



Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences

Aeronautical Engineering Design - Team Project

Prof. Dr.-Ing. Jutta Abulawi

In cooperation with: Airbus Operations GmbH



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Organisational Aspects of this Module

- Compulsary module for BEng Course Aeronautical Engineering (2nd year)
- In a team, 3 - 5 students conceive and elaborate a mechanical design solution for an aeronautical engineering design task
- Workload per student: 150 h

ECTS Credits: 5

Learning Outcome:

- You use a methodical approach to identify requirements, and to define & evaluate various creative concepts.
- You elaborate the favorite concept into a detailed design solution, applying your knowledge in engineering mechanics, machine elements, materials science, and computer aided engineering (CAD).
- You present and discuss your concepts and your final solution, and document the whole project in a team portfolio.

=> Assessed Team Project

Organisational Aspects of this Module

Team size: 4 ± 1

Each team member assumes the personal responsibility for:

- a sub-assembly and its detailed design
- the dimensioning/stress analysis of a critical part
- a purchasing specification

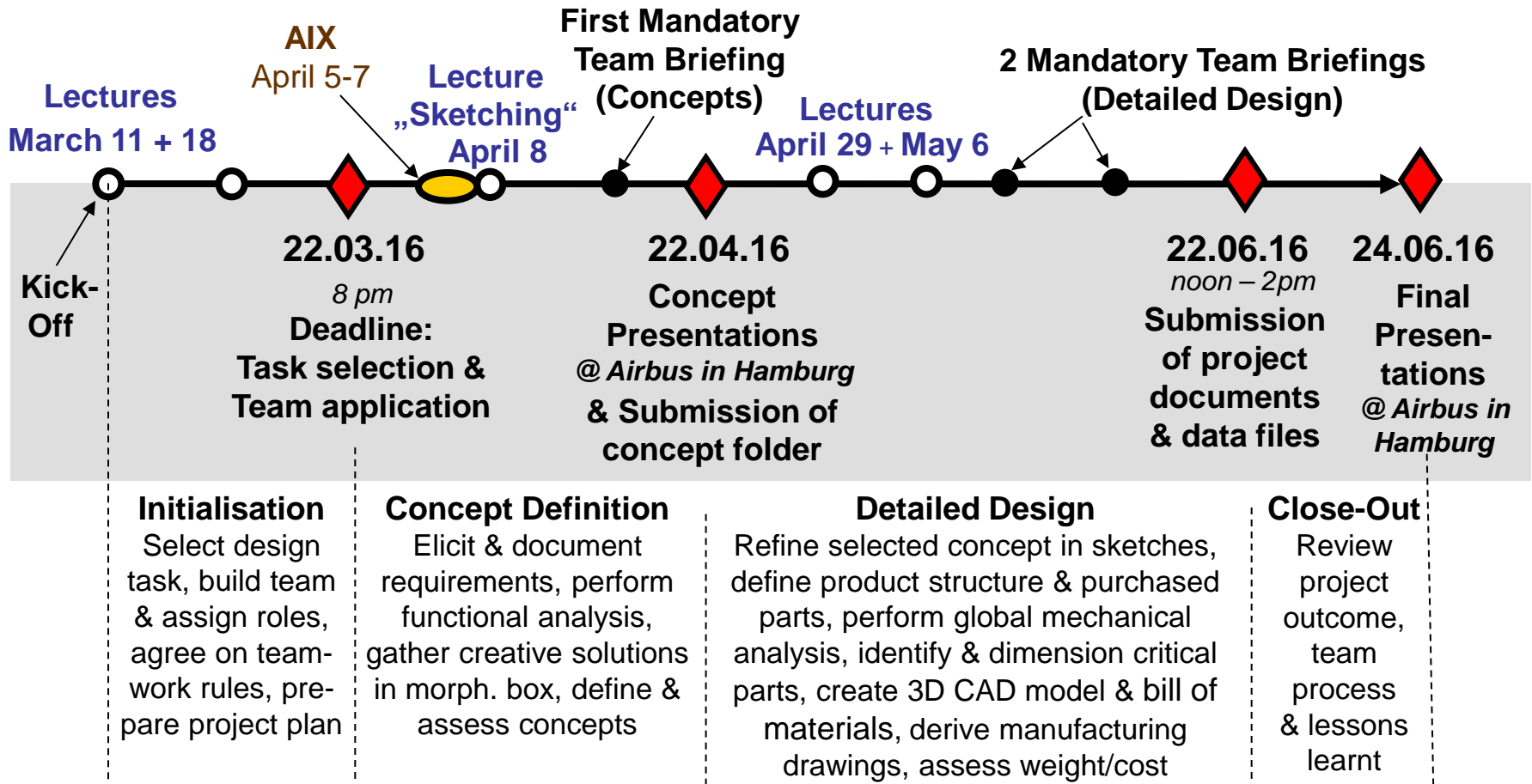
Each team member assumes 2 of the following roles in the team:

- Team Leader
- Requirements Engineer
- Chief Stress Engineer
- Chief Designer
- CAD Manager
- Documentation and Quality Manager
- Manufacturing Planner
- Procurement Engineer

Aeronautical Engineering Design - Team Project

Summer Semester 2016

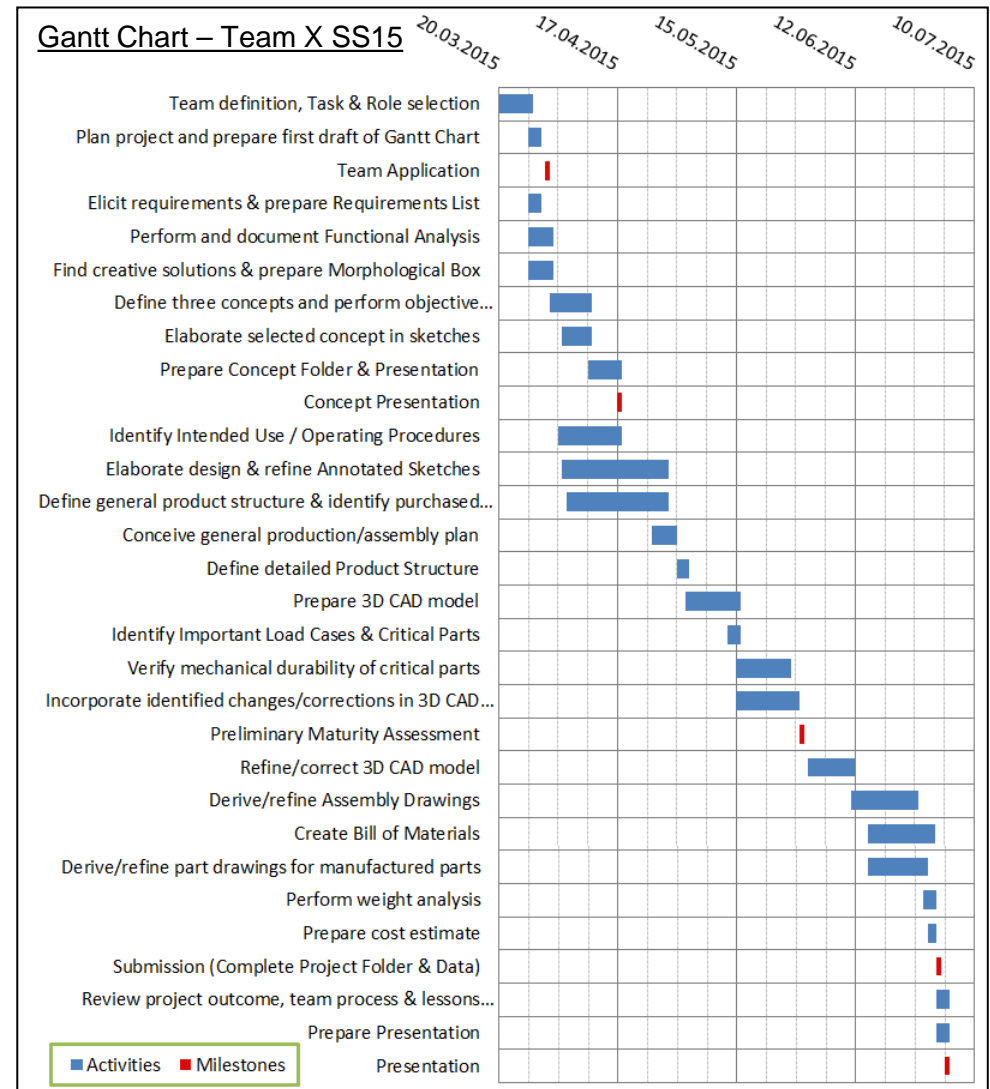
Project Phases + Milestones



Project Planning

Each team shall
prepare a Gantt Chart
with identified project tasks
& milestones

*Optionally, teams can
document responsibilities
of individual team members
for certain tasks in the chart.*



„Learning Outcome“ & Assessment Criteria

- **Systematic, creative concept definition: 20%**
Complete & correct requirements list, systematic functional analysis and morphological box with concepts, presentation of three concepts with sketches and short description in key words, rational concept assessment
 - **Detailed design: 40%**
Design report (illustration and description of overall design and special features, mechanical analysis of overall loads & stress analysis of critical parts, detailed sketches with engineering information, bill of materials, manufacturing drawings, specification of purchased parts, cost & weight assessment, final assessment of requirements fulfilment and maturity of the design
 - **3D CAD model: 25%**
Complete, clearly structured Assembly Design in CATIA V5 with associated CATDrawings
-
- **Project documentation: 5%**
Roles/responsibilities of team members, Gantt chart, minutes of team meetings, results of research for background information & purchased parts
 - **Concept and final presentations: 2 x 5% = 10 %**

85 %

15%

Common team strengths observed in previous semesters

- High motivation and keenness
- Very good team work and team spirit
- Great creativity potential
- Good feeling for styling
- Good familiarity with 3D CAD
- Good research results
- No reluctance to contact experts in industry
- Excellent presentations
- Good project documentation
- Time management



Challenges



- Identification of critical parts with respect to stress/strain
- Practical knowledge of manufacturing processes
- Materials selection
- Specification of tolerances & surface treatment
- Preparation of manufacturing drawings
- Specification of purchased parts
- Consequent & systematic naming of mechanical parts in the 3D model, drawings & bill of materials...

Content

1 Organisational Aspects of this Module

2 Examples from former teams

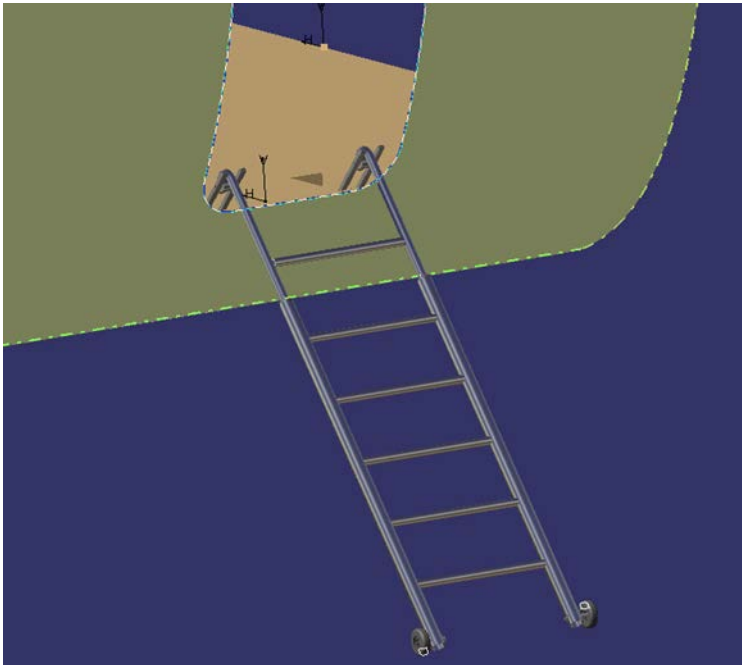
3 Design tasks for SS 2016

4 Initialisation: Your first steps

Boarding/Deboarding aid for A400M

Design solution by Team B:

- Anatoli Schäfer,
- Karl Kieke,
- Alexander Mannov,
- Babak Banaïy



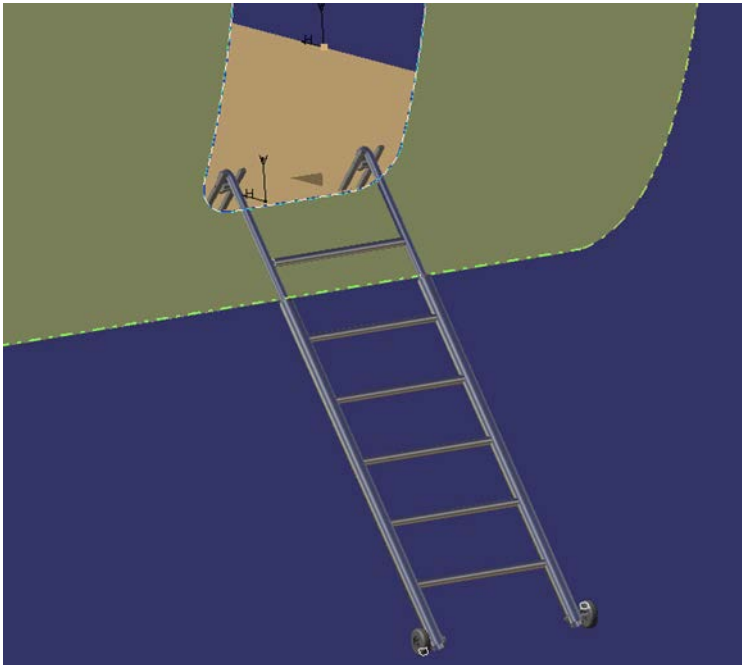
Design features

- Extensible ladder
- Secured with lock bolts
- Simple installation
- Low weight (Aluminium)
- Wheels as ground interface

Boarding/Deboarding aid for A400M

Design solution by Team B:

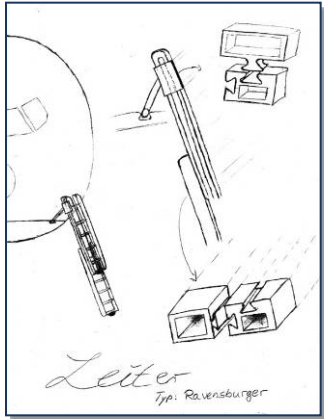
- Anatoli Schäfer,
- Karl Kieke,
- Alexander Mannov,
- Babak Banaïy



Design features

- Extensible ladder
- Secured with lock bolts
- Simple installation
- Low weight (Aluminium)
- Wheels as ground interface

Boarding/Deboarding aid for A400M



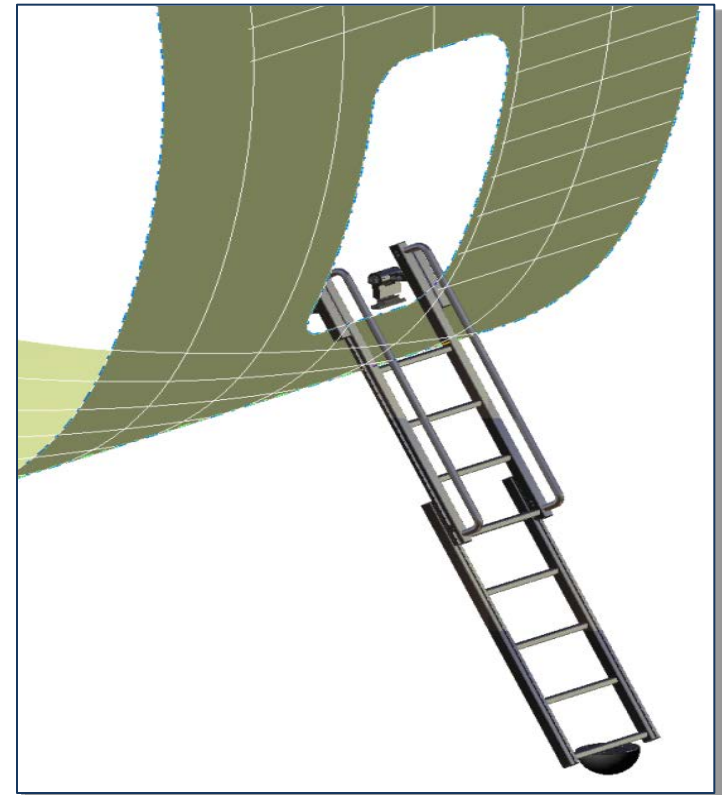
From concept sketches to
a detailed 3D design

Design solution by Team E:

Rieke Bassen, Elena Behrendt, Sebastian Benson, Sebastian Dörr and Friedo Kok

Final design features

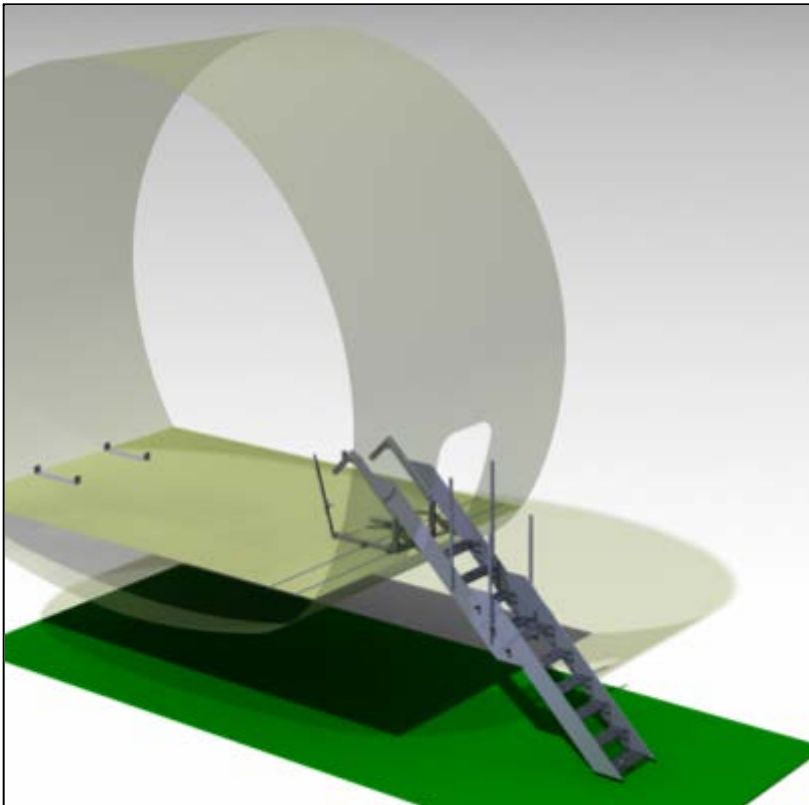
- Two separate ladder segments
- Attaches to seat rail with quick change locks
- Simple mounting & dismounting
- Spherical ground bumper for high stability
- Adjustable to different heights



Boarding/Deboarding aid for A400M

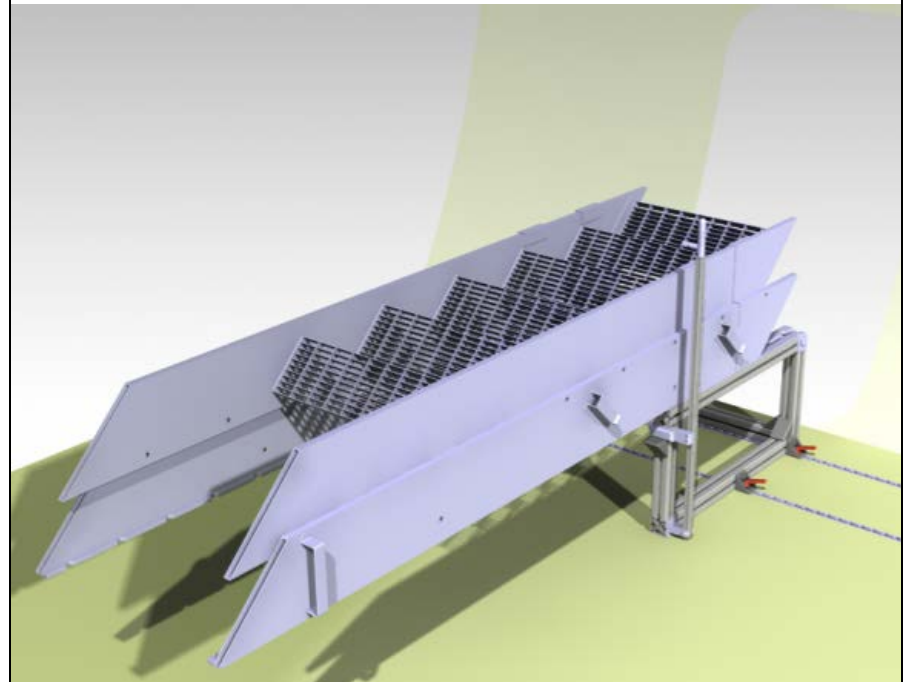
Design solution by Team G:

Moritz Geisberger, Sebastian Dietzsch,
Ruben Hofheinz, Thomas Renz

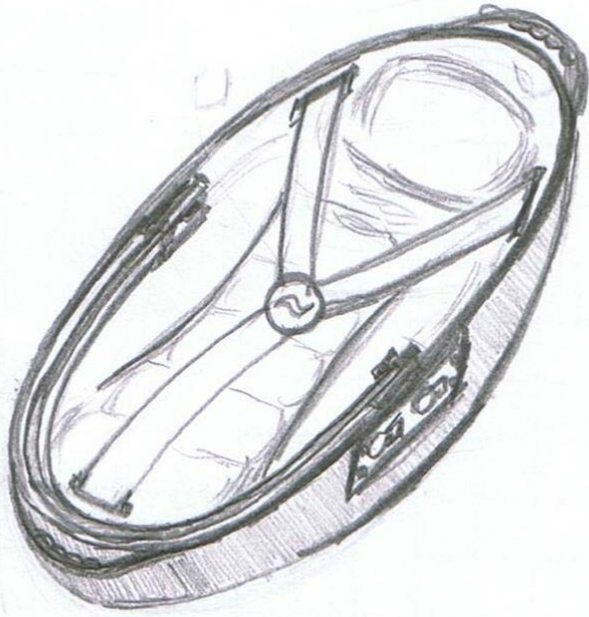


Concept D

Extension ladder „Willi“



Baby Bassinet



Design solution by Team J:
Jan Peper, Konstantin Schurin,
Christoph Reiber, Tim Cegan



Baby Bassinet

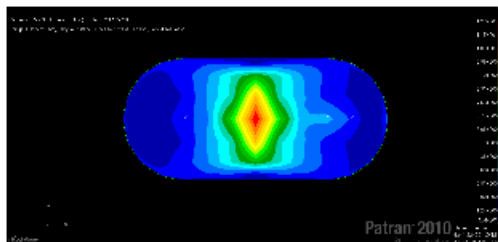
Design solution by Team H:

Martin Funk, Hicham Zridi,
Daniel Marciano, Ramesh Afsali

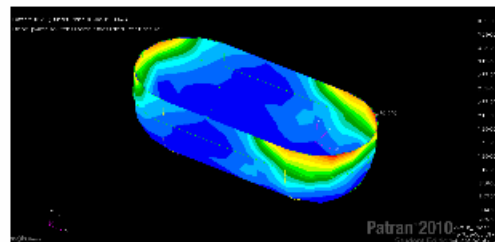


Baby Bassinet

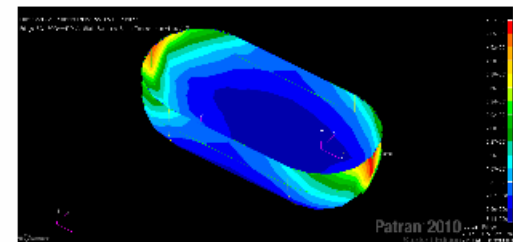
Example of a stress analysis with ANSYS FEM (*Team J*)



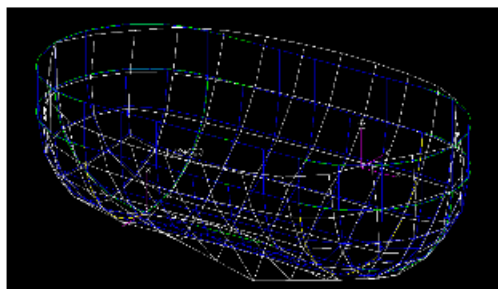
Spannung in der Schale durch nach unten gerichtete Kraft



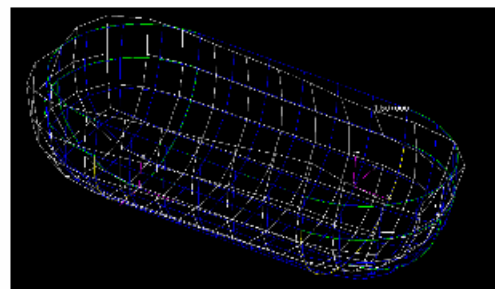
Spannungen in der Schale durch aufwärts gerichtete Kraft



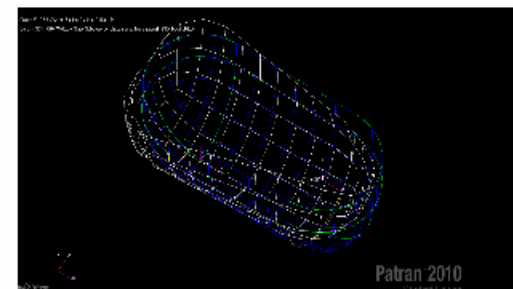
Spannungen in der Schale durch nach vorn gerichtete Kraft



Verformungen in der Schale durch nach unten gerichtete Kraft



Verformungen der Schale durch abwärts gerichtete Kraft

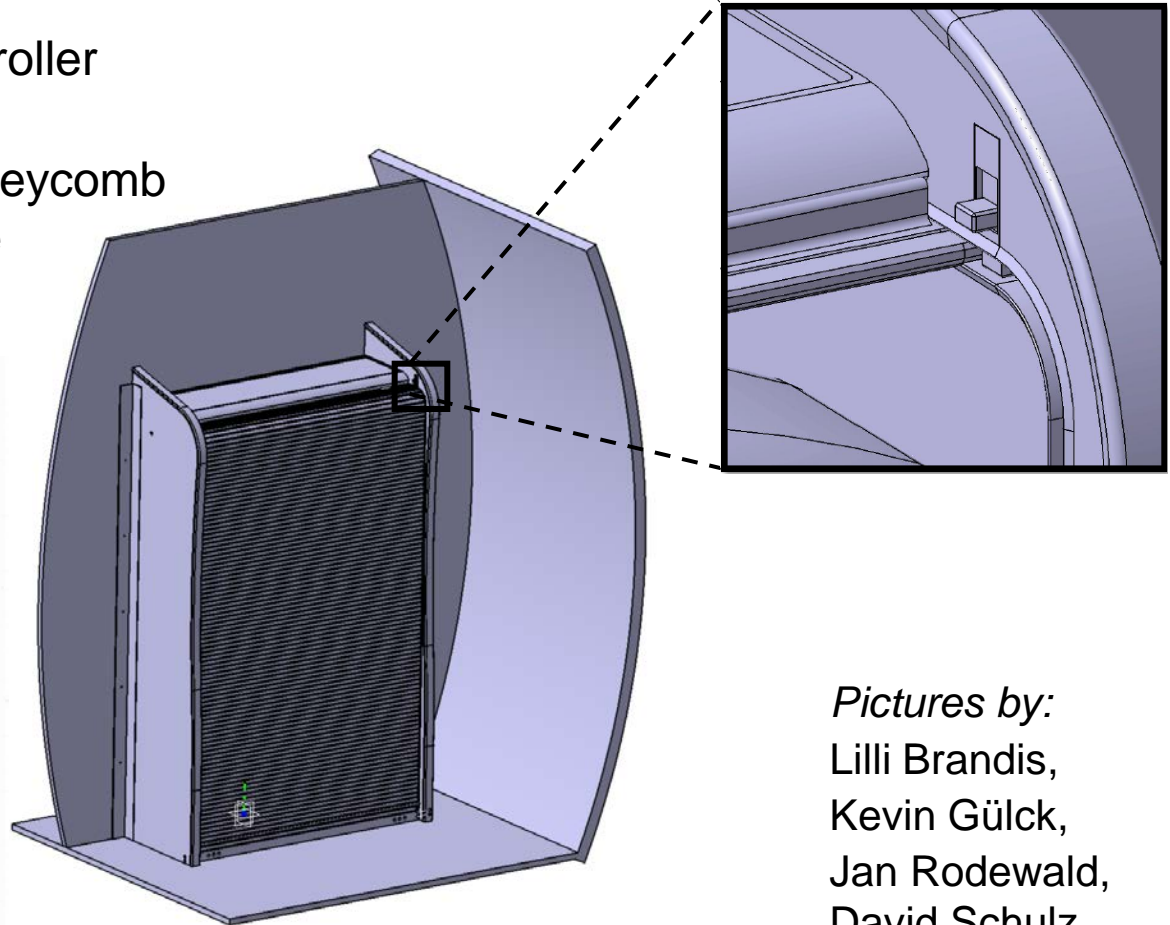


Verformung der Schale durch nach vorn gerichtete Kraft

Jump Seat Housing

Final design

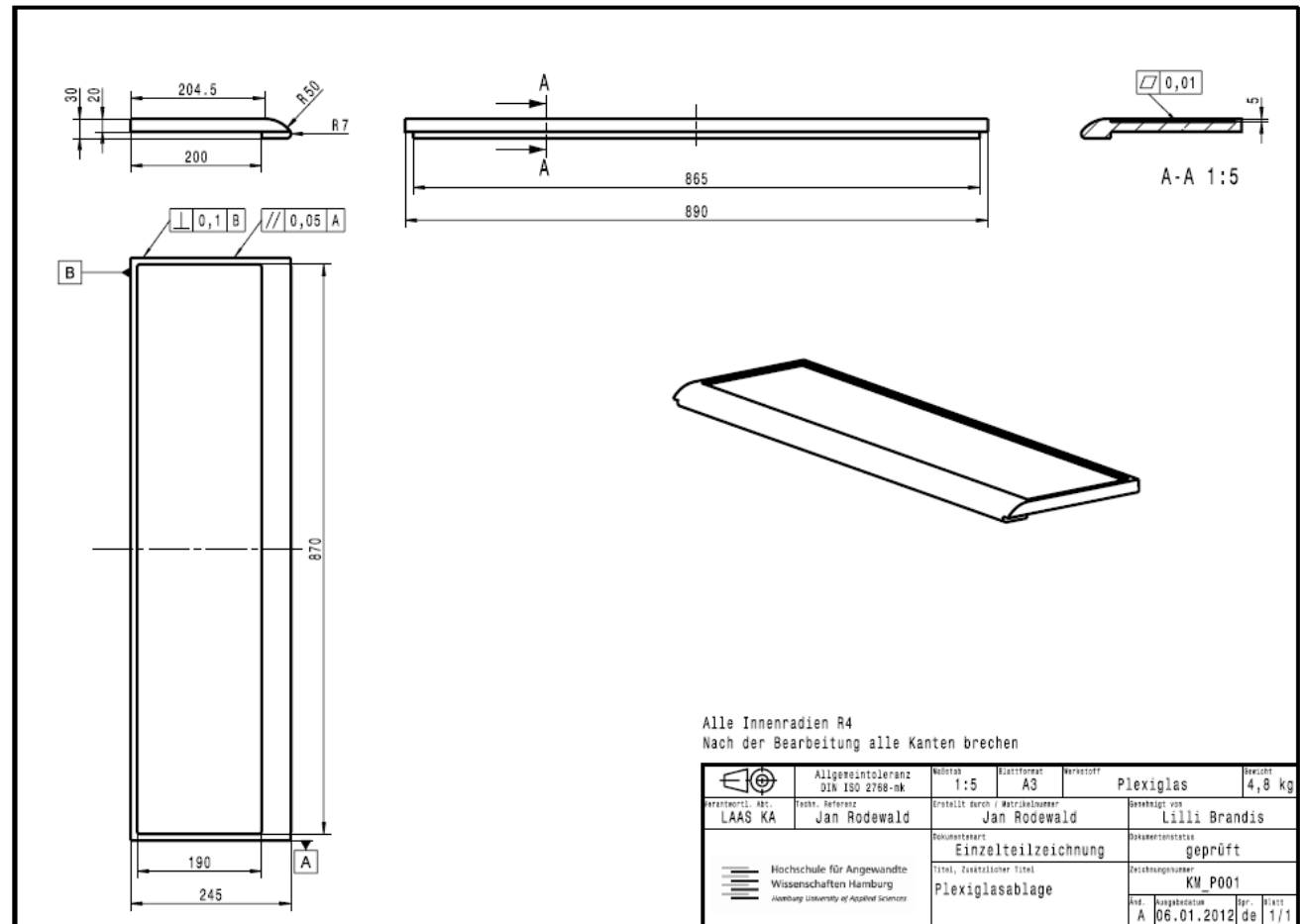
- Front with thermoplastic roller shutter
- Side panels made of honeycomb with stylish curved profile
- Acrylic top shelf



Pictures by:
Lilli Brandis,
Kevin Gülck,
Jan Rodewald,
David Schulz

Jump Seat Housing

Example of a manufacturing drawing



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Design Task # 1: Smart Solution for Passenger Use of Large PED*

Objective: Comfortable on-board use of laptops & notebooks.

*PED = Portable Electronic Device

The design solution shall be integrated into an economy class passenger seat row.

Motivation:

Devices > 1 kg (2 lbs) must be stowed away during critical phases of flight like taxi, take-off & landing.

During catering, large devices are a nuisance because you need space for your meal/drink.

What if you have a seat without access to the overhead stowage, and cannot or do not want to place your laptop on the cabin floor under the seat in front of you?

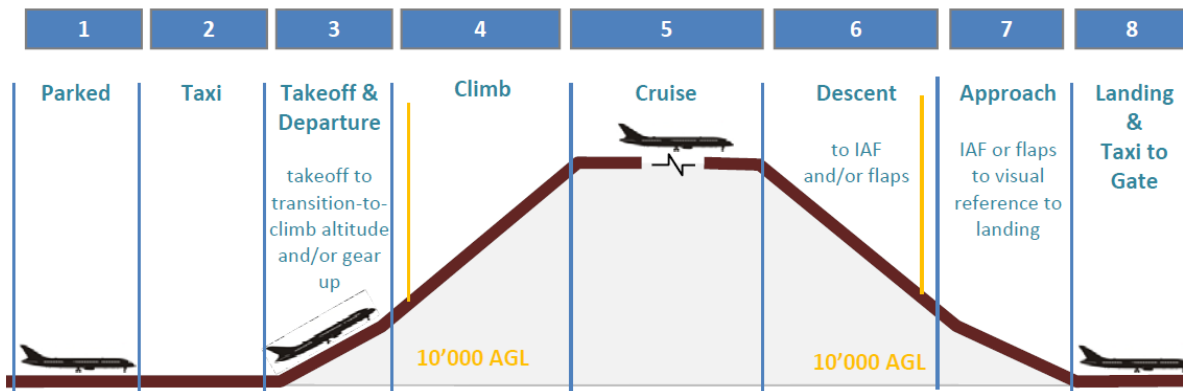


Graphic: <https://www.faa.gov/about/initiatives/ped/infographic/>

Design Task # 1: Smart Solution for Passenger Use of Large PED

Safety requirements for your design solutions

- The design solution must fulfill all safety requirements, and conform to the certification specification for large aircraft CS 25 (in particular CS 25.561, 562 & 853).
- The design must permit the safe stowage of a large portable electronic device like a laptop during „during critical phases of flight and taxiing to prevent possible injuries from projectiles and to allow for egress from the aircraft” [cf. EASA SIB No.: 2013-21].
 - Access to the aisle must not be obstructed by the design solution and the devices/accessories stored in it
 - The design and the items secured by it must not present a hazard in severe turbulence or in case of a crash or emergency landing
 - Emergency evacuation of the cabin must not be impaired/retarded by the design.



Graphic from
https://www.faa.gov/about/initiatives/ped/media/ped_arc_final_report.pdf

Design Task # 1: Smart Solution for Passenger Use of Large PED

Further requirements for your design solutions

- The design must fit in a standard economy seating arrangement (seat pitch: 29“, seat width: 19“).
- Storage space shall be easily accessible for a passenger sitting on an economy seat
- In window seats, it shall be possible to use the PED during all phases of flight, therefore the design shall offer a solution to safely secure the PED while it is in use.
- The design shall not impair the seating comfort of the passenger when not in use.
- The design should not impair the seating comfort of the passenger when in use.
- The design must be easy-to-use and fail safe.
- The design must not present any hazard to any person on board the airplane.
- The design shall be as light-weight as possible.
- The cost of the design shall outweigh the benefit for the passenger.
- There should be a retrofit option to integrate the design into an existing economy cabin.



Foto: Abulawi (AIX-HH, 2015)

Design Task # 1: Smart Solution for Passenger Use of Large PED

Publicly available sources of information used for defining the requirements:

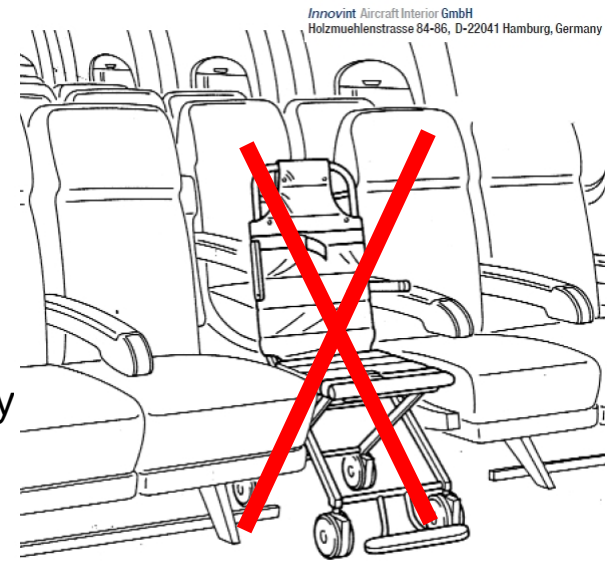
- http://ad.easa.europa.eu/blob/SIB_201321_Use_of_PED_during_Commercial_Aircraft_OPS.pdf/SIB_2013-21_1
- <https://www.faa.gov/about/initiatives/ped/>
in particular: <http://www.faa.gov/documentLibrary/media/Notice/N8900.240.pdf> &
http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/info/all_infos/media/2013/info13010sup.pdf
- <http://travel.stackexchange.com/questions/22630/is-there-a-reason-why-airlines-prevent-laptops-from-being-used-during-takeoffs-a>
- http://www.britishairways.com/cms/global/pdfs/handheld-devices-used-onboard_Dec14.pdf
- http://www.delta.com/content/www/en_US/support/faqs/during-your-trip/personal-electronic-devices.html
- <http://www.seatguru.com/charts/generalcharts.php>

Design Task # 2: New Boarding/Seating Solution for Disabled PAX

Objective: The design solution shall enable a disabled (immobile) passenger to board the aircraft and take/leave a middle seat in the economy cabin without being carried/lifted by another person

Operational Requirements

- The new solution shall replace the current use of on-board wheelchairs, into which a disabled passenger is transferred for boarding and from where an escort lifts the passenger onto the aircraft passenger seat.
- During cruise, the disabled passenger shall be able to use the new design solution for moving to the special accessible lavatory installed in the cabin – without being lifted by a cabin crew member or the escort.
- The passenger seat row used by the disabled person may be mechanically different from other seats, but it must be usable as a standard seat row, offering the same comfort and safety features to normal passengers as other seats.



PNR 2218-series • Transfer to passenger seat requires moveable arm rests

Design Task # 2: New Boarding/Seating Solution for Disabled PAX

Additional Requirements:

- The disabled passenger must not sit in the first row or in an emergency exit row.
- The solution shall be applicable to a middle seat.
- Optionally, the solution shall be applicable to a window seat.
- No seat shall remain empty/unusable as a consequence of the design solution being used by a disabled passenger.
- The disabled passenger is always accompanied by an escort aged over 16, sitting next to him/her.
- The escort assists the disabled passenger during boarding/deboarding and in an emergency evacuation.
- All parts of the design solution shall remain in the cabin during flight.
- Safe stowage solutions shall be conceived for all parts of the design solution which are not in use while the disabled passenger is seated in the cabin.
- The design solution must fulfill the applicable requirements of CS 25.

Design Task # 2: Clever Seating Solution for Disabled Passenger

For your reference: pictures of certified on-board wheelchairs



Design Task # 3: New Stowage for On-Board Luggage in the Cabin

Problem statement:

Passengers often carry more suitcases and personal items on board the aircraft than can be stowed in the overhead compartments and under the seats.

Objective: Provide additional stowage space for carry-on items inside a single-aisle passenger cabin

Requirements:

- The additional stowage space shall not reduce the number of seats in the aircraft.
- If seat row designs are affected by the new solution, passenger comfort must not be reduced/impaired.
- The design solution must be as easy and safe to use as conventional overhead compartments.
- The design solution must conform to the certification specification for large aircraft CS 25 (in particular CS 25.561, 562 & 853).



Design Task # 3: New Stowage for On-Board Luggage in the Cabin

Additional Information:

- The design shall be conceived for an Airbus A320 or A321 (whichever you prefer)
- PDF files with characteristic dimensions of Airbus aircraft are available on: <http://www.airbus.com/support/maintenance-engineering/technical-data/aircraft-characteristics/>
- Existing cabin layouts for passenger aircraft can be found on: www.seatguru.com
- The maximum dimension for cabin baggage items to be stowed is: 55 cm x 35 cm x 20 cm (+/- 1 cm) or 22" x 14" x 8" in overall dimensions, including handles and wheels, as suggested by IATA (<https://www.iata.org/whatwedo/ops-infra/baggage/Documents/iata-cabin-ok-initiative-flyer.pdf>)
- The number of lavatories may not be reduced.
- Note that lavatories may be used for stowing items when passengers are not allowed to use them, i.e. in critical phases of flight = when access to all emergency exits must be unobstructed.
- It is permissible to restrict the access to the design solution and its use of to cabin crew members.

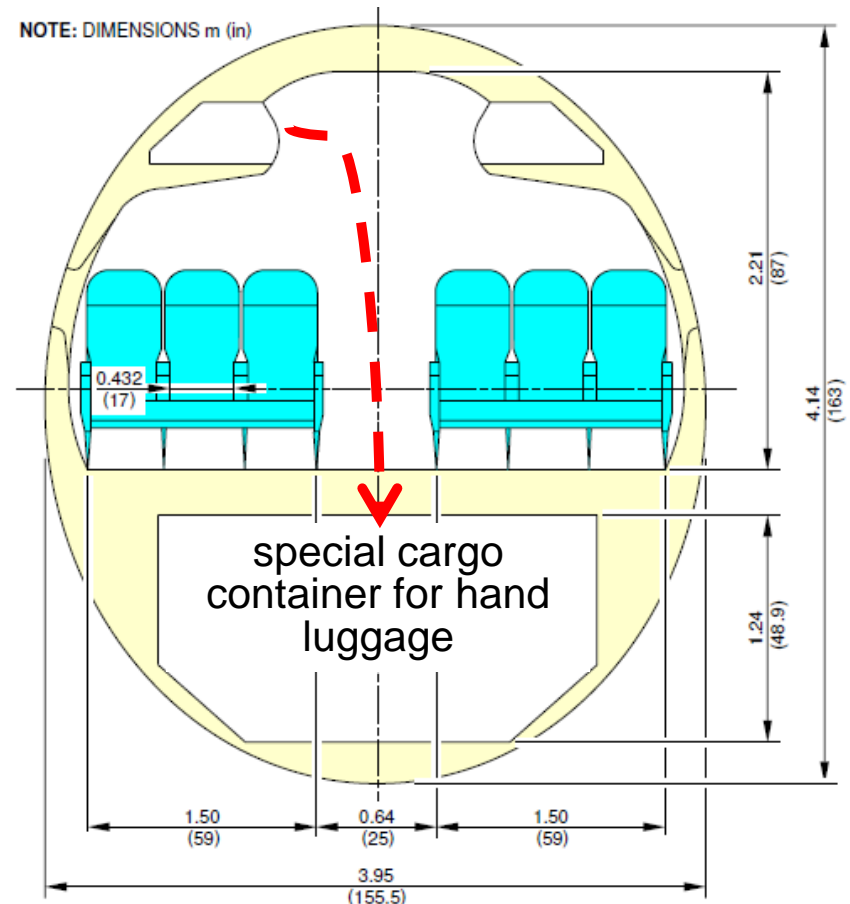
Design Task # 4: Cargo System for Stowing On-Board Suitcases

Objective: Stowage of cabin baggage in the cargo compartment through a special access from within the aircraft cabin

Motivation: Use available space in the cargo compartment for stowing on-board suitcases from within the passenger cabin.
Reduce usage of airport luggage handling infrastructure and ground operations.



Foto: Abulawi (2016)



Graphic from: http://www.airbus.com/fileadmin/media_gallery/files/tech_data/AC/Airbus-AC_A320_01_May_2015.pdf

Design Task # 4: Cargo System for Stowing On-Board Suitcases

Operational requirements:

- The design solution shall be suitable for cabin baggage with the following maximum overall dimensions: length = 56 cm, width 45 cm, and depth = 25 cm.
- A special opening in the cabin floor provides access to the cargo compartment.
- This special opening may only be open when the aircraft is in the parking position, and shall remain safely closed when the aircraft moves. It shall be closed/opened by a cabin crew member.
- Underneath this opening, a special cargo container shall be located in the cargo compartment which stores on-board baggage items.
- The container located in the cargo compartment underneath the opening shall be equipped with a baggage handling system which accepts the baggage items inserted through the opening in the cabin floor and transfers them to a stowage space in the container before taxi/take-off.
- After landing/taxiing to the gate, the baggage handling system shall retrieve all items stowed within the container and transfer the items back to the opening in the cabin door, where they are received by the passengers or cabin crew members.

Design Task # 5: Upper Food Cart Compartment with Lift

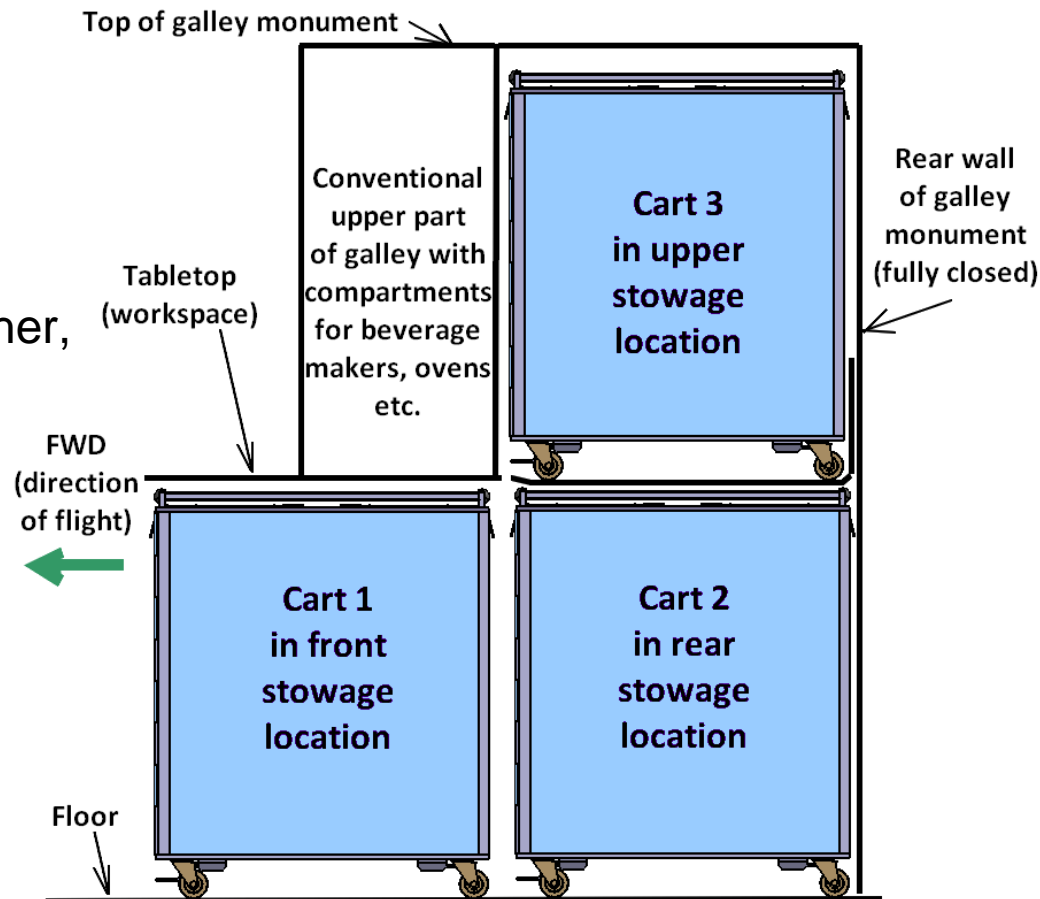
Motivation: Use normally unaccessible space for stowing additional passenger serving carts.

Required design solution:

Serving cart stowage system in the rear of an extra high galley for stowing two carts on top of each other, behind an accessible cart.

Desired operation:

Cart 1 is pulled out first by cabin crew. The system then moves Cart 2 to the front position to make it accessible. After Cart 2 is pulled out, the system lowers Cart 3 and moves it to the front. Carts are stowed in a reverse process.



Design Task # 5: Upper Food Cart Compartment with Lift

Specific requirements:

- The system shall be suitable for stowing three Full-Size ATLAS Trolleys length x width x height = 810 mm x 305 mm x 1030 mm.
- The design solution must be fully safe to operate.
- Only one of the trolleys shall be accessible at a time.
- The other two trolleys are stowed behind the accessible trolley, on top of each other.
- Only the accessible trolley shall be removed/stowed manually by a cabin crew member.
- The system shall automatically stow trolleys in the rear and upper stowage and transfer them back to the front position if that is empty.
- All trolleys must be secured safely in their stowage during taxi, take-off and landing and other critical phases of flight.
- The design solution must conform to the certification specification for large aircraft **CS 25** (in particular CS 25.561, 562 & 853).



Photo: Abulawi (2013)

Design Task # 6: Ergonomic Handling Device for Standard Units

Problem statement:

Standard units are used as containers for aircraft catering supplies. They are usually stowed in the uppermost compartments of a galley.



Photo: www.spiriant.com



Photo: Abulawi (2014)

Usually two units are stowed in a row, one behind the other. Retrieving them from their stowage location and putting them back is extremely unergonomic.

The required lifting efforts and forceful movements can cause painful back disorders.

Design Task # 6: Ergonomic Handling Device for Standard Units

Required design solution:

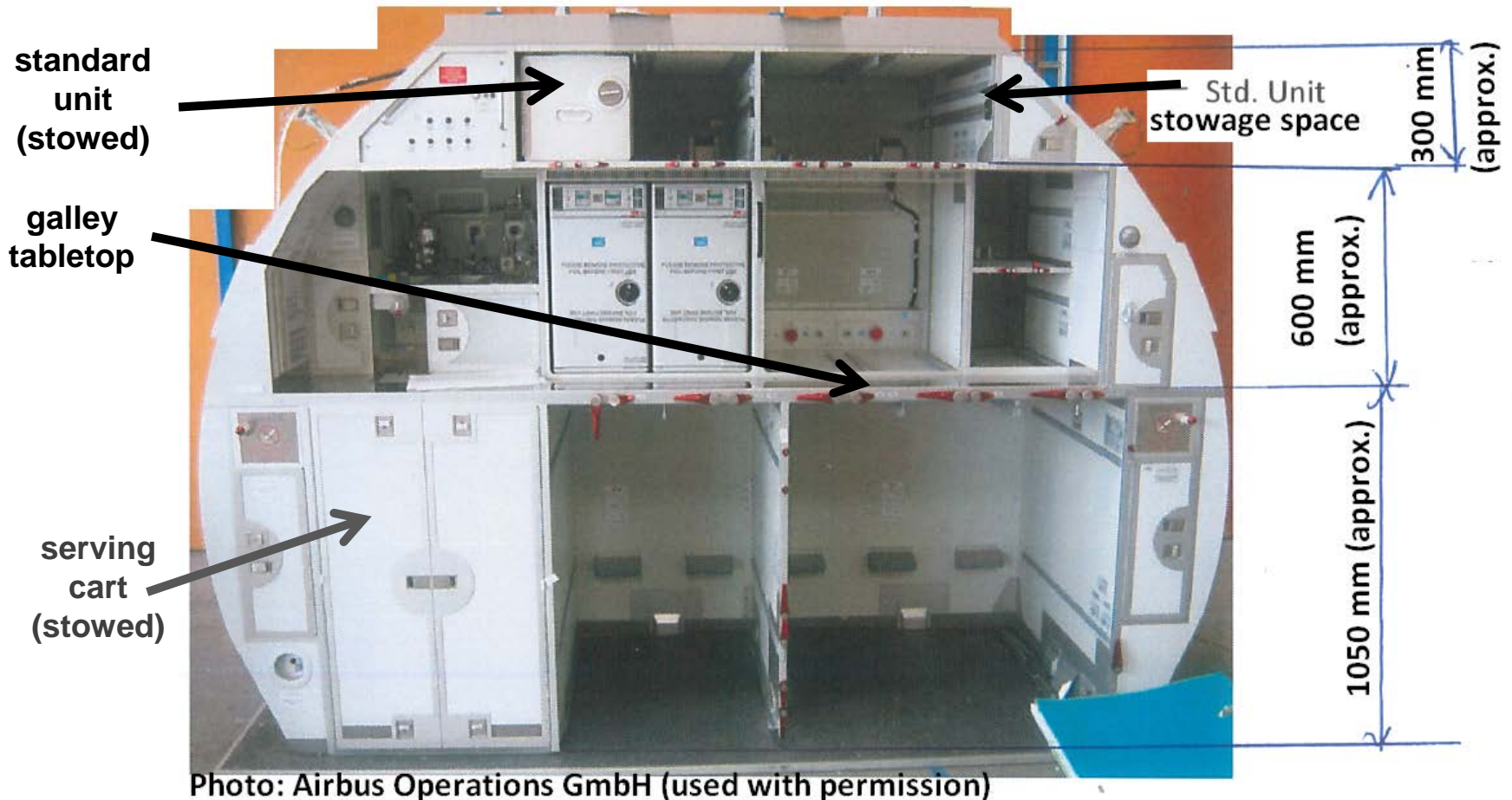
A handling device which assists cabin crew members when they need to access or stow standard units in the top compartments of a galley.

Operational requirements:

- The device shall make it comfortable and ergonomic for a cabin crew member to stow standard units in the top compartment of a galley, and to retrieve them when needed.
- The device shall reduce the effort and avoid forceful movements required for removing a standard unit from the top stowage and lowering it to the galley tabletop or workspace.
- The device shall make it also easy to access a standard units stowed in the rear part of the top galley compartment after the standard unit stowed in the front was removed.
- The device shall make it easy and ergonomic to stow standard units in the top galley compartment, even if the units are full.
- When the design solution is not in use, it must not block or impair access to the tabletop of the galley and the galley units/items installed or stowed in that part of the galley.

Design Task # 6: Ergonomic Handling Device for Standard Units

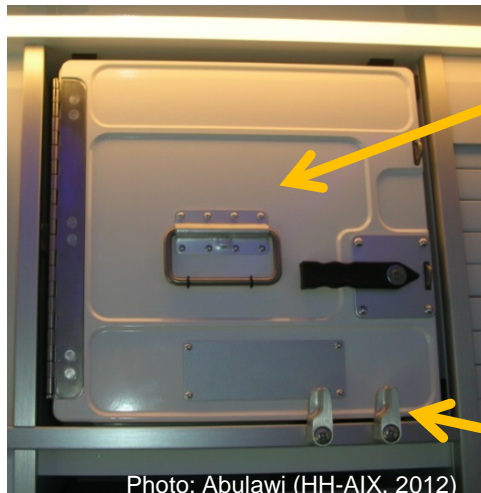
Galley layout and dimensions:



Design Task # 6: Ergonomic Handling Device for Standard Units

Additional requirements:

- Standard Unit dimensions: 413 mm x 292 mm x 280 mm
- Standard Unit weight, empty = 3 kg, full = approx. 10 kg
- The design solution must fulfill all safety requirements, and conform to the certification specification for large aircraft CS 25 (in particular CS 25.561, 562 & 853).



*standard
unit, stowed
in the top
galley
compartment*

*securing
latches*

Photo: Abulawi (HH-AIX, 2012)

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Team exercise: Roles & Responsibilities

1. Get together with all students who are supposed to study the same role.
2. Individual work, making notes:

**Think about your role. What does the role name imply?
For which decisions and deliverables in the design project should the owner of the role assume the overall responsibility? (5 Minutes)**

3. Discuss your notes with the other students in your group. (10 Min.)
4. Agree on the responsibilities of the role and write them on the paper supplied (5 Minutes)
5. Present your group work to the other students and discuss the responsibilities in the plenum

- | | |
|-------------------------|-------------------------------------|
| – Team Leader | – CAD Manager |
| – Requirements Engineer | – Documentation and Quality Manager |
| – Chief Stress Engineer | – Manufacturing Planner |
| – Chief Designer | – Procurement Engineer |

Initialization => Your first tasks

- 1. Study the design tasks**
- 2. Identify your favorite design task**
- 3. Form a team with other students favoring the same task**
ideal team size: 4 students
- 4. In your team, rank the other tasks according to your team preference if there is more than one other team which wants to select your favorite task**
- 5. Assign project roles to each team member**
two roles per team member
- 6. Fill in the team application form and submit it to your lecturer**
every team member must sign the form

Ultimate submission deadline: March 22nd 2016 (8 pm)

7. Agenda items for your first team meeting



- *Agree on regular dates for your team meetings*
 - *Where will your meetings take place?*
 - *Who will write the minutes of the meeting? (Take this job in turns!)*
 - *Agree on communication paths and conventions in your team (Email, WhatsApp, Facebook, Phone, etc.)*
 - *Where will you store your documents/files etc.*
 - *Do you want to use an individual team name?*
 - *What are your goals for the project?*
What do you want to learn?
Which grading do you strive for?
 - *Identify strengths/experiences/special interests of each team member*
- => Document your decisions/agreements in your first meeting minutes!**

Team Building

- **Form a team with other students interested in the same task**
- **Team size = 4 +/- 1**
- **Teams must be international**
=> you must have more than one nationality in your team
- **Max. 2 teams per task**
=> state a 2nd and 3rd choice on your team application form

Conclusion of Previous Teams

The Aeronautical Design
Project consumes time
and requires hard work.

However:

**You can learn a lot
and have fun!**

