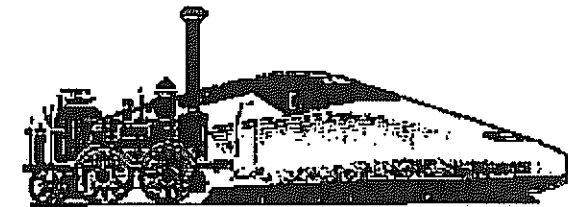




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21st International Symposium
EURO - ŽEL 2013
"Recent Challenges for European Railways"



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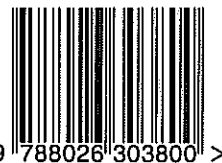
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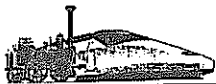


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STORE&GO+ – AUTOMATED LUGGAGE STORAGE SYSTEMS USING PASSENGER FRIENDLY TOP LOADING CONTAINERS

Hans-Christian Graf¹, Egger Martin², Bernhard Rüger³

In near future the effective design and user friendliness of public transport services will be an essential success factor for traffic systems in general. Operators of terminals and railway stations try to meet increasing demands for more comfortable temporary deposits of luggage or shopping bags. Conventional luggage lockers are inefficient and create problems in their use for old or handicapped passengers.

An Austrian research consortium developed the innovative "store&go+" system as experimental prototype for passenger's luggage or baggage. The "store&go+" system represents a new cube adaptive technology for containers which can be top loaded at extremely user friendly drop stations. The system incorporates a novel concept for effective warehousing and handling of luggage, too. The paper provides an overview about needs and expectations of all kind of passengers regarding to luggage storing at the station and how these are addressed by construction details of the "store&go+" system. Finally benefits for station operators and the visions for future services are documented.

1. The Service Approach for railway station operators

An effective design of future transport hubs in the fields of public transportation is an important factor to increase the attractiveness and efficiency of transportation systems in general. Beside attractive travel connections and centrally located railway stations public transport requires also just easy usable depot systems for temporary storage of baggage and luggage.

During a two-year inter-university research collaboration of the universities of applied sciences in Steyr, Wels and St. Pölten and in alliance with the Viennese research company Netwiss the basis for the "store&go+" concept was developed. Last year the Austrian Federal Railways ÖBB and the leading Austrian Logistics systems integrator TGW joint the project to develop a "store&go+" prototype installation, which is funded by the Austrian Research Promotion Agency FFG.

The "store&go+" system addresses public transport hubs (e.g. train stations or airports) of the new generation which are changing more and more into multi-

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functional business centres and do not only offer the travel, but also a local shopping, business communication and shopping service. In this context, the troublesome handling of luggage constitutes a significant stress factor and a loss of comfort for all passengers.

The "store&go+" concept provides an easy way of luggage deposit and overcomes the disadvantages of conventional locker systems (e.g. the difficulty of handling of heavy luggage, which is deemed acceptable to older or weaker travellers). Instead of side or front loaded lockers the "store&go+" system uses specialised containers which can be filled from the top at automated loading stations in ergonomic working height. To protect the private belongings of the user each container is covered and sealed automatically before of its transfer into an automated storage area. Automated storage and retrieval systems ("AS/RS") - which are well established and approved in the logistics industry - transfer the closed and locked container to a free warehouse location of a background racking system. In parallel the user gets a bar coded ticket to pick up his luggage again whenever he likes.

For the railway station (or airport) operators - who are very often in lack of commercial space - the partially patented "store&go+" technology enables the efficient utilisation of free space heights within the station infrastructure as a storage room for passengers luggage containers. The "store&go+" system represents a solution, both technically and economically explored and examined for feasibility, which can be used not only in the planning of new stations, but also for existing buildings. Through the development of innovative technologies for the luggage storage possibly existing acceptance barriers of shall be countered in upfront.

The central idea of "store&go+" is that travellers (or any other passers not traveling) can check in their baggage in close proximity to high frequented parts of the station - like near the front entrance, or the exit of subway stations, or at taxi stand - quickly and easily into an automated luggage depot. In this way, relieved from the efforts of luggage future passenger increasingly may make use of the commercial centre of the railway station (e.g. restaurants, shops, travel agents, communication infrastructure, catering or the facilities for local supply, etc.). Before departure or before leaving the station the customers also easily can retrieve their luggage again.

The "store&go+" concept is a technological answer to meet the demands and challenges of modern depot services and represents an innovative system for short term and long term storage of traveller's luggage at railway stations, but is also foreseen to be used as pick-up place for internet shopping in a self-service automatic unit.

The project "store&go+" is based on a former study which analyses the basic needs of passengers regarding to locking luggage and which identifies the expressed passenger expectations for customer-friendly deposit system.

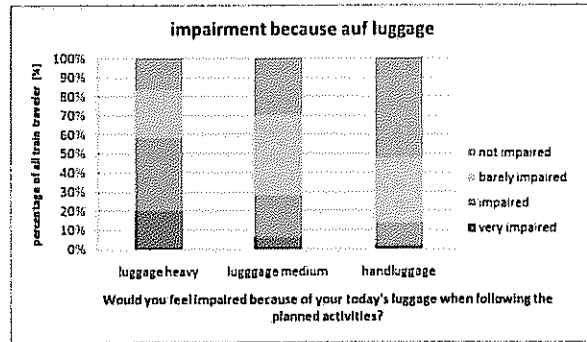


Fig. 1: Felt impairments of travellers because of their luggage

Figure 1 illustrates the large number of potential consumers which want to go for shopping or eating and drinking but can't do that because of impairments by their luggage. This also points out the need and the meaningfulness of short term luggage lockers.

Two main problems regarding today's lockers emerge. In general the handling of luggage is often very inconvenient and especially for short term locking high prices are often not accepted. There is no system known at railway stations that offers short term locking for free or for a special low price.

Beside the price the handling of luggage lockers is an essential criterion for acceptance. The handling consists of easy locating, the potential must of lifting up the luggage, the size of lockers, the immediate handling (payment process etc.), a short time span for the locking process and an easy return of the luggage. Most important also is the size of the lockers and the fact whether the luggage must be lifted or not.

Depending on the age and the sex travellers have got different difficulties when they must lift luggage. For example about 50% of all female passengers with large luggage are not able or willing to lift it, about 20% are able or willing to lift it up to about one meter and only 30% are able to lift it higher.

For about 70% of all female and 40% of all male travellers storing luggage at floor level is important or very important. Also for 70% of all passengers above the age of 60 this is a must.



Fig. 2: Many passengers have troubles when they must lift their luggage

The time needed for storing and especially for getting back the luggage is another very important criterion for acceptance. More than 25% of the asked train passengers say the luggage returning must not need longer than one minute, more than 50% accept a time need between one and three minutes. The time need includes the whole process between coming to the locker until getting the luggage and leaving. Especially the subjectively felt time needed when passengers are in a hurry and they are nervous because of the approaching departure of their train is very important.

Many of today's lockers are too small for usual luggage items. The width of many lockers is 33cm but 40% of all luggage items are bigger than this size. That means 40% of luggage items do not fit into normal lockers. Passengers either cannot store it or must use a normally much more expensive locker for huge items.

It was analysed, that about 80% of passengers staying more than 30min at the station think about using a short term locker for easier moving in order to use the station infrastructure like shops or bistros. For half of them the handling must be very quick and cheap.

2. The store&go+ solution

With regard to an utmost universal use the system is designed for all the fields of railway transport, aviation and other hot spots of public places to be available for commuters, passengers and shoppers. But the focus of this development, however, must depend on railway stations. A technical development that is in working order for stations can then be transferred in other facilities or hot spots of public space easily.

2.1. The focus on passengers health and comfort demands

Core of an automatic and public luggage storage system must be an ergonomic, robust and tailored design, which fits to the needs of all kind of user groups. Any differences, such as age, gender and physically or mental health should be irrelevant. This means that an old person shall be able to deposit her luggage, such as anyone using a wheelchair or a woman with a baby buggy.

The user interface principally has to meet the requirement of the general population. The dimensional design for physiological user heights and gripping areas directly result from the ergonomic body reference. These requirements for a physio-friendly and ergonomic operation have to be supplemented with barrier-free equipment for people with technical restrictions (disabled).

Also the cognitive system requirements factors have to be taken into account for the software and screen design of the user interface. Multilingualism in the user dialogs and the use of readily understandable pictograms and colours have to be applied even for colour-blind people. All operating functions must include logical (= the common expectation appropriate) operating dialogues with any function cancel option for all starting and operating steps with online help function.

All these specific human related requirements have to be added by standardized safety and comfort requirements, ranging from rounded bearing edges for protection

against bruises to the exclusive use of crimples controls which avoid users to be jammed.

2.2. The focus on passengers comfort

Regarding to the anticipated acceptance of a new storage system and regarding to analysed factors like passengers comfort, needs and expectations a new locker system must allow floor level locking or at most a short lifting. The system also must serve the different dimensions of today's luggage.

As part of the research project "store&go+" both the technical and economic feasibility has been proven. After detailed analysis of customer needs the development of a realizable and mature concept is currently in the phase of prototyping. The "store&go+" concept is characterized by the user friendly top loading philosophy and by a patented container volume adaptive technology. A standardized shelf racking is served by automated storage and retrieval robots and by storage conveyor technology. This directly addresses quality objectives and effective container handlings, both for the comfort of passengers.

2.3. The technical solution

The technical solution of "store&go+" is based on proven and reliable automation concepts of the small parts warehousing technology, which are combined with the innovative top loading container system to meet the conditions and demands as defined above. The key solution element is the cube adaptive container system which includes covers (negative boxes) and cover locking.

The requested stability and robustness soon reduced the theoretical freedom of the materials selection to metal. The following frameworks specify the technical demands in more detail:

• Framework of the resulting criteria for the container construction:

- Dimensions:
 - Type A) Length: 100cm, width: 60cm-70cm
 - Type B) Length: 70cm, width: 60cm-70cm
 - A) and B): max. Luggage height 50 cm
This leads to a total container height of 30cm,
 - plus 30cm height of the negative cover whereas 10 cm are overlapping.
- Resistant against vandalism and stealing.
- Free room for the load handling equipment from below: 60-80mm .
- To be inexpensive the construction incorporates experience from established commodities like plastic containers (according to standard dimensions in logistics: 600x400x320).
- Generally easy and simple mechanic to reduce maintenance cost.
- Container has to be captured with an overlapping cover.

• Framework of the Cover criteria:

- The cover shall be secured positively in both directions (lifting and lowering of the lid) in case of swelling luggage (e.g. when it opens autonomously).
- Automatic capping and uncapping takes place inside of the system in order to avoid bruising of the passenger.
- An automatic control of the filling level is necessary.

• Resulting criteria framework for the construction of the Pick Station:

- Several warehouse aisles shall be installed in the longitudinal direction.
- Crosswise access should be excluded because of performance reasons.
- The pick station has to operate for the luggage deposit and the pickup.
- Because of performance reasons a pick station (luggage input and output terminal) shall not serve more than 150 stock locations (bins).
- Passengers should be able to choose a short term (e.g. up to 1 hour) or a long term deposit. (This shall cause an intake to according deposit zones automatically.)
- Payment shall be able to be settled by use of vouchers, international credit cards and money. Instead of returning cash back vouchers may be issued.
- Containers may be tilted for easier loading and unloading according the demands of ergonomics.
- The output orientation of the container shall be the same as for the input task. This allows easier gripping of handles or straps of the luggage.
- A control of the containers filling levels has to be foreseen e.g. by use of cameras or scales.
- Mounted mirrors shall support visible inspection of luggage placement into the container and inspection of emptiness after outtake.
- In case a container is not emptied completely by the customer, it must be stored again automatically.
- The container must be transported underneath its supporting guides to the loading position in such a way, that no customer items are able to fall out. (e.g.: everything falling out of pockets has to fall into the container only.)
- For customer's protection the loading position of the container has to be covered until the container arrives and is presented to the passenger for loading or unloading.
- Any danger of bruising or crushing has to be excluded.
- The handling height shall be 40-60 cm and supported for disabled persons.
- The max weight of luggage shall be about 35 kg per container.
- Initial height measurement or control of overhangs should be done before the move to the inner part of the station takes place. The control of emptiness or of maximal filling levels might be supported by pictures, which are taken within the station, where lighting conditions can be kept constant.

2.4. Some construction details

The following figures show functional details of the construction and possible layouts for installations in railway stations.

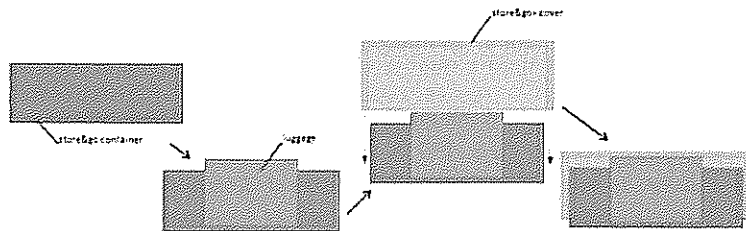


Fig. 3: "store&go+" container topping principle

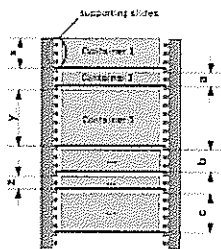


Fig. 4: cube adaptive racking

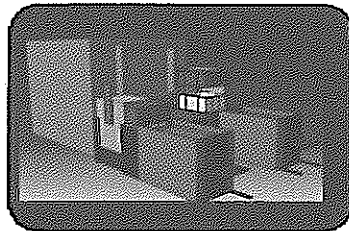
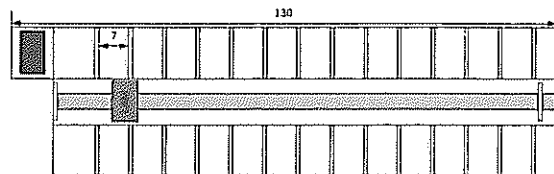


Fig. 5: "store&go+" loading terminal



B ... Box (Container)
 UAM ... AS/RS (Lastaufnahmemittel)

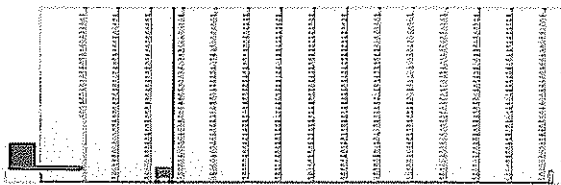


Fig. 6: Indication of a "store&go+" storage area (top view and front view)

3. Conclusions

With the concept of "store&go+" a concrete technical system has been developed for the innovative deposit of luggage in self-control robots. It is characterized by both a volume adaptive container technology as well as a novel luggage storage technology using racking systems and conveyors. These directly address the quality objectives of an effective luggage deposit service, but also the performance targets and passengers comfort.

Travellers will purchase more at the station whenever they can deposit hindering items. "store&go+" enables station managers to meet this need and by means of offering a new attractive service they will increase the attractiveness of public transport in general, too. The easy to understand self-service function is not only a guarantee for good "usability" and user acceptance, but also facilitates urban mobility and stimulates the motivation to use public transport.

The concept "store&go+" addresses especially changing travel behaviours at railway stations, which increasingly will serve not only as enter or exit stations of public transport but also as centres for communication and the daily shopping. The replacement of existing locker systems by "store&go+" systems shall not only address the baggage depot service, but also has the potential for use in the Lost & Found at stations. Furthermore, the new system is ready as pick-up station of internet shopping and for the daily needs of commuters and other travellers. The internet and its constant accessibility via smartphones not only change the communication and mobility but also the purchasing behaviour of working people.

The vision of "store&go+" provides a functional response to the growing demands of the changing mobility behaviour at traffic stations. Travellers (or any other user groups who are not traveling) shall be able to quickly, easily and ergonomically place their luggage in automated self-service depots and always pick it up again quickly after a simple payment process.

The "store&go+" system is designed in modular elements to be implementable in adaptable sizes and storage capacities in railway terminals or airports.

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