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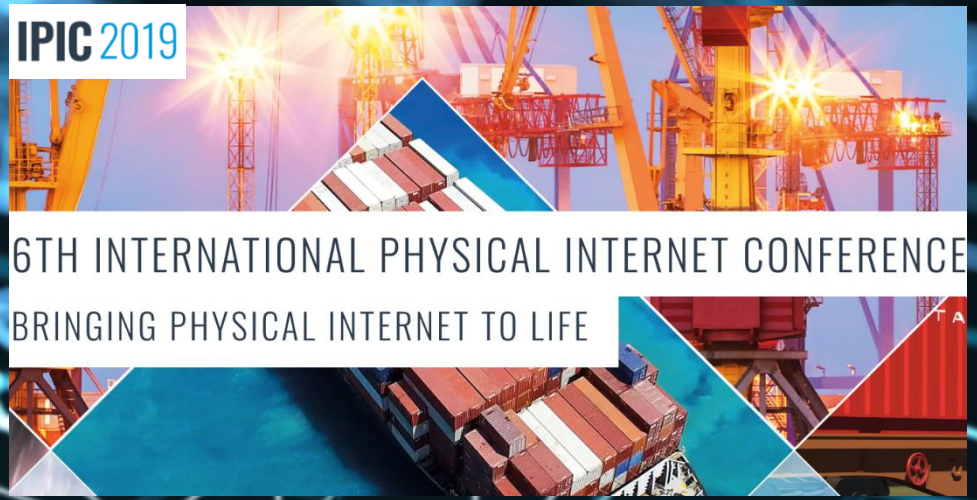


DESIGNING AND EXECUTING EXPERIMENTS FOR SELF-ORGANIZING LOGISTICS – SOLID'S FIRST RESULTS

Hans Quak, Elisah van Kempen, Bernd van Dijk and Frank Phillipson

MISSION OF TNO

TNO connects people and knowledge to create innovations that boost the competitive strength of industry and the wellbeing of society in a sustainable way.

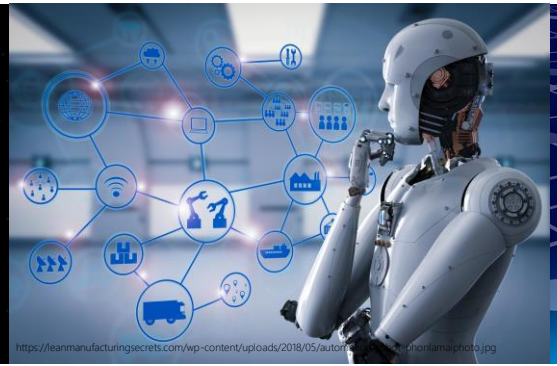
This is our mission and the professionals of TNO have used their knowledge and experience to this end for more than eighty years.

‘INNOVATION FOR LIFE’

TNO innovation for life

TOWARDS A TRANSITION IN THE LOGISTICS SYSTEM

- Global logistics sustainability grand challenge
- Automation and robotization
- Full connectivity in the physical world



BRIDGING GAP BETWEEN LONG(ER) TERM VISION AND SHORT TERM LOGISTICS OPERATIONS

- **Dutch Topsector Logistics** (TKI Dinalog and NWO) requested a research project that would provide an **impulse for self-organizing logistics** as well as a **more concrete perspective for logistics practitioners** with respect to opportunities for new logistics services or activities that on the short term can be expected by taking the mentioned developments in account

SOLiD – 4 EXPERIMENTS SELF-ORGANIZING LOGISTICS IN THE PARCEL INDUSTRY

- **Aim:** Develop **a proof-of-concept** how logistics systems can be prepared for the Physical Internet
- **Starting point**: Existing challenges and expected future developments
- **Application**: 4 experiments towards self-organizing logistics in the parcel industry. In collaboration with DPD and PrimeVision
  - **Simulation**
  - **Learning environment** including universities and Dutch municipalities

DEVELOPING REAL-LIFE EXPERIMENTS STEP BY STEP

- Choosing a relevant industry
  - Parcel industry
    - Increasing development in customer-driven logistics
    - Volumes in this industry increase seriously

- Setting general boundary conditions
  - Experiment are a means rather than an objective in themselves.
  - Experiments need to be executed in running operations.
- Teaming up with relevant partners
  - Parcel distribution company **DPD Netherlands**, Software company **PrimeVision**, Dutch **municipalities** (Utrecht and Amersfoort), **Universities** (University of Groningen, TU Delft, TU Eindhoven, Erasmus University of Rotterdam), TWTG, Thuiswinkel.org.

DEVELOPING REAL-LIFE EXPERIMENTS STEP BY STEP

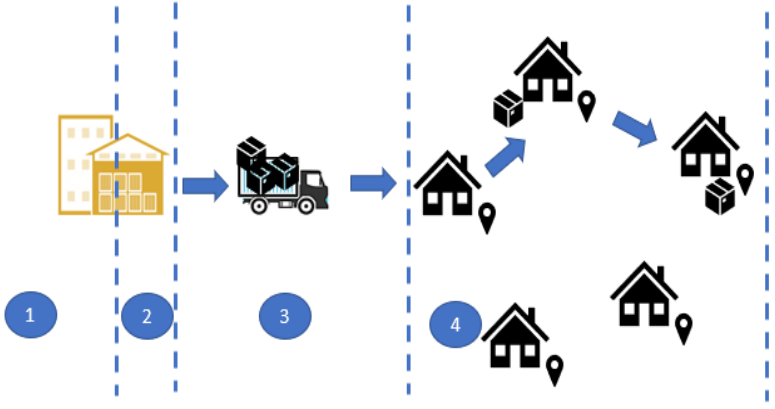
- Identifying challenges in current practices
  - Relative static planning process
  - Increasing receiver demands
  - Relative low hit-rate at certain times in B2C deliveries
  - Expected increase in volume
  - Perceived van nuisance in neighborhoods
  - Separation of tasks: efficiency gains for van driver/ delivery person
- Identifying opportunities due to new technology
  - Autonomous sorting robots
  - Autonomous parcel locker boxes for last mile deliveries

https://www.emerce.nl/content/uploads/2016/05/DPD.jpg

SOLiD REAL-LIFE EXPERIMENTS

1) More dynamically planning delivery areas based local information
2) Adding local intelligence in order to reduce handling activities
3) Continuous replanning of delivery routes based on receiver feedback
4) Making local intelligence of good-performing drivers available

- **Simulation environment** (complementing case 1+ 3)
- **Learning environment** for developing future steps



EXPERIMENT 1 - DYNAMIC PLANNING

- Aim By more dynamically planning delivery areas, this case provides a view on possibilities for decentralized sorting.
- Result A dynamic assignment method that minimizes insertion costs whereby insertion prices increase when a vehicle has more load, leads to most favorable results in terms of costs minimization. (Only 14-17% higher costs compared to a full information solution).
- In progress Adding more information to make forecasts (e.g. using historical data, preregistering parcels)

EXPERIMENT 2 – ADDING LOCAL INTELLIGENCE TO REDUCE HANDLING ACTIVITIES

- Aim It is hypothesized that once handling becomes more efficient, self-organizing logistics can be realized sooner; parcels 'flowing' through the system will become a closer reality.
- Result *First results are discussed in "Decentralized freight intelligence in the parcel delivery industry: An experimental study into the impact on routing efficiency'", Rosemarie M. Cramer & Paul Buijs*
- In progress Setting up measurements: time to load a van by an experienced van driver in a controlled environment and in practice.

AUTONOMOUS SORTING ROBOTS AS A MEANS TOWARDS SOL

- https://www.youtube.com/watch?v=bQ4P1-0uhio

1. The operator scans the parcel and puts it on the Rover

2. The Rover finds its way

3. The Rover drops the parcel at the destination conveyor belt

4. The operator takes the parcel from the roller belt.

- From autonomous sorting robots → Swarming robots and robotic hierarcy → A self-organizing sorting process

DESIGNING AND EXECUTING PRACTICAL EXPERIMENTS

- Providing logistics practitioners with concrete steps for realizing the PI vision

- Inspiring other researchers in the field to translate PI concepts into practical experiments with a perspective for action

TO BE CONTINUED

- SOLiD will be finished in 2020. More results to be expected on:
  - Continuous replanning of delivery routes based on receiver feedback
  - Making local intelligence of good-performing drivers available

- https://www.tno.nl/en/focus-areas/traffic-transport/roadmaps/smart-traffic-and-transport/smart-mobility-and-logistics/first-steps-towards-self-organizing-logistics/

THANK YOU FOR YOUR ATTENTION

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