologies is of prime importance.
- **Design and decision process development:** this final step consists in defining a design process for ILS in production plant of the future and in validating it on real industrial case studies.

Profile and expected skills:

- Having an industrial engineering background or related field
- Solid knowledge about internal logistics, decision-aid tools and simulation/optimization techniques
- Familiar with open source programming (java, python, ...)
- Comfortable with English
- Autonomous, proactive and a team player

Project type: ANR (Agence Nationale de Recherche) project, entitled « Level of Automation Decision for Transportation Operations in Production » (LADTOP 2019-2023)

G-SCOP laboratory: science for conception, optimisation and production (46 Avenue Félix Viallet, 38000 Grenoble)

Scientific advisors: Pierre David (director), Eric Blanco, Zakaria Yahouni

Starting date: from October 2019

Application: if you are interested, please send an email application with your CV, cover letter, recommendations and recent academic transcripts to:

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Some references:

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