Appendix

6

Appendix A: Manual handling factors to measure

Leading indicators

Task design
- Duration
- Frequency
- Load position (height)
- Forced awkward body postures
- Abscene of manual handling tools
- Work patterns

Environment characteristics
- Surface characteristics
  - Insufficient grip
  - Not homogenous (no holes)
  - Levelled
  - Unstable
  - Firmness
- Space constriction
- Climate
  - Humidity
  - High temperature
  - Poor air quality
- Visability
  - Lighting
  - Sight obstruction

Ineffective manual handling training
- Low frequency
- Not personlised
- Bad transfer climate
- No long term implementation

Load characteristics
- Forced heavy loads (not possible to lighten load)
- Forced load asymmetry
- Load size (sight obstruction)
- Balance
- Coupling (Grip)
- Sharp sections
- Hot sections

Safety culture
- High work demands
- Low job control or support (Supervision)
- Lack of reward
- Condition of work place and tools

Individual
- Age
- Experience
- Physical characteristics
- Attitude
- Knowledge
- Lifestyle
- Previous episodes of back-injuries
- Risk assessment capability
- Health and fatigue

Lagging indicators

Torso bending
- Forward
- Side-to-side

Torso twisting

Hand position (relative to lower back)

Unsafe manual handling acts
- Catching falling goods
- Jerking weights
- Voluntarily heavy loads (possible to lighten load)
- Voluntary big load size (sight obstruction)
- Not looking ahead
- Neglecting manual handling tool use
- Voluntary high manual handling task duration or frequency

Appendix B: Aesthetics exploration process

Redbrick style

Sole characteristics

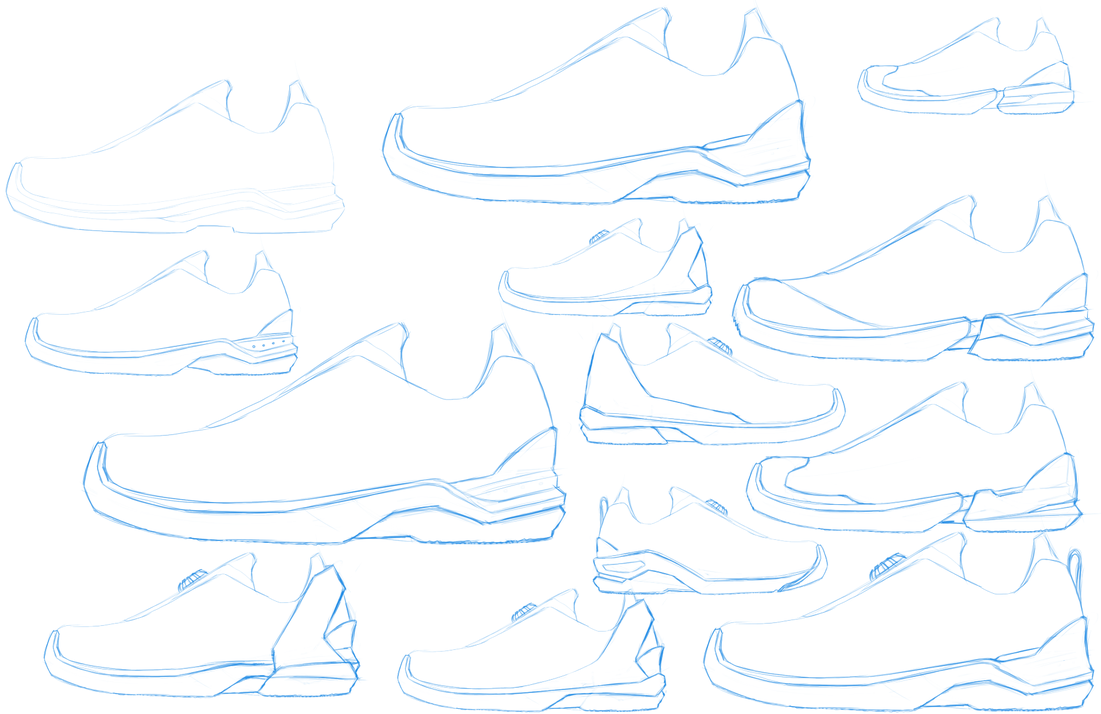
Flat sole (perhaps a slight increased heel)
Small sole profile
Sloping heel

Upper characteristics

Integrate sole and upper design
Explore colour minimalism
Hard plastic heel and toe for protection
Make use of rhythm and rhyme
Try to combine eyelids and upper design
BOA laces
Sloped upper heel
Low profile (low-tops)
Everything in the upper “needs“ to have a function

General style characteristics

Current style is the “everyday sneaker“
Modern and fresh style
Medium price
Logo on the side (red/white or red/black)
Logo on sole
Logo on side of upper
Logo on heel



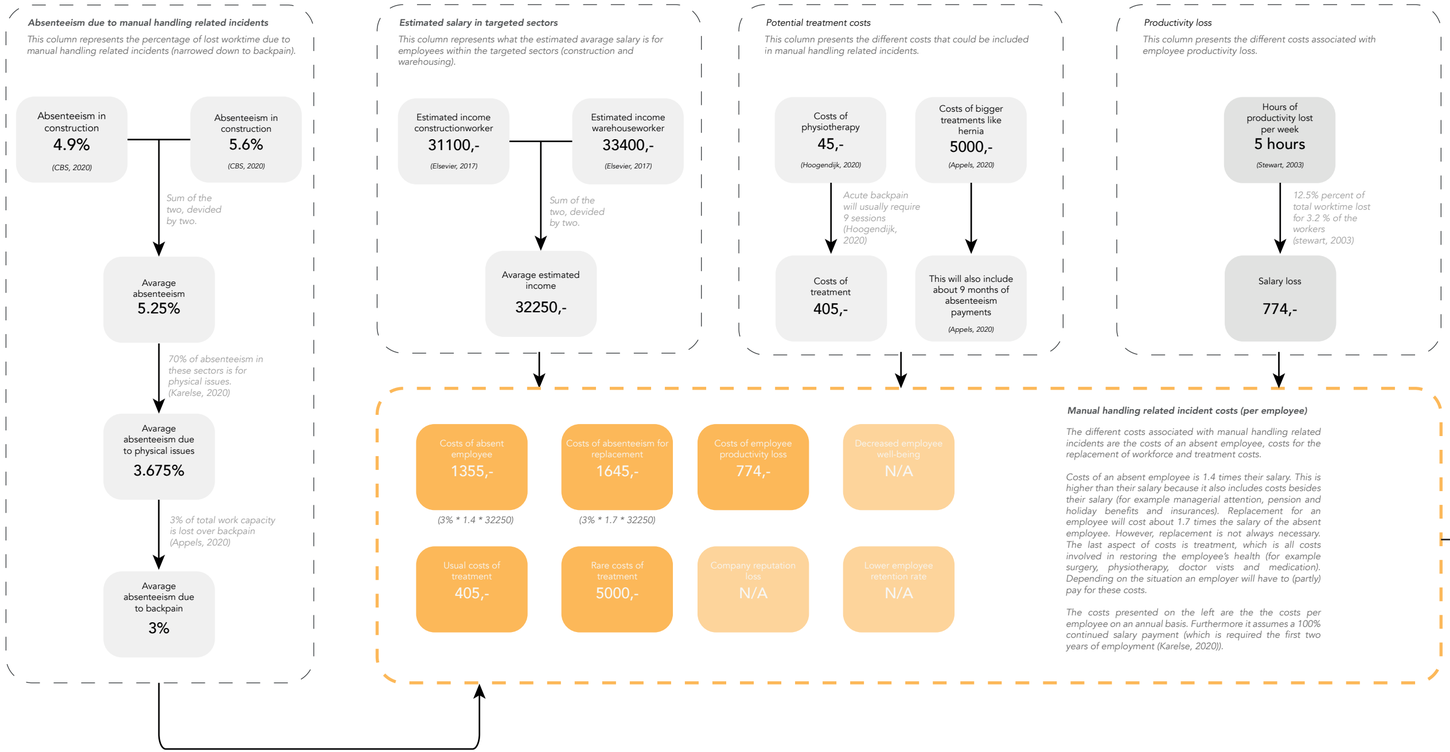
Appendix C: Criteria weights

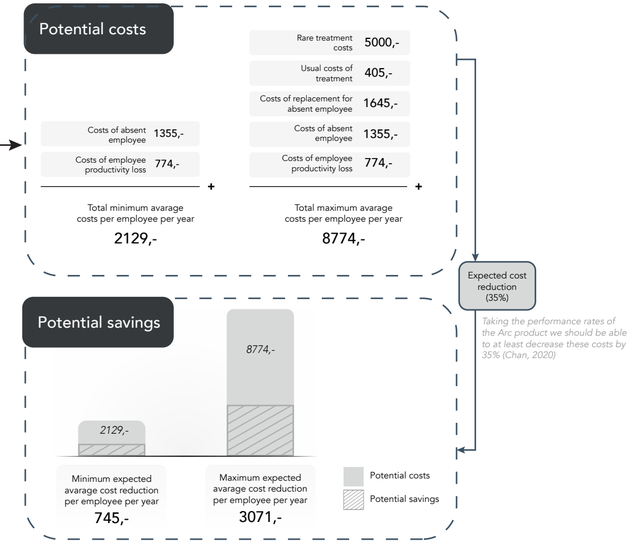
General Criteria	1.0	100 %
Desirability	0.400	40 %
Feasibility	0.300	30%
Viability	0.300	30%

Detailed Criteria	1.0	100 %
Impact on safety	0.250	25 %
Weight	0.100	10 %
Impact on costs	0.075	7.5 %
Sustainability	0.075	7.5 %
Generalizability	0.075	7.5 %
Future proof	0.075	7.5 %
Scalability	0.050	5.0 %
Price	0.050	5.0 %
Reliability	0.050	5.0 %
Multi-value	0.050	5.0 %
Shoe-spotlight	0.050	5.0 %
Influence of culture	0.050	5.0 %
Privacy	0.050	5.0 %

Appendix D: Annual costs associated with manual handling related incidents

Per employee, per year





Appendix E: Desirability survey

Occupational safety: Manual handling

This is a survey on occupational safety and how we can maybe improve on this the coming years. All your answers will be anonymous, this is not meant as a control of your view on safety. Please help us improve your the safety of your working conditions!

20. How often do you experience/suffer from backpain *

	1	2	3	4	5	
Daily	◯	◯	◯	◯	◯	(Almost) never

21. Do you think your work plays a role in the causation of backpain?

- ◯ Yes, work is the biggest factor.
- ◯ Work is part of the cause
- ◯ Work plays no role in this
- ◯ Other:

22. Have you ever received training for manual handling? *

Manual handling means to lift, carry, push and pull weights/loads in the worksite.

- ◯ Never
- ◯ Yes, once.
- ◯ Periodically, at set moments.
- ◯ Other:

23. How much do you apply the gained knowledge from manual handling training into daily practice?

In case you've never had manual handling training, skip this question

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	I consciously apply this knowledge with every handling.

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24. To which of the following elements do you pay attention while performing manual handling?

More answers possible.

- ☐ Technique and posture
- ☐ Surrounding
- ☐ Load risks (weight, steadiness, size and shape, grip quality, etc)
- ☐ None of the above

Other: ☐ _____

25. Do you ever notice other people performing incorrect/unsafe manual handling?

	1	2	3	4	5	
Daily	◯	◯	◯	◯	◯	(Almost) never

26. In case you do see others perform incorrect/unsafe manual handling, how do you respond to this?

_____

_____

_____

_____

_____

27. Do you see value in smart wearables that assist in performing safe manual handling? *

Smart wearables are intelligent technological devices, like smartwatches.

	1	2	3	4	5	
No, absolutely not.	◯	◯	◯	◯	◯	Yes, definitely.

7/12

27. Do you see value in smart wearables that assist in performing safe manual handling? *

Smart wearables are intelligent technological devices, like smartwatches.

	1	2	3	4	5	
No, absolutely not.	◯	◯	◯	◯	◯	Yes, definitely.

28. Can you please explain your choice? *

_____

_____

_____

_____

_____

29. What kind of feedback on manual handling would you think are valuable?

- ☐ Personalized tips and advice on how to improve your manual handling
- ☐ Insights in personal risks
- ☐ Insights in personal incorrect manual handling
- ☐ No feedback at all

Other: ☐ _____

30. How often would you like to receive the above mentioned feedback?

- ◯ Multiple times a day
- ◯ Once a day
- ◯ Once a week
- ◯ Once a month
- ◯ Once a year
- ◯ Other: _____

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31. Would you wear smart shoes that assist you in correct/safe manual handling? *

	1	2	3	4	5	
No, I'd rather not.	◯	◯	◯	◯	◯	Yes, definitely.

32. Can you please explain your choice? *

_____

_____

_____

_____

_____

33. Would you like to receive the above mentioned feedback via your smartphone? *

	1	2	3	4	5	
No, I'd rather not.	◯	◯	◯	◯	◯	Yes, definitely.

34. Can you please explain your choice? *

_____

_____

_____

_____

_____

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35. In case we were to do a test with smart shoes that help you with correct/safe manual handling, would you be prepared to participate? *

- ◯ Yes
- ◯ No, I'd rather not.
- ◯ Other: _____

36. In case you answered "Yes" to the previous question, please leave your e-mail here.

_____

37. Do you have any comments, leave them here!

In case there are things that you still wish to say, but couldn't do so in the previous questions, please do so here. Perhaps you have any other ideas for the smart shoes, perhaps some that aren't safety related. Everything is welcome!

_____

_____

_____

_____

_____

38. Please select your age range

- ◯ 15 and under
- ◯ 16-30
- ◯ 31-40
- ◯ 41-50
- ◯ 51 and above

39. Job title

_____

Thank you for your participation!

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Appendix F: Original project brief

SMART SAFETY SHOE

Our story
The Netherlands excels at logistics, construction and transport and these industries are growing fast! A huge number of people work in these sectors and working in warehouses, on construction sites and/or with heavy equipment involves risks. Since safety is crucial, we are investigating ways to minimise the risk and consequences of injury. Safety shoes are required in many workplaces and 1.5 million pairs of safety shoes are sold in the Netherlands each year, with Allshoes Benelux BV as market leader. Our company owes its success to our courageous decision to introduce revolutionary safety footwear that reflects the latest fashion and sports trends into a conventional market.

Our aim
Despite many measures to prevent accidents at work, 60 people are killed and 2,300 seriously injured every year. Safety shoes only protect the feet and only provide protection when an incident occurs. In other words, safety shoes currently play a static role. Allshoes Benelux BV wants to change this. We want safety footwear to make the transition from offering static protection to providing proactive protection. And we want to research how to do this with TU Delft. Our goal? To create a 'smart' safety shoe that detects and alerts the wearer to danger in high-risk situations.

Your task? Develop a Smart Safety Shoe
On behalf of Allshoes Benelux BV, we challenge you to develop a smart safety shoe that will increase safety at work. We imagine this will involve the use of sensors. Maybe to alert the wearer to potential hazards, such as a dangerous edge when working at height, or to navigate safely past traffic, or to detect tiredness and calculate breaks based on personal algorithms and walking routes. Of course, you may have other ideas! If you accept our challenge, there's one thing you need to bear in mind: the safety shoe must meet circular economy requirements.

Who are we looking for?
Do you want to create innovations that will drive change and maybe even save lives? Then you are the person we're looking for!
You are inquisitive, have the drive to achieve real innovation in our market segment and are able to develop an idea into a tangible prototype using applied market-oriented solutions. You do not hesitate to ask for information or assistance: during the project our colleagues will be there to offer helpful insights and advice.

What do we offer?
We offer a great workplace at the heart of safety-shoe land at our office in Amsterdam. You will have access to a large network of manufacturers and a budget to develop your idea into a prototype with the aim of marketing it!
Our organisation is informal, we have short lines of communication and celebrate success as a collective achievement. You will receive an graduation allowance and your travel expenses will be reimbursed.

Will you be the one to develop the Smart Safety Shoe?
If you're interested, please contact Jan.Arts@allshoes.eu

Allshoes Benelux

Graduation Opportunity

Develop the Smart Safety Shoe of the Future!

Part 2

Our story

The Netherlands excels at logistics, construction and transport. These industries are growing fast! A huge number of people work in these sectors. Working in warehouses, on constructions sites or with heavy equipment involves risks. Safety shoes are required in many workplaces and 1.5 million pairs of safety shoes are sold in The Netherlands each year, with Allshoes Safety Footwear as market leader. With own brands such as Redbrick and Mr. Miles and exclusive distribution rights for Grisport and Vismo, our company owes its success to our courageous decision to introduce revolutionary safety footwear that reflects the latest fashion and sports trends into a conventional market.

Our aim

Despite many measures to prevent accidents at work, 60 people are killed and 2,300 seriously injured every year. Safety shoes only protect the feet and only provide protection when an incident occurs. In other words, safety shoes currently play a static role. To help prevent manual handling injuries, such as back problems, we want to contribute in proactive incident prevention. Our goal? To create a "smart" safety shoe that detects and alerts the wearer to danger in high-risk situations. In cooperation with TU Delft and a SPD graduation student, research was conducted regarding this topic. A strategic concept has already been developed in which a smart safety shoe measures the leading and lagging indicators with regard to manual handling. This shoe can then give feedback by sending the measured data to relevant parties in order to eliminate the causes of manual handling incidents. It was strongly suggested that machine learning and/or AI offer predictive capabilities with strong potential, but concrete deployment of these technologies needs further elaboration.

Your task? Make the concept of "smart shoe" concrete.

On behalf of Allshoes Safety Footwear, we challenge you to further develop the smart safety shoe that will reduce the number of injuries caused by manual handling. It is your task to follow up on the current strategic concept; build tangible prototypes, test them and finally end up with an innovative smart safety shoe with the aim of bringing it to the market. You will continue to develop the current idea including the technology behind it.

Who are we looking for?

Are you the one who wants to bring the smart safety shoe to life and who wants to drive change with us? Then you are the person we are looking for! We are looking for an IPD graduation student who is able to develop an idea into a tangible prototype. You are willing to explore the potential of machine learning, AI, IoT and related cutting-edge technologies, and meaningfully incorporate these into your design. You do not hesitate to ask for information or assistance: during the project our colleagues will be there to offer helpful insights and advice.

What do we offer?

You can make use of a great workplace at the heart of safety-shoe land in our brand-new office in Amsterdam. However, it is also possible to work remotely. You will have access to our large network of manufacturers to gain all the information needed. There will be a budget available for you to develop your idea into a prototype. Our organization is informal and we have short lines of communication. You will receive an internship allowance and your travel expenses will be reimbursed.

Will you be the one to develop the Smart Safety Shoe?

If you're interested, please contact Jan.Arts@allshoes.eu
Wilfred van der Vegte from the Knowledge & Intelligence Design section is the envisaged chair for this graduation project. He can offer support on machine learning and related technologies. He also chaired the foregoing SPD assignment and is available for additional info: w.f.vandervegte@tudelft.nl

Allshoes
safety footwear