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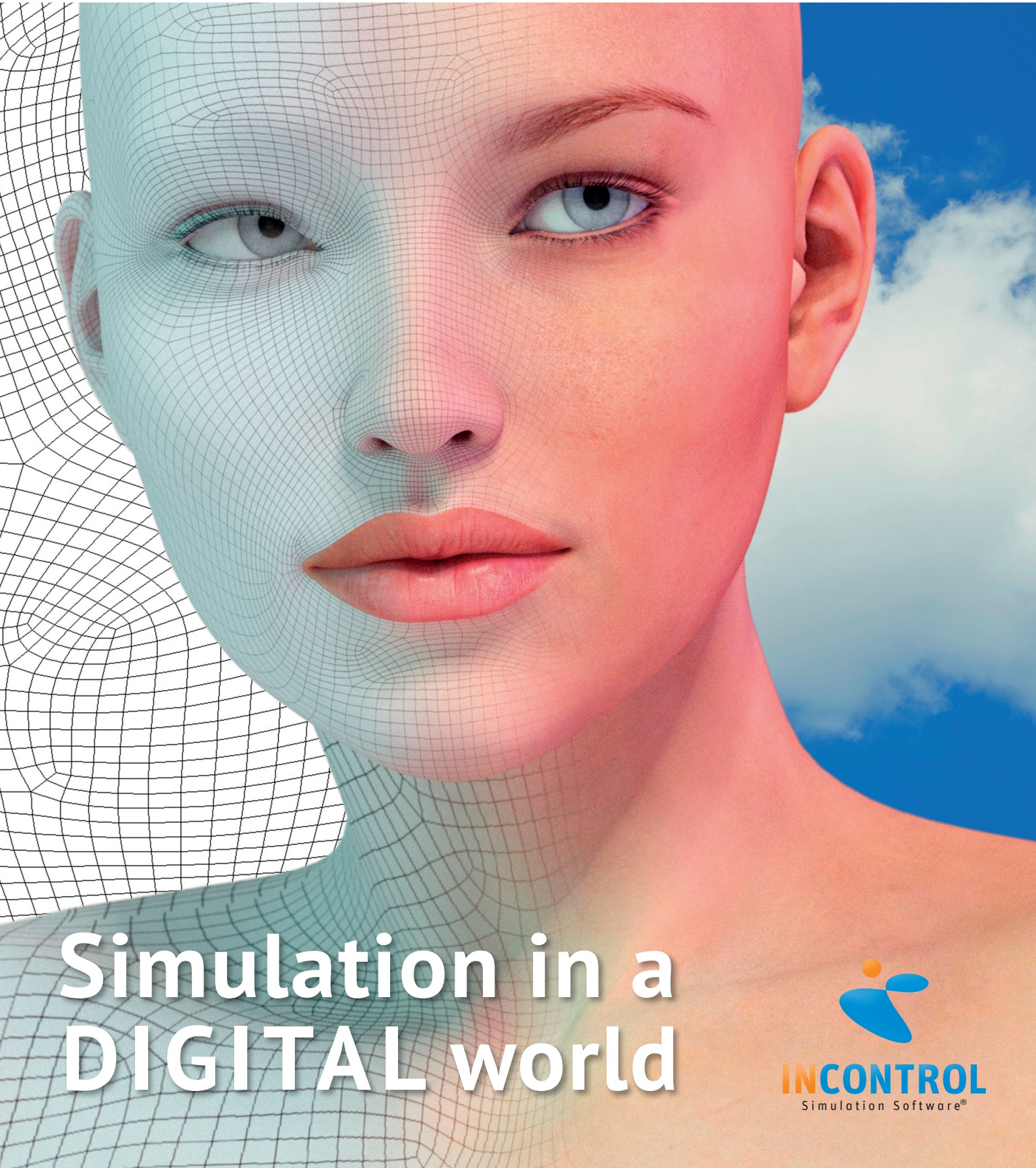
Simulation in a DIGITAL world

INCONTROL
Simulation Software®

A WORD FROM THE CEO

Simulation in a digital world

We all want to live in a sustainable and safe world, but both sustainability and security are under pressure. We must be more diligent and efficient with all of our resources to take care and even guarantee the safety of our critical infrastructures. At the same time we see a world that is rapidly becoming digital, integrated and extremely dynamic. What is relevant and true today is changed or obsolete tomorrow.

A digital world means an algorithmic world. We must ask the questions; which algorithms will influence and drive our behavior and how? Integration means that we are connected on personal and business levels. We influence each other's behavior and decisions every day. Boundaries in place, time and location disappear. Business processes are integrated inside organizations, in supply chains, in networks and in our homes. We are clients, participants and stakeholders all at the same time.

Dynamic means that things are changing rapidly and constantly.
- So how do we manage our digital, integrated and dynamic world?
- How do we gain transparency and get insights?
- On what parameters do we base our decisions?
- How do we stay and keep in control?
- What is the contribution of Predictive Analytics?

A crucial element is that we can reliably predict what is most likely to happen in the near future and over time. Can we manage specific projects and more complex integrated processes? Simulation has been seen as a tool, but the importance and contribution of simulation can be much more. We see a need for integrated data to enable simulation, data analysis, planning and optimization of operational processes. Multi-source data processing to determine a high complex setting requires a flexible and fast simulation, planning and processing platform.

The demand of customers, management and business partners in the supply chain to be more predictive requires that you can work with a platform that is aligned with your business processes. We believe that our Enterprise Resource Simulation platform excels at delivering on that promise. As a (potential) customer, Academic, Applied Sciences, R&D and Business partner I wish you high performance and predictive results!
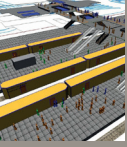
Kind regards,

Louis T. Schijve, CEO

Content

Colofon

Seamless Flow

Dynamics in a study to contribute to and validate the program. With this software, simulation models of future situations are created and different scenarios are compared. The model includes processes and equipment for Seamless Flow, such as kiosks for one-time enrollment and verification, on-the-move immigration control gateways, automated access gates.

The models are used:
- to study the dynamic requirements and behavior per border control filter
- to determine the required number of facilities in order to be able to meet service levels
- to perform a sensitivity analysis for impact of variation in process times
- to compare the results between a configuration with Seamless Flow facilities and one without for a future situation.

The analyses have determined the impact on the required infrastructure and the passenger flow time and are used as an important input for the business case of the Seamless Flow program. It also allows for anticipating gaps and bottlenecks.

Simulation of seamless flow: biometrics in airport processes

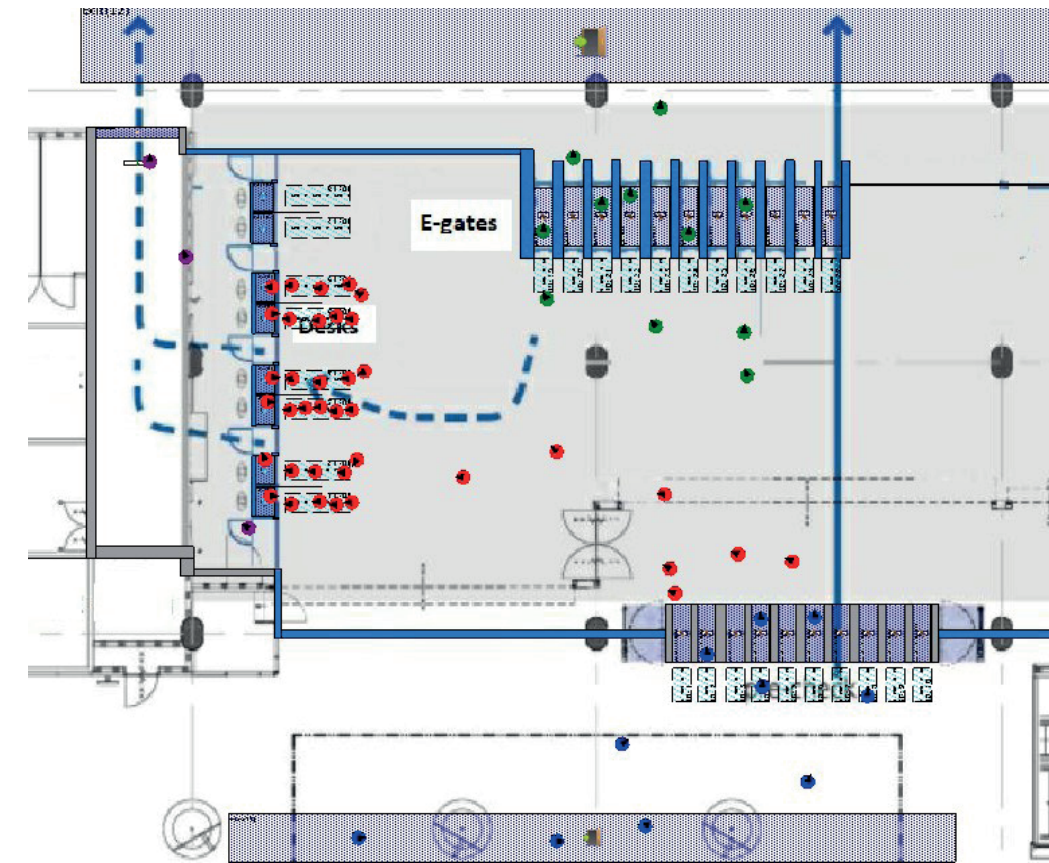**Airport operators** around the world are investing significant time and money in researching and implementing smart, efficient digital solutions to improve the passenger journey. Self-service units for check-in, baggage drop, and boarding are available on the market; innovative programs like Smart Security, initiated by IATA and ACI, focus on improving the many security processes.

The ultimate goal is an undisrupted passenger journey from curbstone to airside with a minimum of inconvenience and an optimal operational efficiency.

To achieve this, Amsterdam Airport Schiphol has started a comprehensive development process to create a smart and digital airport, through the use of predictive analytics.

An important element in this process is Seamless Flow, the program to use biometrics for identification of passengers and staff. Biometrics identification enables a seamless flow throughout the whole passenger journey without repeatedly using passport checks. It only requires one enrolment process, the verification of the passenger identity, including a facial scan. From this moment, your face is your identifier.

Once the identification is successfully completed, security processes can already be started. This provides the authorities more time to perform background checks and detect risks before the passengers actually arrive at the checkpoint or border. The advantage for the passengers is found in reduction of process times at check-in, baggage check, at the border and at the gate/boarding.

Currently, Amsterdam Airport Schiphol and its program partners (the Dutch ministries of Justice & Safety and Defense, the Military Police, Customs, HUB-airline KLM, and private companies) carry out pilot tests at a border control location to determine the performance and feasibility of the biometrics checkpoint and to gain experience with the required process times for enrolment and the border processes.

INCONTROL Simulation Software was asked to apply its simulation software Pedestrian

> **"**
> **The results from INCONTROL's simulations provide important insights into which parameters we need to pay most attention to during further development of the system, and to see the effects of multiple operational concepts early on.**
>
> *Hedzer Komduur*
> Value Stream Owner at Royal Schiphol Group

A Digital World and Industry 4.0 both heavily rely on Predictive Analytics

Industry 4.0 is an integral part of the emerging Digital World and is already touchable in well-tuned machines, industrial equipment and logistic processes. Besides highly developed production systems, we see that virtual systems are gaining relevancy. Virtual systems allow us to mirror the world and also allow us to integrate data from several data sources into a model where events and processes can be simulated.

Frank van Poeteren, CCO

Recently Gartner published the 10 technology trends for 2019 and not surprisingly included Augmented Analytics and Digital Twins. Both technical areas are a sine qua non to enable simulation and analyze high volume data. Events and processes can be visualized in the time frame of this moment, today, as well as coming week or even year. The outcome consists of reports or dashboards and scenarios including insights and (info) graphics.

Our software enables our customers to predict, optimize, and secure their events and processes during Design & Building phases and also can be part of Optimization & Innovation programs. Predictive Analytics and therefore Simulation and Planning become an integral part of companies' core processes.

A valid question in this case: Are you ready for the Digital World and Industry 4.0? And more specific: Is Simulation & Planning already part of your operation? Contact us at: siminfo@incontrolsim.com
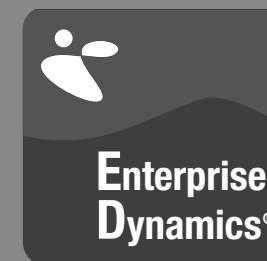
It was essential for all involved that the solution closely reflects the real-world supply chain both in its functionality and visual representation. Thus, increasing the understanding and interpretation of simulated scenarios in development and testing of operating procedures. The pos-sibility to stress test specific supply chains configurations before deployment further enhances the operational level and security of supply. Narrowing the gap between preparations before deployment and experienced reality when deployed is a key factor in the overall operational success.

The simulation modeling was powered by INCONTROL's Enterprise Resource Simulation Platform (ERSP).

> "
> The army logistics simulation tool has already proven itself and lead to valuable discussions on senior officer level how we manoeuvre under various conditions. The simulation tool will probably become an integrated part of future training of officers wthin logistics.
>
> Head of Danish Defence Simulation Technology
> *Royal Danish Army*

INCONTROL - Sponsor of the ASIM conference Simulation Award 2019

The semi-annual ASIM Dedicated Conference is Europe's largest conference on simulation in production and logistics and presents future-oriented trends and current developments, scientific works as well as interesting industry applications.
INCONTROL is always present as an exhibitor at the ASIM symposium to support our customers and partners.

The next ASIM Dedicated Conference will be in Chemnitz: "Award for Discrete-event Simulation"

Two outstanding final theses (Master, Bachelor or Diploma) in the field of discrete-event simulation to be awarded at the ASIM dedicated conference "Simulation in Production and Logistics", which takes place on 18-20 September 2019 at the Fraunhofer IWU in Chemnitz (Germany).

In 2019, the award will be sponsored by:

SIMPLAN

INCONTROL
Simulation Software®

The prize is endowed with € 1,000. The winners will report on their work at the conference. The price therefore also includes the conference fee and a lump sum of 500 € to cover travel and subsistence costs. Furthermore, the membership in the ASIM is free of charge in the year of the award ceremony and in the following two years.

The submitted works must meet the following criteria:

- The date of submission of the thesis must be between 01.01.2017 and 31.03.2019.
- A confirmation of the grade of the written thesis must be submitted with the submission.
- The work has a clear relation to the subject area of the section.
- The thesis must be written in German or English.

An application for the simulation prize can be made via the supervising professor or a member of the ASIM section.

Please send your complete application documents by 30 April 2019 by e-mail to the chairman of the jury (award@asim-fachtagung-spl.de), which is also available for further questions.

Applications received after the deadline cannot be considered.

Danish Army Logistics Simulation

Royal Danish Army Logistics develops and executes new operating procedures for tactical and operational army logistics. It is a complex and expensive maneuver to test and validate new operating procedures in real life full scale exercises. It is, however, crucial to thoroughly test and validate these procedures to ensure best possible safety and supply for the soldiers on the ground before going into battle.

Danish Army Logistics therefore partnered up with simulation experts from Integrate who developed a customized simulation solution. The simulation model enables the army logistics professionals to develop, test, and validate new operating procedures without interfering with the real-world processes. With empirical data from army engagements around the world the simulation solution helps the army logistics professionals to spot the critical bottlenecks in the supply chain. Moreover, the general understanding of hard limits within the supply chain under various circumstances is enhanced. As a result, the army professionals are enabled to perform critical improvements to the supply chain.

Bearing that in mind the logistics simulation solution developed by Integrate directly helps the dedicated army professionals in ensuring the best and safest possible supply chain for soldiers in battle.

The simulation solution has been realized in a close cooperation between Integrate and Danish Army Logistics. The development process has been an iterative process with relatively small closed loops and frequent status meetings.

[integrate]

Integrating layout planning and simulation for logistic nodes

When a new logistic node (e.g. a terminal) is planned or needs to be optimized, layout planning and simulation analysis are typically two separate tasks. While layout planning is an intuitive and visual but static approach, simulation is dynamic but more complex. Integrating both approaches would be highly beneficial. The idea of the integrated tool is to create first a static layout on a touch-screen planning table.

Main challenges for a successful integration are the logistic processes and strategies on the terminal. Both are not included in the layout planning but are essential for a valid and realistic simulation model. Therefore, relevant process and strategy variations as well as typical research questions are defined. The integrated approach is an innovative solution to optimize existing terminals, as well as those being planned.

In order to realize the integration of layout planning and simulation, two existing software tools are chosen. Thereby, the planning software visTABLE® by plavis and our simulation software Enterprise Dynamics® represent the respective software. The integration can reduce the required time to plan a logistic node significantly as simulation models have to be modelled otherwise by experts in extensive work based on the designed

In order to meet the high demands for faster handling in a shorter time window and with higher quality, it is necessary that logistical nodes in ports and the hinterland continuously review their operational and administrative processes and adapt them as necessary. This applies in particular to container terminals and intermodal terminals due to the high transshipment numbers and the increasing requirements. Therefore, when planning new and existing logistic nodes, it is important to use space and technical systems for handling, transport and storage as efficiently as possible. Simulation has become increasingly important for securing and optimizing solutions for planning processes in logistics in general and especially for container terminals. It is increasingly important to integrate the simulation in early planning phases and with little effort.

> " The ISI-Plan project takes terminal planning to a completely new level. It will become possible to evaluate existing processes and to determine different capacity expansion. Terminals can be planned more efficiently and governmental funding is optimally supported.
>
> *SGKV*

layout. Further project partners are the Fraunhofer CML, the Institute for Maritime Logistics (MLS) and the Study Association for Combined Transport e. V. (SGKV).

Therefore, this innovation directly supports an efficient and rapid planning phase of logistic nodes to provision an extension of transport infrastructure suitable to the market needs. The integration of layout planning and simulation studies is - in a first step - developed for inland waterway container terminals and terminals for inter-modal transport.

The goal of the research project ISI-Plan is the creation of a functional prototype consisting of the innovative integration of the planning table and the logistical process simulation. Therefore, that prototype will support the rapid and efficient planning and development of logistics hubs.

This innovative software tool directly supports efficient and fast planning of logistic nodes, which are necessary for a demand-oriented expansion of the transport infra-structure. In Germany alone, there are more than 300 logistic nodes that can benefit directly from the integrated planning and simulation tool.

This work was funded by the German Federal Ministry of Education and Research (BMBF) as part of the research project "ISI-Plan - Integration von ereignis-diskreter Logistiksimulation und Layoutplanung für logistische Knoten ".

Andre Heller, Plavis

Leonhard Heinisch, SGKV

Margit Thomsen, INCONTROL

Clemens Bochynek, SGKV

Simulation in a digital world

Business processes are inextricably digitalized. That is exactly where INCONTROL Simulation Software positions its Enterprise Resource Simulation Platform® (ERSP). ERSP enables organizations to innovate and improve their business processes.

MANUFACTURING, LOGISTICS & SUPPLY CHAIN PARTNERS:

**Integrate A/S
SW-Development Ltd
Logistics & Automation Consulting s.r.l.
Simplan AG
ZYNEX Corporation Pte Ltd**

The platform is not only used in the design and analysis phase but also on a daily basis to support planning and decision making processes.

INCONTROL Simulation Software is integrated in curricula at Universities, Applied Sciences and R&D Institutes. Together with these partners we have implemented solutions in the Process Industry, Transportation, Logistics, Crowd Management and Public Safety.

Interested? We want to share our vision, technology insights and business cases on how simulation can improve your performance.

**Contact us via: siminfo@incontrolsim.com**

Internship at INCONTROL Simulation Solutions

I am currently doing my internship at INCONTROL Simulation Solutions which as the name suggests is a company providing a software platform for simulation of real-world problems.

As the pedestrian behavior is stochastic, there is a possibility to have varying results with each run. My aim during this internship is to study this variation and determine the number of runs needed to have a statistically significant result. This also requires exploring ways to represent this data obtained from multiple runs and aggregating them to have a sensible output.

Hence, the literature on traffic flow was used as a reference which also involves randomness due to human behavior. This was used as the basis to develop a methodology to determine the number of runs for a set of specified Confidence interval and error.

The main outputs being analyzed for the confidence level and error value are total travel times, average travel time, flow counters reading and density of an area with
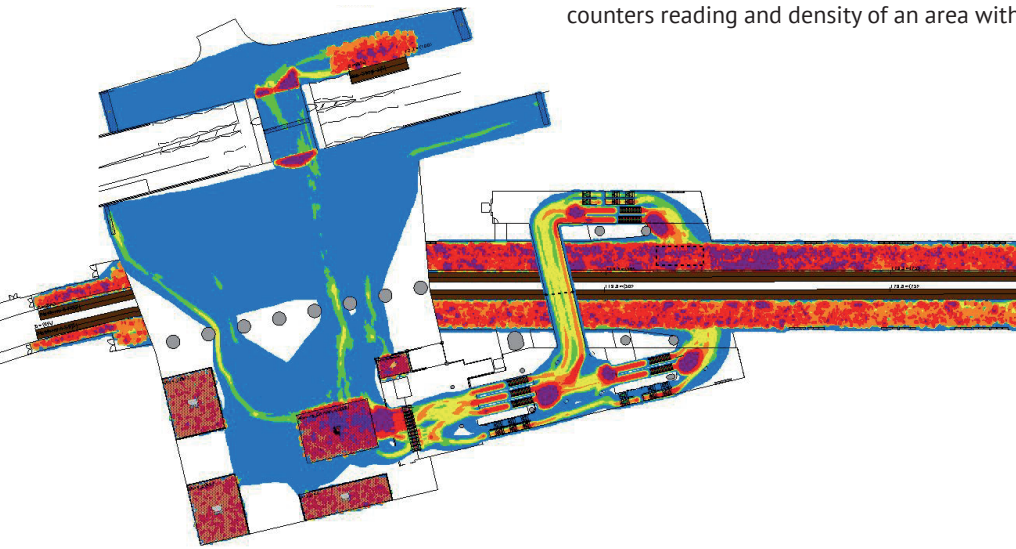
During my initial days, I learned the basics of modelling, simulation and analysis using the Pedestrian Dynamics software. This helped me understand the working of the software while also gave me an idea on the outputs that should be considered for while calculating the number of runs for a certain confidence interval. This was followed by a thorough literature study on the sample size of a stochastic model. Though, not much literature was found describing the estimation of the number of runs to account for stochasticity in a pedestrian simulation.

time. This methodology is now being applied on some projects done by the company. I will investigate how the results of multiple runs could be presented in the report and how the conclusions would be affected. In addition, I am also looking into the ways to improve the overall display of outputs by suggesting some alternative layouts and including additional outputs which might provide greater insights into the model results.

Apart from work, the company has a friendly and comfortable environment which helps in developing confidence and communication skills. During my second week of working at INCONTROL, I was invited for the Employees Annual day which involved the whole day of outdoor activities such as playing golf, highland games followed by drinks and dinner. Company employees from Germany also joined the event. It was a nice experience to interact with colleagues outside the formal office environment. Recently, I got a chance to attend a meeting with NS which involved the final presentation of results from the simulation of a train station model. As my

Dutch is not very good, everyone agreed to switch the discussion to English which was overwhelming. This helped me to take part in the discussion aimed at proposing solutions to the overcrowding in train station. It provided me valuable insights into the extensively thoughtful process behind managing the railway stations in Netherland.

Being an international, it is a nice experience to learn Dutch working culture of being efficient and punctual. When I compare my internship days with the first year in college, I think I have much more time for myself now. The relaxed working hours and a comfortable company environment has increased my productivity and helped me in being efficient and motivated. I also like the concept of 'keek op de week' which is a weekly general company meeting where everyone discusses the work that was done in the previous week and the plan for the upcoming week. This helps in understanding the direction in which the company is moving and the role each member is playing in it. Everyone at the company is easy to approach and ready to help in every way possible. Overall, it is great to work in a professional environment and have a hands-on experience of how the industry functions.

ASIM Fachgruppensitzung at Amsterdam Airport Schiphol

INCONTROL - an active member of the ASIM (Arbeitsgemeinschaft Simulation) for more than 15 years. ASIM is the association promoting and developing fundamental simulation and applications.

In September 2018 INCONTROL hosted the ASIM Fachgruppensitzung at its headquarters in Utrecht, The Netherlands. The president of ASIM Prof. Dr.-Ing. S. Wenzel of the University of Kassel welcomed a large number of the ASIM members in Utrecht.

As part of the meeting, INCONTROL organized together with Amsterdam Airport Schiphol an introduction and tour, sharing the ins and outs of the impressive logistic operation of the baggage handling systems. Schiphol is the 3rd busiest Airport in Europe, processing almost 70 million passengers last year. The baggage handling system is not only one of the largest, but also one of the most advanced systems in the world. It includes high speed individual carrier systems for backbone transport, large automated baggage storage & retrieval systems and robots for automated baggage container loading.

Key aspects are an efficient process which delivers baggage in all kind of sizes, forms and weights in time to the baggage make-up locations or reclaim belts in a safe and secure way.

The baggage handling systems of Schiphol Airport are simulated by INCONTROL. INCONTROL provides its software, simulation platform as well as consultancy for continuous improvement.

For more information:
ASIM: www.asim-gi.org/asim
Royal Schiphol Group:
www.schiphol.nl/nl/schiphol-group
INCONTROL: www.incontrolsim.com

How airports can prepare for the effects of EDS Standard 3

Safety and security remain an important topic for airports. Ensuring the safety of passengers during flights or while spending pastime in the airport itself, comes down to the application of international safety rules and regulations set by global organizations and councils.

EU Regulation

One of these measures is EU Regulation 1087/2011. This regulation indicates that all airports within the European Union should screen all their Hold Baggage with Explosive Detection Systems (EDS) Standard 3 approved. This is a framework designed by the European Civil Aviation Conference (ECAC) and sets a minimum required level of detection. Standard 3 detects extremely small explosive quantities and provides the ability to view different parts of the baggage in a 3D image. The deadline for applying this regulation is set for 1 September 2020. In the United Kingdom, the regulation should even be applied before the end of September 2018.

By many in the airport industry, transferring to Standard 3 is seen as one of the most difficult and costly undertakings in recent years. The large investment does not allow any fai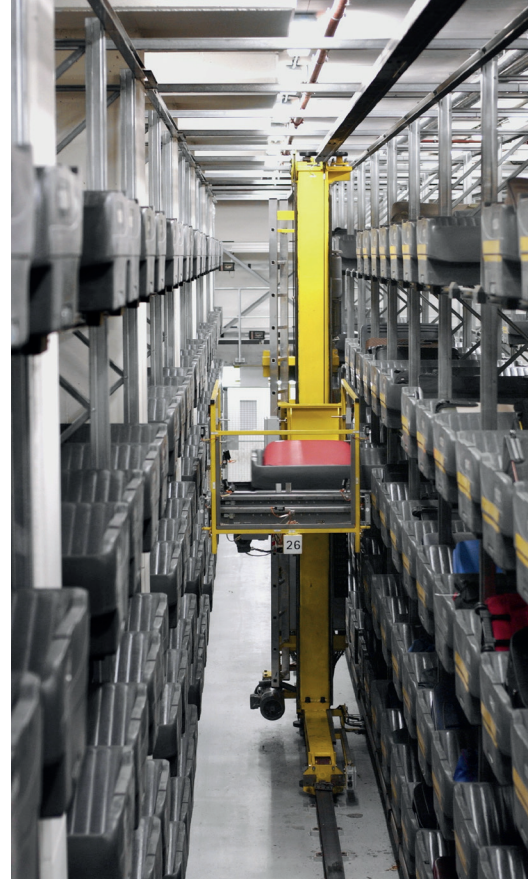lure from project management side. Changing equipment from Standard 2 to Standard 3 requires a fairly long implementation time, which derives from various project phases that need to be considered. For example, processes and technological requirements need to be defined, capabilities and capacity of the current Baggage Handling System (BHS) needs to be reviewed, the appropriate EDS supplier needs to be selected, design specifications of the BHS need to be determined, installation, pre-testing phases and final testing. All before going live.

Challenges for Baggage Handling Systems

So, what does applying EU Regulation 1087/2011 actually mean for all the airports involved? Where do challenges arise? What will the impact be and why are many airports hesitant to start?

The hesitance in upgrading to EDS Standard 3 might have to do with many airports only recently transferring to Standard 2. Several airports had to deal with a growing amount of flights and therefore more baggage to screen. Standard 2 machines have been used as a solution to meet these growing demands. The obligation of transferring to Standard 3 now influences available budgets. As indicated previously, other concerns arise in areas like logistics, integration in the BHS and operational issues. First of all, Standard 3 machines are significantly more expensive to buy and maintain than the traditional X-ray units. So how many EDS Standard 3 machines should be purchased? What is sufficient to ensure a suitable throughput of baggage?

After all, airports want to avoid having more spare parts than necessary. In addition, stakeholders emphasize that the investment should last for the coming 15 years.

Secondly, from a logistical point of view, the new EDS Standard 3 machines should be integrated into the current baggage handling system at the airport. Standard 3 machines are significantly larger than Standard 1 or 2 machines. This adds extra stress on the capacity of the airport and therefore a (re) design of the baggage handling system infrastructure might be necessary. Thirdly, Standard 3 has a big impact on the screening process. According to a whitepaper by BEUMER Group, the new EDS Standard 3 machines initially process the same amount of bags per hour (1500) as the traditional X-ray machines, but the main advantage can be seen in a clearing rate of about 80 percent versus 70 percent for the traditional X-ray technology. Even though the clearing rate of Standard 3 machines is much higher, the further processing of rejected bags in the rest of the BHS should be measured and calculated. The aim is that the BHS altogether has a constant flow and congestion is avoided.

How simulation can help with upgrading to EDS Standard 3

Simulation software provides the possibility to create a digital model of the entire Baggage Handling System and can be used to measure the effects of new regulations, like EU Regulation 1087/2011. To ensure a smooth upgrade to EDS Standard 3, simulation software can help by assessing all options to:

• Minimize the effect on the current screening process;
• Integrate Standard 3 machines into the available capacity;
• Meet not only EU Regulation 1087/2011 requirements, but also future growth needs of the airport;
• Validate the amount of needed EDS Standard 3 machines and minimize the investment

With simulation the most efficient layout of the Baggage Handling System can be determined. Simulation models can be built in such detail that each conveyor and screening machine is included. In this way, travel times for each bag can be calculated and congestion can be easily spotted. Simulation software provides the ability to test various scenarios backed by data.

EDS Standard 3 Validation

In conclusion, transferring to EDS Standard 3 is mandatory and certainly challenging. New screening equipment is expensive and airports want to avoid having more machines than necessary. Furthermore, the objective of every airport is to prevent lost or delayed baggage because the screening process has taken too long or has been inefficient. Simulating the Baggage Handling System with regards to transferring to Standard 3, provides one of the most validated ways to analyze each option or change in design before making any physical changes.

Simon van der Weij
Team Manager
Aviation

How KNAPP uses simulation to minimize implementation time

Since warehouse automation is quite an investment, in some cases KNAPP provides its customers with a full range computer simulation even before the contract is signed. Simply to reassure the customer that whatever they ordered will indeed work. To that end, KNAPP uses INCONTROL's simulation software.

Once the order is placed the process of implementing the new warehouse management solution still lies ahead, looming in the dark. "That's another area in which computer simulation proves to be very helpful", Klaus Malli, Head of Simulation at KNAPP acknowledges. "*Software in general is a nightmare; even if 95 percent of your customer's specifications are common, the remaining five percent of extras will always cause difficulties. In simulation, we show customers what can be done and what needs to be done under the given circumstances.*"

"*In complicated warehouse situations it is of eminent importance to have a clear view of the entire process: what happens when? Somewhere in the flow of the process you'll inevitably meet surprises, but using computer simulations you are one step ahead. Thus, simulation minimizes the implementation time; we can run several tests on the site itself and make modifications on the spot. Customers rely on the quality we provide, simulation makes it easier for us to maintain that standard.*"

Operational Functionality

But that's not all. The in-house development programs at KNAPP also benefit from INCONTROL's expertise. Malli: "*We develop and build new machinery and software applications ourselves. It stands to reason that we would want to check their operational functionality before releasing them. Again, simulation rises to the occasion; it gives us the chance to experience whether the new product is usable, user friendly and reliable. It's mostly in this particular field of expertise that we rely on INCONTROL's specialists to offer detailed support.*"

Conclusion

"*We are firmly rooted in both the pharmaceutical and food industry, where every day millions of cartons and packages run over and through our caster roller sorters, zip sorters, pusher systems, check stations, continuous scales, belt conveyors and so on. Making sure the customers get exactly what they need when the need it is crucial. Simulation helps us in doing just that.*"

About KNAPP AG

The KNAPP AG is the world's leading provider of automatic order fulfillment systems. Located in Hart bei Graz, Austria the company offers a wide variety in warehouse management solutions. From goods-in to goods-out and from simple transport to complex warehouse computer systems, KNAPP enables wholesale operations, mail-order and e-commerce business, supply chain distribution centers and manufacturing plants to deal with large numbers of orders at short notice.
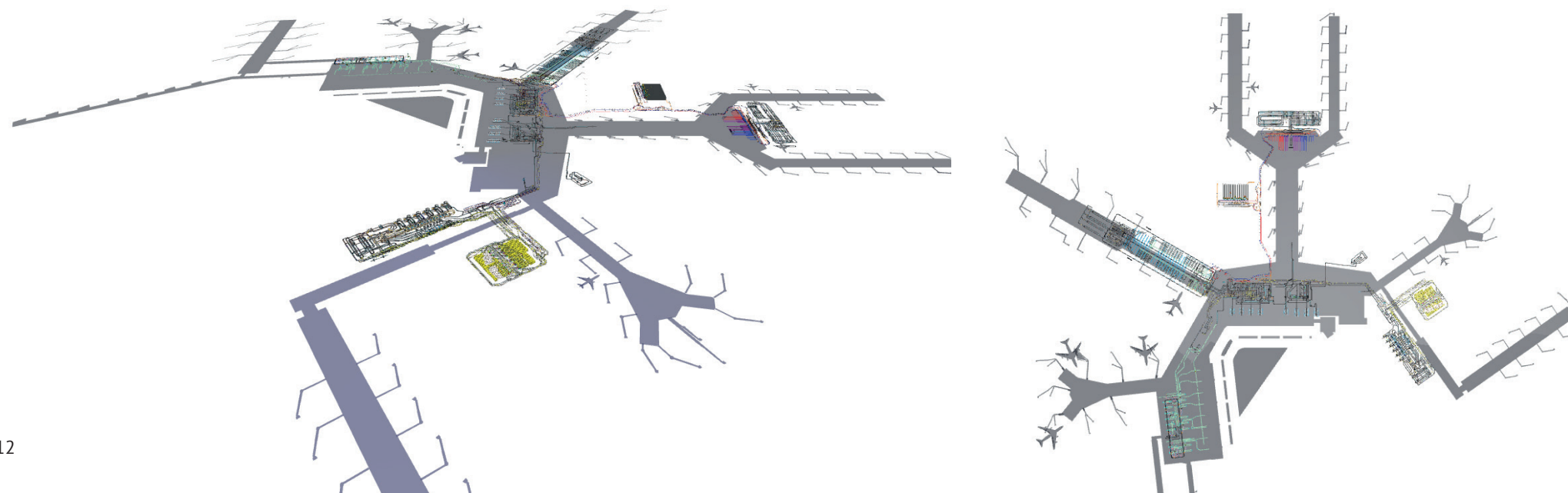
Railway simulation using Enterprise Dynamics

For the coming years, public transport by train is expected to grow steadily worldwide. Railway companies, especially in high-populated areas, face multiple challenges regarding this growth. The main challenge is to optimize rail infrastructure, maximize rail utilization and satisfy both passengers and freight operators. Solutions to this challenge are constraint by safety regulations and the wish for energy efficiency.

Simulation has been proven to be an indispensable decision support tool for solving these challenges. Simulators are a key tool for rail network managers when performing for example punctuality and robustness analysis of train schedules. Simulation is also used by rail network managers for safety, capacity and energy analysis of (future) infrastructure.

For more than 23 years INCONTROL has been working on the development of customized railway-traffic simulators using the Enterprise Dynamics (ED) simulation platform. During these years, INCONTROL has become an expert in railway simulation, understanding the concepts and systems that are relevant to railway operation. By uniting the ED platform with customer applications, tooling and datasets, INCONTROL creates large scale microscopic multi-purpose railway simulators, which can be used for

- Simulation studies (Use simulation to support the design/construction and optimization of train schedules, track occupation and energy efficiency),
- Innovation support (Evaluate the effect of innovative measures and systems before putting them into practice),
- Serious gaming (Train employees and evaluate procedures and processes during large-scale multi-application gaming sessions, using a distributed simulation environment).
- Communication purposes, for example informing management, staff and customers about the effects of the introduction a new timetable

Simulation Studies: Railway optimization

INCONTROL's latest Dutch railway simulator developed for ProRail, the Dutch infrastructure manager, allows users to simulate and visualize large networks on microscopic level. The Flexible Rail Infra Simulation of Operations (FRISO) supports users by automatic generation of a complete simulation model from company data sources containing:

- Infrastructure data (e.g. tracks, signals, switches, routes and slopes),
- Rolling stock data (acceleration and braking, "circulation"),
- Train schedules (arrivals, departures and connections).
- Traffic control configuration data

Simulation models may also be altered or designed by hand, allowing users to create (variants of) existing train schedules and rail infrastructure without any effort.
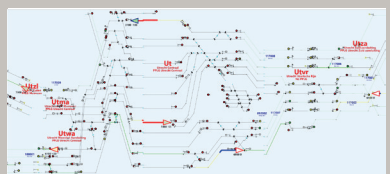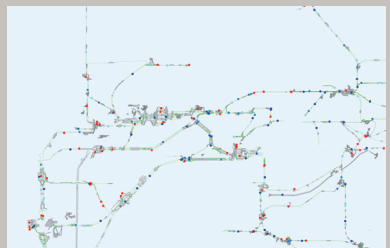
Multiple levels of detail in a FRISO model

FRISO models virtually all aspects of a railway network. Signals, interlocking, switches and intersections work according to their real-world characteristics. FRISO supports both the Dutch NS'54 and European ERTMS safety systems and implements the ATB-NG and ETCS train protection systems. The movement of trains in FRISO is modelled according to their physical characteristics and external factors (slopes, resistance and power supply). The effect of human factors on the operations is modelled by different kinds of train operators and train dispatcher agents. Together, these components form a realistic railway simulator.

Output components like train graphs (distance/time, speed/distance & height/distance) and track-occupation diagrams allow the user to evaluate the quality of train schedules and infrastructure easily. Extended logging on the other hand allow users to create their own visualisations and perform statistical calculations/analysis on the simulated realisation data.
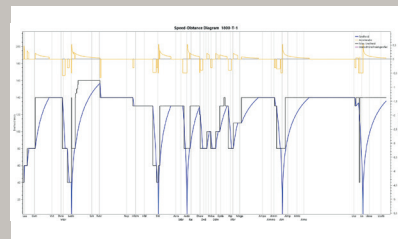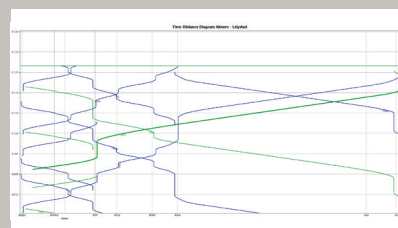
Time-Distance graphs and Speed-Distance graphs
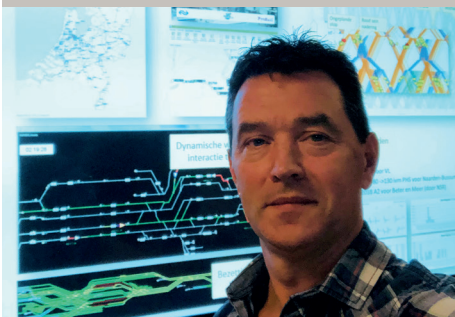
Dick Middelkoop, Programma Manager Modelontwikkeling, ProRail

Development and Evaluation of New Innovative Measures and Systems: TMS, ATO and ERTMS

FRISO can transmit and receive real-time information about the state of trains and infrastructure. Using this information, train operation (train driver and guard) and train dispatching tasks can be taken over by external applications. For example, the Traffic Management System (TMS), a system designed to optimize traffic and improve punctuality, safety and or energy consumption levels in a local area by means of advisory speeds, re-ordering and re-routing of trains, can be connected to FRISO. The TMS achieves these goals by monitoring traffic, detecting future conflicts, rescheduling and optimization of speed profiles. Using FRISO, TMS variants can be compared and optimized before being used in practice.

To investigate the differences that exist among train drivers, several train driver models have been implemented, including an energy-efficient and a plan-based train driver. The most accurate train driver model is an agent-based model that is created using realisation data. Similarly, FRISO allows rail network managers to study the effects of the introduction of Automatic Train Operation (ATO). Recently, a module that simulates ATO has been added to FRISO. At the moment this module calculates the required speed profile for a train so it will reach the planned goals on time. In the future, a real ATO component might be connected to FRISO in order to evaluate its effectiveness before being put into operation. Currently, FRISO supports external control of trains, but no binding to real ATO systems have been made yet.

For a small-scale ERTMS pilot between Amsterdam and Utrecht, a FRISO simulation model was developed implementing ERTMS and Dual Signalling. The main goal of the pilot was to obtain and record critical knowledge and insights about the transition from existing safety systems to ERTMS in a responsible way.

> **"**
> **With FRISO we are able to show the interaction between trains, robustness and safety performance of timetables for every location in the Netherlands or the entire country. A shared picture is worth a thousand words.**
>
> *Dick Middelkoop*
> ProRail
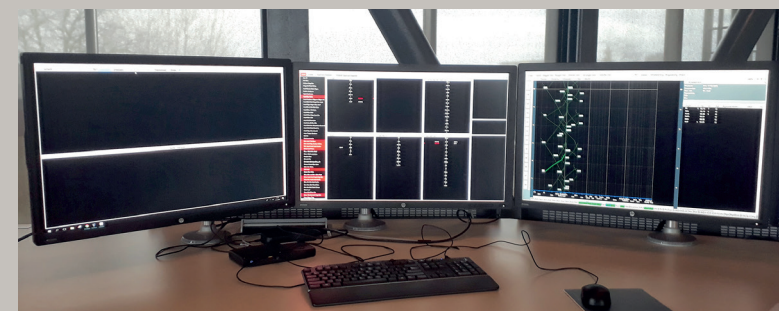
TRINITY distributed simulation environment; train dispatcher and network operator screens

The implementation of ERTMS in a dual signalling environment in FRISO has successfully been validated by independent experts. FRISO has shown to be a useful tool for ERTMS capacity studies and energy efficiency studies.

Serious Gaming: Simulation based training

For 8 years, FRISO has been deployed in the so-called TRINITY distributed simulation environment. Here, both operational and simulated railway applications communicate with FRISO as if they communicate with reality. Applications for train (re-)scheduling (ProRail), Crew planning and Rolling Stock planning (NS) can be used simultaneously during gaming sessions. This unique simulation environment allows large-scale gaming sessions with up to 40 participants with 4 different roles.

The TRINITY simulation environment has been successfully used to prepare train dispatchers for changes to the railway infrastructure at Utrecht Central Station, the main Dutch train station serving 285.000 passengers a day. Simulation has helped a smooth transition to the operation of an infrastructure with only one third of the original number of switches.

The Trinity simulation environment has also been used in a pilot for a new train schedule with 6 intercity trains per hour between Amsterdam and Eindhoven.

During the gaming session, multiple scenarios have been evaluated, including scenarios with people walking on the tracks and defective trains.

Your challenges, our concern

INCONTROL's simulation experts would be happy to use their expertise for your challenges. INCONTROL builds your customized multi-purpose railway simulator(s) that help you face the future. Simulation provides a nearly unlimited amount of opportunities for your company. Whether you want to improve your train schedules, innovate your systems, train your employees or create a digital twin of the rail, simulation can help!

Please feel free to contact INCONTROL to find out what the simulation experts can do for your railway company.

Joris Steneker, Team Manager Rail

Enterprise Resource Simulation Platform

The Enterprise Resource Simulation Platform is a comprehensive simulation development environment that allows you to develop your own simulation applications. These applications can be general-purpose in nature or very domain specific.

The simulation platform supports you in the development of your own simulator by providing easy-access to an extensive simulation object library, a fast and easy-to-learn simulation language, a visualization engine optimized for large-scale visualizations, and many (industry) standards.

Combined with a set of tools to support the development and deployment making the Enterprise Dynamics Simulation Platform the ideal starting-point for the development of a simulated application.

Some of the features we have added in the latest version of the platform:

- Generation of simulation models based on external file formats like BIM, CityGML, 3D Objects, and CAD.
- Enhanced support for high-volume database communication with dbExpress.
- Parallel execution capabilities of simulation and non-simulation events.
- The ability to push visualization directly to the video card buffers.
- The support of Doxygen for documentation purposes.

Fred Jansma
CTO

allow flexibility the platform needs to be open, fast and stable, supporting many standards. There is a long list of standards that are supported by our simulation platform.

Some examples are:

- native support for SAP
- support for OPC (the platform can act as an OPC-client)
- TCP/IP and UDP
- External devices:
  - Occulus Rift
  - 3DConnexion SpaceMouse
  - Raildriver Desktop Cab Controller
  - XBOX One controllers

For our customers we provide a detailed SDK with many examples to develop your own solutions. Together with universities and other research institutes we also continually research tomorrows standards.

Enterprise Resource Simulation Platform

Airports · Pharmaceuticals · Stadiums · Universities
Rail · Machine Builders · Expo · Institutes
Traffic · Material-Handling · Amusement Parks · Research Labs
· Automotive · Museums ·
· Warehouses ·
Critical Infrastructures · Manufacturing & Logistics · Leisure & Entertainment · Science & Education

Impact Analysis ● Near Real-Time Failures ● Cascading Effects ● Multi-Level Planning ● Predictive Analytics

The INCONTROL products Enterprise Dynamics and Pedestrian Dynamics have been developed with the platform using the same functionalities available to other developers. A customer like Knapp Automation & Logistics has developed their own simulator, using our platform with which they provide to their end-customer a simulation tool as part of their own material-handling solution. Hyster-Yale uses their own developed simulator to provide their sales staff with a tool that makes it possible to calculate and visualize the needs and possible solutions for (potential) customers and ProRail/Dutch Railways have developed an impressive set of training and simulation tools for the simulation of time-tables and rail infrastructure.

These new functionalities have been utilized immediately in our products Enterprise Dynamics and Pedestrian Dynamics, also in several of the simulators developed by our partners and customers.

Specialization in simulation platform development
Simulation can be used for a variety of fields. However, trying to provide a simulation solution for all these fields is nearly impossible. Providing a solution for a specific field doesn't mean you can use that same product for a different field.
INCONTROL has specialized itself on developing a simulation platform. On top of this platform experts from various fields can develop their own specific simulators. To

CROWD MANAGEMENT, SAFETY & SECURITY PARTNERS:

**Crowd Professionals
National Center for Spectator Sports, Safety and Security (NCS4)
TECSA s.r.l.
Crowd Risk Analysis Ltd
Movement Strategies
DAT.Mobility
360 Solutions
Simplan AG**

How does simulation help when implementing EO 13636 and PPD21

INTRODUCTION The ability to model and simulate infrastructures at each level of required detail and the virtualization of these infrastructures allows you to analyze the behavior of such infrastructures and their cascading effects under all sorts of hazardous conditions. Such as egress, traffic congestions, queuing, evacuations/ sheltering, bomb threats, active shooter, adverse weather, congestion during ingress and equipment logistics.

Running scenarios in the design and preparation phase and during staff training allows you to develop a situational awareness capability of how the infrastructure and people within it are functioning under normal parameters as well as the potential risks and threats. By visually analyzing these potential risks and threats, simulation can assist you in understanding the cascading consequences of the infrastructure, individual movement, equipment and procedural failures.

SAFETY ACT CERTIFICATION
Simulations can be used pre, during and post event as a predictor, operational tool, training module and for after-action lessons learned. Simulation is used as the preferred tool to provide assistance in preparing

organizations for the Safety Act Certification. It allows these organizations to analyze possible risks and threats and how to mitigate the effects. Simulation allows you to visualize the risks and threats and the designed procedures to all staff and first responders making it an excellent training, preparation and evaluation tool.

Simulation can satisfy the fire marshals need to validate safe person capacities and evacuation times. It further provides accuracy and clarity in business continuity and disaster recovery planning.

Gary Gartner
Director of Safety and Security Applications

Little Caesars Arena

INTRODUCTION Detroit Red Wings new facility - Little Caesars Arena leverages INCONTROL's simulation software for safe & secure crowd management in arena and surrounding congested neighborhood. For the multiple type events that will occur at the Little Caesars Arena and the adjoining neighborhood, the safety & security team will be in a better position to anticipate, plan, train, communicate and deploy staff, to effectively and efficiently manage a safe environment for attendees, participants and staff.

"For the multiple types of events that will occur at the Little Caesars Arena and the adjoining neighborhood, District Detroit, the safety and security team will be in an enhanced position to anticipate, plan, train, communicate and deploy staff to effectively and efficiently manage a safe environment for attendees, participants and staff." Said Richard Fenton, CSSP, Vice President, Corporate Security and Safety, Ilitch Holdings Inc.

> " Using the INCONTROL's simulation software was an intricate part of our Safety Act Certification preparation and application, by demonstrating our ability to develop effective safety/security plans.
>
> CSSP, Vice President, Corporate Security and Safety, Ilitch Holdings Inc.
> *Richard Fenton*

Benefits for Little Caesars Arena

Planning

The solution assists the planning team in developing and validating event and emergency plans, resulting in the identification of gaps in resources and training. Little Caesars Arena is able to simulate unlimited functional scenarios such as ingress, egress, crowd flow, evacuation, and sheltering to experiment and explore various response options.

Training & Exercise

By using the simulator it helps the venue safety & security team, as well as their public safety partners to define appropriate roles and responsibilities, allowing them to customize training plans and sharing venue-specific needs with event staff and stakeholders. The solution runs the "What-IF" scenarios that can be encountered during any event and is intended to serve as a road map for them to continually make improvements. Finally, it allows them to visualize the response to plans, and helps the team SEE how to implement those plans.

Operations

The INCONTROL simulation software addresses operational needs such as estimating queue times and crowd flows, identifying resource requirements, maximizing the effectiveness of signage and asset positioning, as well as optimizing commercial areas and retail locations within a venue or event. By addressing these needs, operations and processes can be both tested and validated. Any data inputs can be presented on a visual representation of the Little Caesars Arena.

About INCONTROL

INCONTROL Simulation Software develops and implements simulation solutions based on their products Enterprise Dynamics (manufacturing & logistics), Pedestrian Dynamics (crowd simulation), and TOPVenue. TOPVenue is the training environment on top of Pedestrian Dynamics that has been developed in close cooperation between INCONTROL and the US National Center for Spectator Sports Safety and Security (NCS4).

> " Simulation allows us to visualize the risks and threats of crowd management and the designed procedures for all staff and first responders making it an exceptional tool for preparation, training and evaluation.
>
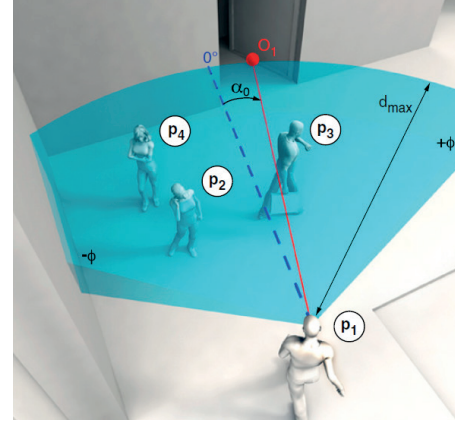> Director, Corporate Security & Safety, Detroit Red Wings, Inc.
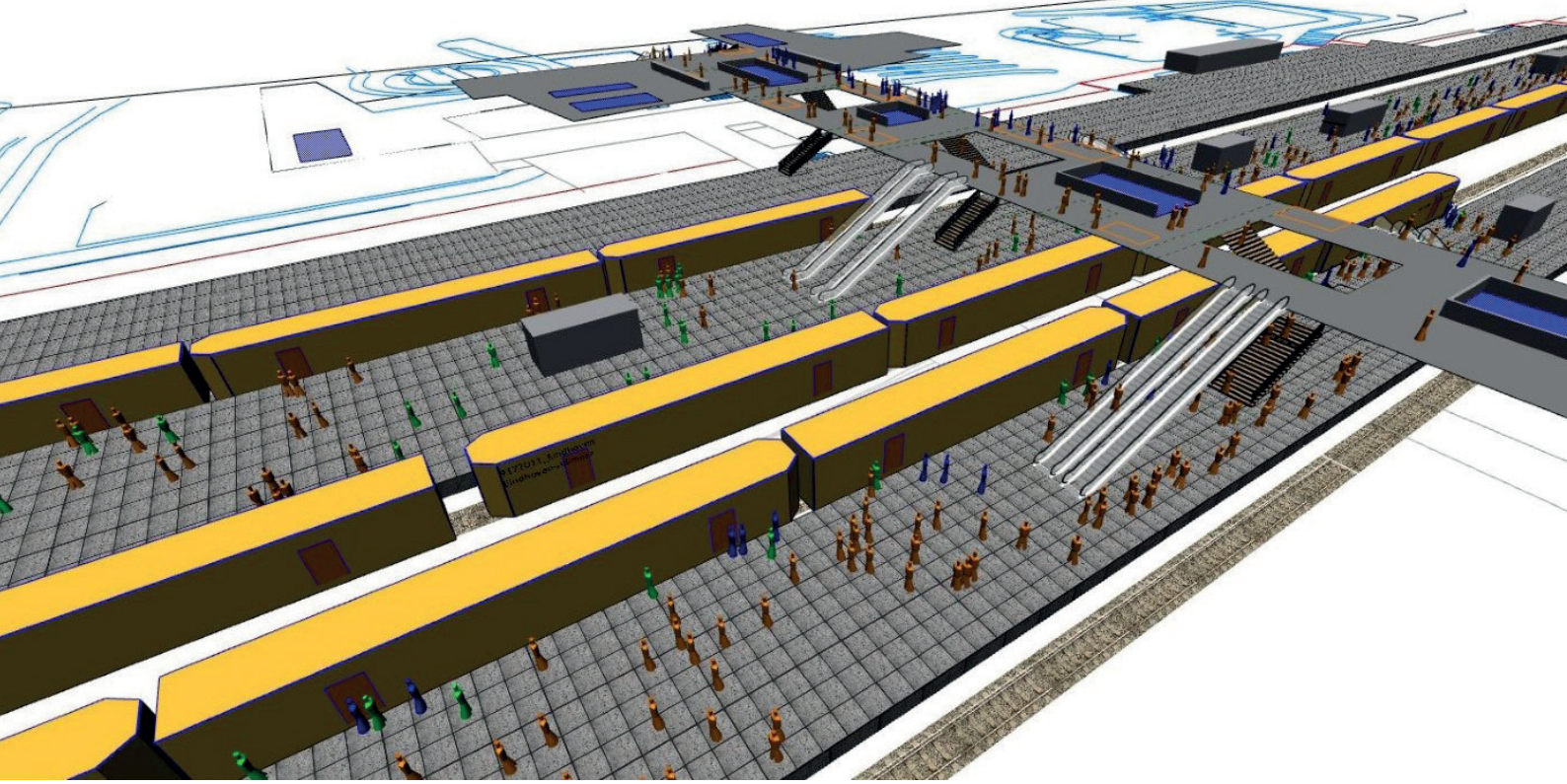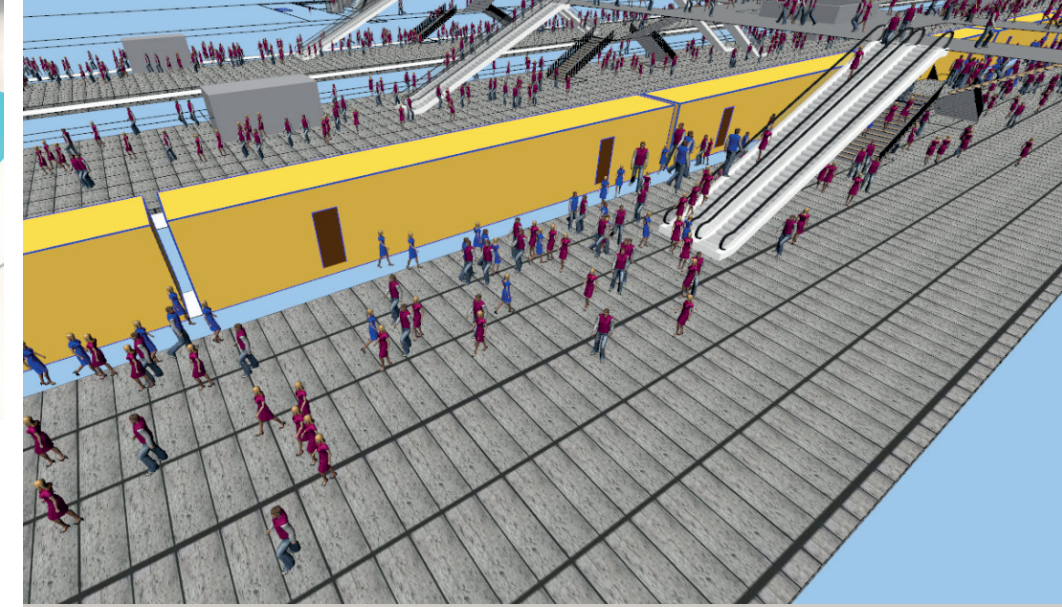> *Johnny Jackson*

How virtual passenger modelling prepares you for the future of railway stations

The future of railway stations. The rail industry is changing. The focus shifts from the most effective and efficient way of getting passengers from A to B, to the total seamless journey. The trend is that railway stations not only function as a location for catching a train, but also leisure and business. Restaurants, shops and office buildings become an integrated part of the station. This is where the cohesion between travel, leisure and the city arises. As railway stations are a central point of social interaction for cities, imagine picking up orders at the online-shopping point or meeting-up with a friend, drinking coffee at one of the shops.

Urbanization and growing population numbers contribute to added stress on city- and rail infrastructures. The United Nations states that globally, the world population is likely to reach 9.7 billion citizens by 2050, approximately 66% of the population will reside in cities. Utilizing the city infrastructure in a more efficient, intelligent and integrated manner seems to be the key. Yet, how will the rail sector anticipate towards a rising amount in passengers?
When it comes to this industry, the desires and expectations of passengers push towards innovation. Convenience, comfort, safety and reliability remain to be the vital elements for passengers to choose for travel by rail. In addition, rail is a sustainable and responsible means of transportation. Passenger expectations indicate limited waiting times, reliable time schedules and seamless journeys integrated with other modes of transport which could be offered as a service, the so-called "Mobility as a Service". Imagine planning journeys ahead, taking advantage of a combination of various transport modes like trains and a

shared automated vehicle to cover the last mile from the central station to work.
Individual, custom information marks excellent customer service. To realize these expectations, insights need to be created and future possibilities addressed. For railway stations this means a removal of the thin line between railway function and community services. Passengers will not only commute but also dwell around the station environment.

All of these principles have a significant impact on passenger flows and therefore the use of the station's infrastructure. Industry innovations like pedestrian location tracking significantly support monitoring and analysis of passenger flows. But how can future changes of the railway station be achieved? Is the current station infrastructure capable of dealing with the ongoing growth of passenger's number's, technological innovations and change of use?

> The British Rail Delivery Group has indicated 9 key principles for the future of railway stations. The principles are described as:
>
> 1. Increased customer focus
> 2. Intelligent use of technology
> 3. Seamless journey experience
> 4. Reflect local needs and opportunities
> 5. Safe and secure environment
> 6. Entrepreneurial spirit
> 7. Flexible and long-term stewardship
> 8. Shared industry know-how
> 9. Optimized network.

Illustration of a pedestrian facing three other subjects and trying to reach the destination point O_1. (PNAS/Moussaïd et al)
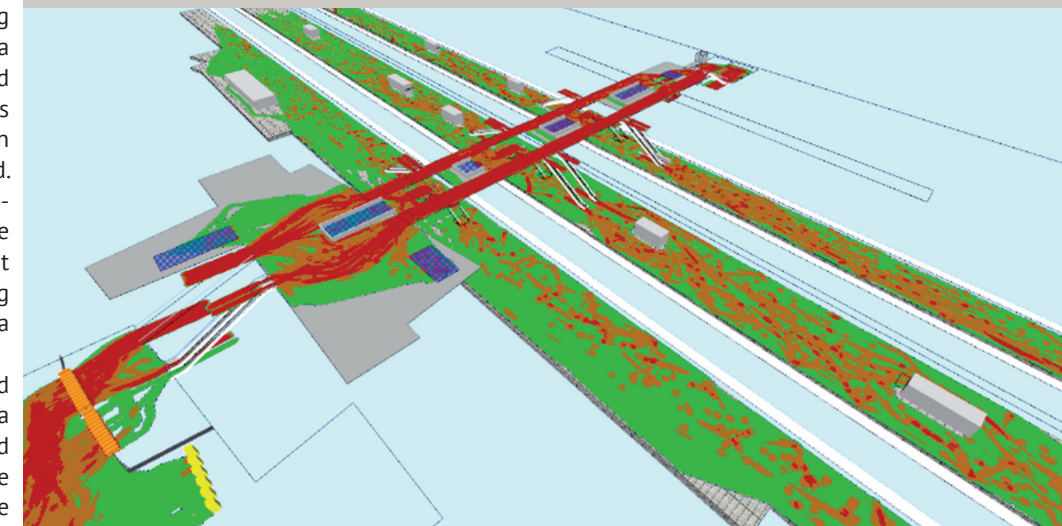
Virtual modelling

In order to cope with all the future changes creating insight in the passenger journey is essential. Insights can either be created in the (re)design phase of the building but also during operations. This is where virtual modelling comes into play. Simulation provides one of the solutions as a modelling tool to create a virtual representation of reality. Developing a crowd model enables the designer to create insight in the crowd flows of alternative designs. Visualizing processes, while dealing with uncertainty in an understandable way. It allows you to assess, compare and improve alternative designs, plans and policies without having to experiment in a real-life situation. Data insights and analytics help to eventually shed light on the underlying gaps and problem areas while keeping customer experience, station capacity and the safety perspective in mind. The evaluated scenarios help to reduce time-consuming mistakes and overall cost while improving continuity and creating insight toward safety. Simulation supports answering the "What if" scenario involved and how a process will perform in the (near) future.
With the use of simulation, the city- and rail infrastructure can be utilized in a more efficient, intelligent and integrated way. Assessing the entire infrastructure and pedestrian flows in and around the train station and surrounding areas is of importance. Bottlenecks in the infrastructure, timetables, flow and safety of passengers can be analyzed and pinpointed. Commercial attractive areas can be identified. The technology can be used to predict consequences of various incidents and other emergency situations. Surrounding areas of the station are influenced by incidents, so necessary changes in design, plans or policies might need to be identified in order to help the area perform better and become more resilient. Overall, simulation provides the possibility to increase throughput rates to accommodate rising passenger numbers, simulate morning and evening peak moments, crowd flow, calculate the 'social cost' involved, increase overall revenue and improve customer experience.

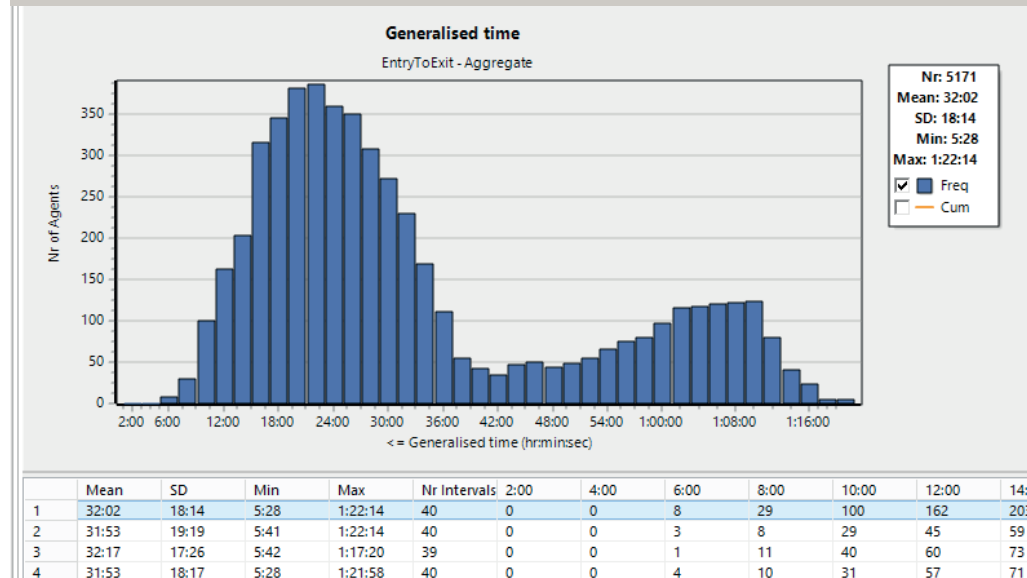## Implementation of virtual modelling

Simulation as a virtual modelling tool enables you to visualize crowd flow scenarios. The implementation can be realized by importing CAD drawings or BIM models in the software. The outcome reflects the geometry of the design. The ability to define inputs such as train schedules, train load, passenger demands and route preferences brings the design to life and simulates the passenger flows through the 3D model.

Data generated in the simulation software provides the designer with quantitative statistics to assess the overall design of the railway station. Density maps analyze the crowdedness in the stations; which can be distinguished by various travel times to ensure passengers can get to their next destination in time. The so-called "social costs" element determines the business case of the train station in terms of capital and resources.

▲ *Example of a density map*   ▼ *Example of Generalized journey times per agent*

Generalised time
EntryToExit - Aggregate

Nr: 5171
Mean: 32:02
SD: 18:14
Min: 5:28
Max: 1:22:14

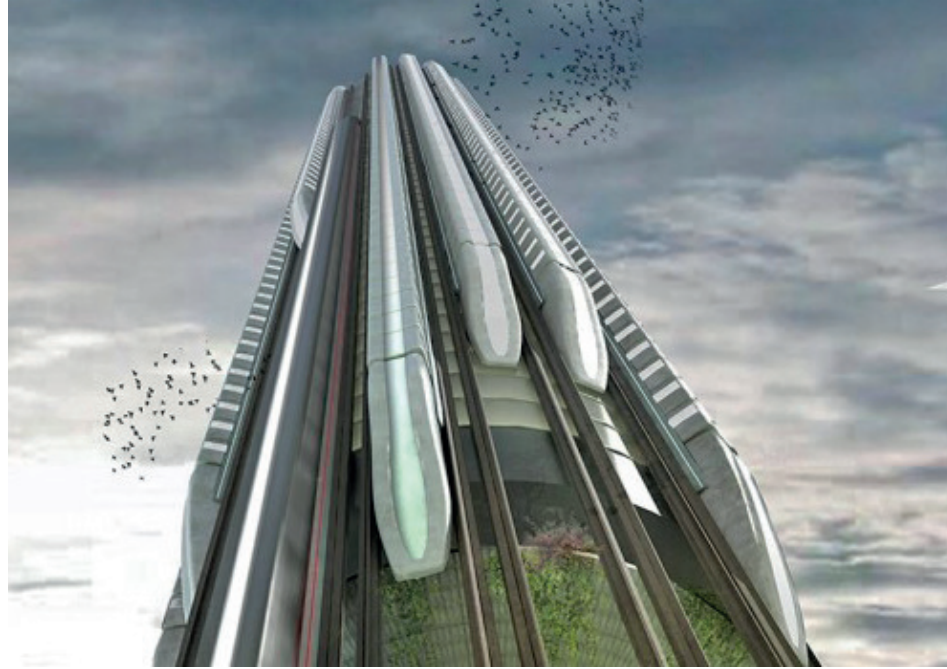|	Mean	SD	Min	Max	Nr Intervals	2:00	4:00	6:00	8:00	10:00	12:00	14:0
1	32:02	18:14	5:28	1:22:14	40	0	0	8	29	100	162	203
2	31:53	19:19	5:41	1:22:14	40	0	0	3	8	29	45	59
3	32:17	17:26	5:42	1:17:20	39	0	0	1	11	40	60	73
4	31:53	18:17	5:28	1:21:58	40	0	0	4	10	31	57	71

Preparing for the future

As indicated previously, the rail industry changes. Whether the future of the industry leads into more futuristic ways like the 'Hyper Speed Vertical Train Hub' as envisioned by Christopher Christophi and Lucus Mazarrasa or the proposed 'Hyperloop', anticipated as "the fifth mode of transport" by entrepreneur Elon Musk, no one really knows.

One thing is for certain, the rail industry must deal with current changes in the field of urbanization and growing population numbers. The increasing desires and expectations of passengers push towards innovations like intelligent use of technology, the seamless journey experience as well as ensuring safe and secure environments. Simulation, as a virtual modelling tool, creates the insight needed to meet the above- mentioned innovations for all public transport passengers.

'High Speed Vertical Train Hub' as envisioned by Christopher Christophi and Lucas Mazarrasa
(Courtesy: eVolo)

Marlies Wouters, Team Manager Crowd Simulation

The 'Hyperloop' as the fifth mode of transport by entrepreneur Elon Musk
(image: Unlim3d/123RF)

Light beyond illumination

Signify, formerly known as Philips Lighting, is the world leader in connected LED lighting products, systems and services. Through innovations, the extraordinary potential of light for brighter lives and a better world is unlocked.

In stress situations vision is the only human sense that will remain sensitive and functional. Scent/taste, haptic sense and hearing will become insensitive (in that order). People also tend to move in the direction where doors are open, or where light levels are highest, irrespective of whether this is the safest and fastest route. Connected lighting inside venues (pitch, facade, functional and entertainment) could be used as an actuator to improve efficiency of evacuations. When adding sensors, measured data can be used to help select scenarios more accurately. In non-incident situations lighting could be used as guidance solution or experience enhancer.
Signify and INCONTROL together develop integration of simulation software and lighting. So light can be used as guidance during evacuations or directing people in overcrowding situations based on near real-time calculation of safe scenarios reducing the risk of casualties and injuries.
The system can also be used to indicate the positions of personnel based on their cell phones without using a carrier network or Wi-Fi infrastructure. The nearly failure free LED lighting system is used instead.

Modernize Train Stations in Warsaw

The Polish Railway Infrastructure Authority plans to modernize one of the main stations in Warsaw, forming a complex intermodal transport hub, connecting railway, underground and trams/buses. Pedestrian Dynamics has been used to analyze existing and planned public transport infrastructure for predicted pedestrian flow for 2020 and 2025.

The passenger demand forecast was based on the Warsaw traffic model, developed in Visum.

The Pedestrian Dynamics crowd simulations allowed to determine the bottlenecks of existing infrastructure. As a result, the optimized new entrance/exits to the underground station and reconstruction of railway platforms were proposed.

Matthijs Jongboer
Manager Support

SUPPORT
Visit us online at support.incontrolsim.com

There are several options to assist you in achieving your goals with INCONTROL Simulation Software.
The following list gives important channels as a quick reference.

Help / Online Help
The software comes with an extensive integrated help system with over 4000 dedicated pages.

Community
The software has a dedicated and active community.
Visit: community.incontrolsim.com

Support
If you encounter a problem, have any development requests, or want to learn more about a specific topic just send an email to: support@incontrolsim.com

Phone
Feel free to call us when you require additional information:
Global support: +31 30 6703798

Academic
Students and academic users can visit the dedicated section on: academy.incontrolsim.com

Training
For use and application of the software, as well as specific trainings, workshops or in–house trainings, see our training schedule or contact our training department at www.incontrolsim.com/training

Example models
INCONTROL Simulation Software omes with a large set of example models explaining its basic and advanced features. Simply click the 'Example Wizard' button in the software.

INCONTROL
Simulation Software®

www.incontrolsim.com