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BETTER CYCLES

An analysis of the needs and requirements of older cyclists

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Better cycles

An analysis of the needs and requirements of older cyclists

by

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Author´s foreword

The project in this report is one of the needs analyses financed by VINNOVA to obtain data as to what should be included in the investment, planned to start in 2008, in the living environment of older people. VINNOVA's investment will consist of needs-driven research aimed at developing products and services which facilitate day-to-day life for older people.

In an initial stage, needs analyses will be conducted to gain qualitative and quantitative information on the needs of older people. These analyses will then form the basis of an "innovation work concentrating especially on user-driven innovations contributed to and influenced by older people themselves. Future investments will address the various challenges and opportunities for innovations which satisfy the needs of older people and which can also provide market advantages to Swedish industry."

This project is thus one of the needs analyses of the initial stage.

The Swedish Association for Senior Citizens, SPF, was the responsible organisation and I was project manager. A large number of people have contributed to the project. I would like to extend particular thanks to everyone who took part:

Leif Lundgren, for recruiting of members from the Swedish Association for the Promotion of Cycling to group discussions and for his contribution otherwise. Naturally, my thanks include all those, too many to mention, whose experiences made the group discussions so rewarding.

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Stockholm in October 2007

Krister Spolander
Spolander Consulting

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Summary

The purpose of the project has been to analyse the *need* for more comfortable and safer cycles for elderly people, the *possibilities* of achieving this, plus *how to initiate* such a development and the role of research in this context.

Background to this is the increased interest in the cycle as a mode of local conveyance in urban areas, a European trend which more recently has reached Sweden. A prerequisite for increased cycle traffic is a better cycle infrastructure but also better cycles.

The basic design of the cycle is over 100 years old. Its development has been *greatly inhibited* by tight international rules (for competition bikes) which have set the frame geometry of all cycles in stone.

Three different activities were conducted to highlight the need for better cycles for older people: *group discussions* with elderly cyclists, *test-riding* with a new type of cycle with displaced frame geometry and an *expert seminar* with participants from the cycle industry, design and ergonomics, research and public institutions.

From the point of view of elderly people, it is quite clear that today's cycles are marred by many shortcomings. The group discussions highlighted obvious comfort and manoeuvrability problems. The frequent starting and stopping in urban traffic is awkward, the riding position which stresses hands, arms and buttocks is uncomfortable and the high step-through means that, with age, it is difficult to climb onto the cycle.

The safety analysis showed a remarkably strong age effect, involving a considerably greater relative risk of serious injury for elderly cyclists than for elderly people walking and motorists; two to three times greater.

Furthermore, the step-through emerged as a major injury problem. Just over one quarter of all medical care days required by injured elderly cyclists relate to mounting and dismounting.

There seems to be a lowest common denominator for both comfort and safety problems: *seat height, riding position and step-through height.*

A high riding position has at least two negative safety effects - fall height and exposure of the head in a fall.

If the seat position can be lowered, the fall height is reduced. A more reclined riding position with the feet first reduces exposure of the head.

Comfort and manoeuvrability also improve with a lower seat position, as indicated by test-riding this type of cycle. The test cyclists reported that stopping/starting was much simpler. They simply remained seated and put their feet down. Manoeuvrability was better, especially at low speed. The upright riding position was found to be more comfortable with less stress on hands and arms than with a conventional cycle.

Weight was another problem which was criticised. Generally, cycles are too heavy for comfortable handling; they get heavier the older a person gets.

Technically and in terms of design, there are great opportunities to develop more comfortable, safer cycles. A long list of ideas in that direction was discussed in the expert seminar and group discussions. There were the issues of seat height, riding position and step-through to deal with, but also many components to improve functionally and ergonomically. The requirements appear consistent regarding design - a design which provides better comfort but also better safety.

The conditions for successful development work do exist in Sweden. However, it is crucial to have a partnership between the cycle industry, technical research, design and ergonomics and safety authorities. This can take place within the framework of a research and development programme.

Finally, the concept of “bikes for the elderly” is doubtless unworkable for marketing; just as unworkable as the concept of “cars for the elderly”. This is a case of launching designs for people who want more comfortable, safer cycles and such people exist at all ages.

1 Background and Purpose

1.1 The new traffic policy role of the cycle

After an absence of several decades, the cycle has begun to re-enter the context of traffic policy, initially in a number of cities where there is growing realisation that ever-increasing car traffic in densely packed urban areas is irreconcilable with the inhabitants' wish for urban quality and good environment.[1]

This has been taken up on a national level with traffic policy objectives. In its infrastructure policy resolution of 2002, the Swedish parliament stated that cycle traffic should increase not just absolutely but as a *proportion* of travelling.[2] Under the concept of sustainability, it stated amongst other things that there "should be work on measures to influence demand for transport in the direction of sustainable travel, i.e. travel which is more efficient, more environmentally sound and safer than the individual journey by car". There were various measures to "reduce individual travel by car to the benefit of more environmentally sound methods of transport such as walking, cycling and public transport".

This objective remains in the latest government transport policy bill, *Modern transportation*, in which the government says that "the proportion of the number of journeys by cycle traffic should increase, particularly in urban areas" with the justification that "an increase in safe cycle traffic, particularly in urban areas, is important in order to increase accessibility. It also has advantages from an environmental and public health point of view."[3]

In the parliamentary discussion, this ambition was reinforced in an interesting way. "A unanimous Committee would emphasise that the cycle has a natural place in sustainable travel. The cycling issue should therefore not be regarded, as traditionally, only as a matter of traffic safety but also *a phenomenon of significant import to transport policy*" (italics mine). In the view of the Committee, cycling should be promoted by a combination of

[1] City planning instead of traffic planning and building planning, The National Board of Housing, Building and Planning, Karlskrona 2002.
2 Govt bill. 2001/02:20; Infrastructure for a long-term sustainable transport system, and the Committee on Transport and Communications 2001/02:TU2; Infrastructure for a long-term sustainable transport system.
[3] Govt bill. 2005/06:160.

various controls and measures. This means such things as infrastructure measures, traffic regulations, information and campaigns.[4]

The interesting thing about the parliamentary declaration is the shift in perspective from the cycle as the problem to the cycle as an essential mode of transport. This is the first time this has been done in such an authoritative context.

It is as a *local mode of conveyance in urban areas* where the cycle has its role, either as principal mode of conveyance or in combination with buses, trains or other public transport. This is not a particularly Swedish idea. Quite the opposite; we are following the European development. Within the EU, there is great awareness of the drawbacks of city traffic and a striving for *more* public transport, cycling and walking and *less* car traffic in cities.[5]

Environmental benefit is in proportion to how many car journeys the cycle replaces. An amazingly large proportion of urban residents' car journeys are shorter than 3 km. In Sweden, that is 35%.[6] It should be possible for the cycle to take on half of these short car journeys.[7]

1.2 Weak technical development

Naturally, an important prerequisite for increased cycling is a better cycling infrastructure making it more accessible, safer and more attractive.

However, *better cycles* are also important in order to increase cycling. Not a great deal has happened regarding comfort and safety. The cycle has retained its fundamental geometry since the end of the 19th Century. The riding position is the same, with the stress on the arms, hands and buttocks. Safety has not improved noticeably; the fall height is high and the head is exposed in collisions and falls.

Compare this with the development of the car. Car and cycle were born at around the same time, but the car has developed enormously. Its safety has improved greatly, as has its comfort. Operation and maintenance have become simpler. The pace of technological development has increased in

[4] Committee on Transport and Communications 2005/06 TU5 (Modern transportation).
[5] Green book. Towards a new culture of mobility in cities. European Commission, KOM(2007) 551, Brussels 25/9/07.
[6] Bjurström J. Travelling habits in Swedish cities: A GIS method for analysis of the national travelling habit studies from a free selection of areas, Tema Stad & Trafik, Chalmers University of Technology, Göteborg 2002.
[7] According to the assessment in Traffic for an Attractive City, TRAST. Handbook. The National Board of Housing, Building and Planning, the Swedish Association of Local Authorities and Regions, Swedish Road Administration and Swedish Rail Administration, 1st edition, 2004.

the last 30 years as a result of social and market-generated demand and the new opportunities opened up by IT. But then, the car was also the leading object of the last century, a position it still holds.

The cycle could learn a great deal from the car.

Firstly, there should be considerable room for development. Unlike the car, the cycle has *been inhibited by tight international rules* laid down in 1934. These rules applied to competition bikes, but ended up setting the frame geometry in stone for all cycles; only in recent times did a certain emancipation start to become discernible (see Frederik Van De Walle's contribution to the expert seminar, Appendix 3:11). Consequently, the riding position has been stuck within narrow margins, to the detriment of comfort and safety.

Secondly, it is important to bring the bicycle back as an interesting and exciting technical object. This is important in competition with other modes of conveyance and cannot happen without research and development; an obvious lesson from the car.

1.3 Older cyclists

The disadvantages of current cycle design become particularly clear when examined from the point of view of older cyclists. The most obvious thing is the lack of *safety*. Of the cyclists killed in traffic accidents, over 40% are 65 years of age or older.[8] This is not at all in reasonable proportion to their share of the cycle traffic but can probably be explained by fall height and head exposure combined with the susceptibility of elderly people to the physical trauma arising in cycle accidents.

Also from the *comfort standpoint*, riding position and riding stability are harder for elderly people. General age-related changes include diminished suppleness and muscle strength, longer reaction times and less reliable balance (major individual variations). This makes it harder to manoeuvre and balance a conventional bike; and less comfortable. Age-related changes will probably diminish tolerance for the cycle's lack of ergonomics and comfort.

All this goes to limit older people's use of the cycle and means they stop cycling unnecessarily early; this is also negative from a medical standpoint. As stated in Peter Lamming's seminar contribution, it is not just the environment but also people who are harmed by our passive transport

[8] In the years 2000-2006, 258 cyclists were killed in road traffic, of which 42% were 65+ (official statistics, SIKA [the Swedish Institute for Transport and Communications Analysis], www.sika-institute.se).

systems (Appendix 3:2). Half the population is insufficiently physically active and this is proportionally greater amongst elderly people with a passive lifestyle.[9] The cycle can play an important role here.

1.4 Purpose

The purpose of the project has been to analyse the following issues:

- *Need*. Is there a need for better cycles? What do active older cyclists think themselves? What are the problems from a comfort and safety point of view? What significance might better cycles have in healthy activities for elderly people?
- *Opportunities*. Can better cycles be made? Can problems be overcome using various technical solutions and design?
- *How do we initiate such technical development*? What role can research play? How do we bring about a partnership between industry, research and public interests?

[9] The importance of recreating the conditions for everyday physical exercise in the design of our cities and landscapes has been noticed in recent years, see the knowledge survey which the Swedish National Institute of Public Health ordered for the government commission "Built Environment and Physical Activity" (Faskunger J., The influence of built environment on physical activity, Swedish National Institute of Public Health, report 2007:3).
It relates to planning so that people can walk and cycle instead of taking motorised transport.

2 Organisation and implementation

2.1 Three activities

Three activities were conducted in order to obtain data for the analysis: (1) group discussions with active older cyclists, (2) test-riding a new design, and (3) an expert seminar.

2.1.1 The group discussions

The purpose of the group discussions was to examine the problems of current cycles identified by elderly cyclists themselves and the need for improvements in various regards, with the emphasis on manoeuvring and handling of the cycle.

The discussions were held on three occasions during October 2007. Two of the groups were from the Swedish Association for the Promotion of Cycling, all regular cyclists. With one exception, they were 60+.

The third group consisted of regular long-distance cyclists aged 63-70. The majority have been making annual long trips for a couple of decades.

In total, 40% were women and the rest men.

The discussions touched upon three aspects: (1) *manoeuvring* (starting and obtaining steering speed, manoeuvring at lower and higher speeds, braking, changing gear etc.), (2) *handling* the cycle (taking it in a lift, up and down stairs, parking and locking it etc.), and (3) *management* of baggage, cycle helmet, servicing and maintenance.

The results in detail are reported in **Appendix 1**.

2.1.2 The test-ride

In the light of the group discussions, test-riding was conducted on a small scale with a type of cycle which uses displaced frame geometry to obtain a lower seat height and a more upright sitting position. The hypothesis was that it would facilitate manoeuvring - particularly stopping/starting - and reduce stress on hands and arms; some of the problems with conventional cycles which emerged in the group discussions.

The test was conducted with a Rans Fusion, an American cycle launched in 2004 under the Crank Forward (modified crank) concept. The test run took place in Malmö during October 2007. Two cyclists participated; a man and woman, both 65 years of age.

The results in detail appear in **Appendix 2.**

2.2 The expert seminar

The seminar took place in October 2007 with participants from the cycle industry, design and ergonomics, research and public bodies; 13 people in all.

The participants each gave a prepared 10-minute talk. These were documented on some sheets which were sent out in advance. The talks were given in series of about four, after which there was a lengthier discussion. The next series was then run, with subsequent discussion.

The seminar tackled the three themes: (1) the need for cycles for older people (in the light of the current offering), (2) opportunities to improve the cycle in terms of technology and design, and (3) prospects for commencing a development process.

Appendix 3:1-12 reproduces the written contributions to the seminar.

3 Results

The analysis is arranged as follows: Starting with comfort, manoeuvring and handling based on the group discussions and test-riding.

The safety problems are then addressed, based on data presented at the expert seminar.

The opportunities for making better cycles are then considered based on what emerged in the expert seminar. The whole thing concludes with some general points of view on the role of research in increasing the tempo of development.

3.1 Comfort and manoeuvring problems

3.1.1 Step-through too high

It must be simpler to get onto and off the cycle, according to a largely unanimous view in the group discussions. This becomes more important the older a person gets. It is a bigger problem with so-called gents' and unisex cycles than in cycles with a deep U-frame. The discussion participants questioned the division into ladies and gents and wanted to see gender-neutral cycles with frame geometry and design determined by field of application rather than the gender of the cyclist.

A surprisingly large proportion of injury costs were associated with the step-through; see the section on safety problems below (3.2.3).

3.1.2 High saddle position and uncomfortable riding position

On a conventional cycle, the saddle is positioned high; not infrequently, higher than the handlebars. This gives a more or less forward-leaning riding position which is advantageous in regard to air resistance.

However, in the experiences of the discussion participants, it is not particularly comfortable. The riding position stresses the hands, arms, neck and shoulders plus the buttocks; and the discomfort increases as the cycle ride gets longer.

Furthermore, the discussion participants indicated that it impedes stopping/starting, a frequent action in urban traffic (such as at crossings and traffic lights). This means getting off the cycle at a stop or leaning it over to support oneself on one leg and then starting off again as normal.

All this would be more comfortable if it were possible to *stay seated* in the saddle with both feet on the ground when stopped. As the discussion participants see it, starting and stopping would then be simpler.

The saddle itself proved a persistent concern. Many discussion participants reported difficulties in finding a comfortable saddle. Some had tried many saddles before finding one which worked tolerably. Saddles are about riding position and anatomy. A narrower saddle is more comfortable for a forward-leaning riding position, whereas a broader one is preferable for an upright riding position. Anatomical differences between individuals are significant in regard to whether one or the other saddle is comfortable. Men and women have different preferences. Therefore, the selection should be larger.

3.1.3 Increased comfort and manoeuvrability with a lower riding position

To gain an impression of the importance of riding position, a practical small-scale test was carried out with a new type of cycle with altered frame geometry; a forward crank diagonally between saddle and handlebars. The saddle can thus be lowered sufficiently for the cyclist to sit with both feet on the ground. The modified crank means that the cyclist can still pedal with sufficiently straight legs. Furthermore, the riding position is more upright with less stress on hands and arms.

The test indicates that comfort and manoeuvrability thereby increase significantly. The test cyclist reported that it was much more comfortable to stop/start than on a normal cycle. At a red light or stop, all they had to do was brake, remain seated and put down one or both feet. Manoeuvrability at very low speeds was also better.

The upright riding position was found to be comfortable without major stress on hands and arms. Cyclists sit at an adequate height in traffic with a good view and according to the test cyclists it was easy to look back.

The riding position requires a broader saddle, which contributed to the comfort (see image in Appendix 2).

3.1.4 Difficulty of adapting the cycle individually

The discussion participants reported difficulty in individually adapting the cycle according to size and desired riding position. It should be possible to set both saddle and handlebars without tools. The current quick-release catches for adjusting saddle height are often too stiff (a common viewpoint from the female discussion participants).

It was also desirable to be able to adjust saddle height and handlebars whilst riding. It would then be easier to find an optimum setting.

3.1.5 Stiff controls

With age, our hands get weaker. Often, gear and brake levers require too much hand strength. The power transfer in the controls needs to be better, preferably individually adjustable according to hand strength. Furthermore, better standardisation of controls is desirable.

3.1.6 Changing gear, braking, electrical assistance etc

The older a person gets, the greater the need for gears, particularly light ones. Many cycles are too highly geared.

Automatic gear changing is very interesting according to the participants. Particularly if optional combinations of pedal revs (cadence), pedal force and speed at which gear changes take place can be set according to taste and preference.

Also, stepless gearing can be a comfortable facility for easing changes of gear. Then it should be easier to find optimum combinations of cadence, pedal force and speed.

The participants thought that it was too easy to lock the front wheel with the front brake and reported various incidents with this. Lock-free breaks should be produced, particularly in regard to the front brake.

Electrically assisted cycles were mentioned as an interesting alternative, particularly by those who often cycled on uneven surfaces. However batteries and motors should not be so heavy or bulky as to destroy the feeling of cycling under muscular power.

Three-wheelers may be appropriate in the case of balance problems or on slippery road conditions. However, the models on the Swedish market have such associations with bikes for the elderly, according to the discussion participants, that the idea will not get very far on the market. There are also other imperfections in terms of riding behaviour, weight and manageability. To have any chance on a broader market, the three-wheeler must take an entirely different approach.

One idea which came up in context was a folding support wheel for starting and extreme low speed, which folds away at higher speed.

3.1.7 Difficulty of handling

Commonly, the cycle must be stored indoors and carried on stairs and out through doors and gateways.

The older a person gets, the heavier the cycle becomes. Cycles are too heavy, according to one mostly unanimous viewpoint. Most weigh 15-20

kg, which should be reduced down to 10-11 kg or thereabouts, according to the participants. The development of aluminium frames, especially in terms of manufacturing, would make it possible to produce lighter, low-cost cycles. Low weight should be given priority in the design of wheels, pedals, lighting, brakes and other components for everyday cycles.

The importance of weight to the cycle's riding properties was brought up in all groups (for example on inclines, when accelerating etc).

Folding cycles would simplify handling in tight spaces as well as indoor storage. Another advantage brought up in the group discussions was that folding cycles can be taken on to trains and buses, thereby significantly increasing the radius of operation.

3.1.8 Other viewpoints in the group discussions

One thing which came up in the group discussions was handling cycle locks. These are time-consuming to lock and unlock on casual errands. The discussion participants made a comparison with the development of car locks and wanted to look into things like keyless remote controls or personalised locks which could be opened by fingerprint.

Theft protection needs to become more secure in the view of the discussion participants. They put forward various ideas about a "handlebar lock" which would make it impossible to balance the cycle or a "pedal lock" which would make it impossible to pedal. Another idea which came up was alarms activated by vandalism or theft.

There was also discussion on cycle helmets. This is after all, the cyclist's only protection of any significance in the event of an accident. However comfort and manageability are poor. The straps and clasps on cycle helmets need much improvement according to some participants. The strap is difficult to adjust, fiddly to handle and uncomfortable to wear.

A range of other problems and difficulties with existing cycles were tackled in the group discussions, which should be considered in development work; see also Appendix 1.

3.1.9 R&D questions regarding comfort, ergonomics, manoeuvrability etc

Regarding the comfort, ergonomics and manoeuvrability of the cycle, there is a range of interesting questions to study in long-term development work.

Some examples: what do optimum riding positions look like for different individuals with different speed requirements? How can the best comfort level be achieved without compromising the efficiency of cycling effort?

What is the connection between riding stability, manoeuvrability and comfortable riding positions? This can take place in studies where the geometry, angles, sitting and working positions are systematically varied.

Other questions relate to how the cycle should be designed in order to obtain the best stability possible when starting and at low speeds. On the motorcycle side for example, there are scooters which act as three-wheelers at low speed and two-wheelers at high-speed.

Development of components such as controls, gears, brakes, lights and so forth requires technical research.

Electrically assisted cycles will become more common, but require light motors and energy-efficient, quick-charge batteries to break through.[10] That is a major field for many other products and should provide good applications for the cycle. The skill lies in not detracting from the cycle's properties under muscle power.

3.2 Safety problems

3.2.1 High risk of injury in the case of falls

The risk of injury in the case of a fall or other accident is high. Even if wearing a helmet, the cyclist is very much unprotected.

The risk of injury is even higher for older cyclists, because frailty increases greatly with advancing age.[11] So, the number of people killed per hundred injured cyclists –a measurement of the degree of seriousness – is five times greater for 65-74-year-olds compared to those of working age, and ten times greater for cyclists of 75+. This was shown in data presented by Gunnar Carlsson at the expert seminar, see the table below (from Appendix 3:3).

Standardised death risk. Number of peopl 1

	Age			
	18-64	65-74	75+	
Car drivers	1	1.71	3.70	
Cyclists	**1**	**5.43**	**9.62**	**2-3 times greater age effect than for motorists and pedestrians**
Pedestrians	1	2.41	3.89	

[10] In the Netherlands, it is estimated that 90,000 electrically assisted cycles will be sold in 2008.

[11] For a summary of the frailty problem in traffic, see pp. 31-34 in Spolander K. Elderly people, mobility and Vision Zero. On traffic for the third age. NTF Förlag, Stockholm 2003.

It is interesting that *the age effect is much greater for cyclists* than for motorists in cars and pedestrians; two to three times greater. Why is there this difference? If it were only age-related frailty coming into play, the age effect should be the same.

We can leave motorists aside – they are protected by quite effective systems which may have reduced the age effect – but let us compare pedestrians and cyclists. They are both unprotected. Why this difference?

The reason is probably the kinetic energy in single-vehicle accidents. A single pedestrian who takes a fall has a kinetic energy upon impact which is so small that the forces almost never lead to fatal injuries. The kinetic energy upon impact depends largely on fall height, but also the speed of the pedestrian. The small number of fatal injuries affect almost exclusively very old people.

Conversely, a single cyclist who comes off their bike has a kinetic energy around two to three times that of the pedestrian. This is because of greater speed and fall height. The contribution from the speed and fall height are estimated to be on the same scale. Thus in many cases the energy of impact can be so great that a fall is fatal. One fifth of cyclists who die are killed in single-vehicle accidents, i.e. falls with no-one else involved. Elderly people are probably overrepresented in this context.[12]

3.2.2 High riding position

So, the high riding position has at least two negative effects. One is fall height. The other is exposure of the head in an accident. It is probably this in combination with the cyclist's speed which explains the difference as opposed to pedestrians.

If the sitting position can be lowered, the fall height is reduced. If a more reclined riding position with the feet first can be obtained – as in the test-ride (Appendix 2) – exposure of the head is reduced. In a fall, the cyclist impacts with their feet rather than their head, as is often the case with a forward-leaning riding position.

Also in the case of strong braking, the reclined sitting position is a plus as there is not such a great risk of flying over the handlebars as with a normal cycle. It is thus an advantage to place feet first.

[12] The fact that it is the energy in single-vehicle accidents which explains the difference between cyclists and pedestrians is bolstered by the fact that the energy difference for cyclists and pedestrians in collisions with cars is very small. Moreover, see Appendix 3:3.

3.2.3 Mounting on dismounting

Mounting and dismounting is an injury-generating action according to data from the injuries register in Accident and Emergency departments (Per-Olof Bylund's seminar contribution, Appendix 3:4). One in five elderly cyclists injured in cycling accidents did so in connection with mounting and dismounting and almost half were admitted to hospital.

These cases required medical care. It was apparent that *just over one fifth of medical care days* required by elderly cyclists were related to mounting or dismounting from their cycle. For example, of hip and femoral fractures, 40% occurred during these actions.

Reasons given for these accidents including tripping, mounting wrongly, catching on clothing, losing balance.

A development of the design of the cycles to make mounting and dismounting easier would therefore be of major value. Also undoubtedly relevant in that context is starting stability, before the cyclist gets up to steering speed, plus corresponding stability when reducing speed and stopping.

3.2.4 R&D issues in connection with development of safer cycles

There are many issues which need to be studied more closely in order to be able to develop safer cycles. Without going into too much detail, here are a few examples:

It is important to obtain more information about the role of the cycle in connection with the recording of injuries in Accident and Emergency departments. Over time, a great deal of material has been collected. For example, the Accident Analysis Group at Norrland University Hospital, from which the above data was obtained, has amassed information over a 12-year period on approx. 6,000 injured cyclists. If this, or a part of it, could be enhanced with details about the cycle or manoeuvre, it would no doubt be possible to isolate the critical factors better.

However, fall height and head exposure relative to the limbs is thought to be of crucial importance in generating injuries. It should be possible to study this at the crash test laboratory at the Swedish National Road and Transport Research Institute. Test methods and simulation models exist for use in such studies (they have been developed for studies of cycle helmets).

3.3 Opportunities to develop better cycles

The opportunities to develop better cycles are great, or even very great. The cycle's basic construction is over a hundred years old and its development has been strongly inhibited by a regulatory system introduced in the mid 1930s (see section 1.2). There are many deficiencies concerning safety, comfort and manoeuvrability; deficiencies which become even clearer from an age perspective.

As already stated, sitting height, riding position and step-through height are considered critical factors. These are also the kind of things which can be improved, as witness the test-ride.

The expert seminar gave a clear opinion on the potential for development.

Ideas as to actual development processes were contained in the seminar contributions from Mats Westerberg (Appendix 3:5) and Oskar Juhlin (Appendix 3:6). Per Kågeson gave an account of important general function requirements based on the circumstances and needs of elderly people (Appendix 3:7).

The cycle industry, represented at the seminar by Claes Alstermark and Roger Lindahl from Cycleurope Sverige AB, highlighted a dawning trend to differentiate cycles by target group. Comfort is important in this context. Cycleurope has a number of projects in progress which should make things easier for elderly people. The most interesting of these is perhaps the development of the electrically assisted cycle, for which battery life and other technical solutions are even now being rapidly developed.

Other areas are load capacity of the cycle, safety in the form automatic lights, stepless automatic gear hubs and better chainless drive systems.

Electrical assistance was also discussed by Bo Dellensten (Appendix 3:10), as well as three-wheeled cycles.

The three-wheeler was further expanded upon by Lars Viebke who highlighted the advantages of inclined parallel wheels for enhanced cornering stability; otherwise a problem with taller three-wheelers (Appendix 3:9). The advantage is that the three-wheeler can then be made narrower. This makes it more flexible in traffic and simpler to manage when parking and storing.

Many ideas can be taken from the small but highly creative niche for recumbent cycles. This was developed by Frederik Van De Walle (Appendix 3:11). Recumbent cycles have proved popular in recent times amongst active elderly cyclists in the US. The crucial motive seems to be the *comfort*, not so much the lower air resistance (which essentially means a

significantly higher speed for the same energy input). Due to medical problems, many elderly people could not cycle at all until the recumbent came along. They have joint pain, bad backs and knees, impaired balance etc. American doctors are even prescribing recumbents for patients.

Hans Erik Petterson discussed the need for ergonomic knowledge and in particular, the ergonomic requirements set by elderly peoples' limited ability to move (Appendix 3:12). It is possible that this knowledge already largely exists. The important thing then is to compile it in such a way that it is usable by the cycle industry. He furthermore discussed the need to develop measurement methods to better describe cyclists' needs both qualitatively and quantitatively.

3.4 Role of research and development

3.4.1 The market

Without going into too much detail on this, I would like to point out to different problems in this context.

One is a *market problem*. There are obviously designs and components on the international market which are not on the Swedish one. How will these reach Swedish cyclists, not just the elderly ones?

Elderly people are a growing group with strong purchasing power and thereby constitute a large potential market. The question is how that market can be opened to new and better cycle concepts.

This may be an important research question.

As mentioned in the introduction, it is a question of retrieving the cycle as an interesting and exciting technical object. It is important to increase the attractiveness and strengthen the cycle in competition with other modes of conveyance, a general lesson easily taken from the car. But to make the cycle interesting on the social agenda requires research and development.

The concept of "bikes for the elderly" is doubtless unworkable where it concerns marketing; just as unworkable as the concept of "cars for the elderly". This is about launching designs for people who want more comfortable and safer cycles, and such people exist at all ages.

3.4.2 Collaboration for technical development

The second problem concerns *developing new designs,* in other words ones which are not yet on the market.

As already discussed, there is a long list of questions which are important to tackle in research and development work, relating to such things as comfort, ergonomics and manoeuvrability (section 3.1.9) as well as safety and injury-generating factors (section 3.2.4).

The conditions for a successful development may be considered good in Sweden.

Firstly there is a strong cycle industry presence in the country: Cycleurope Sverige AB which is part of the European group Cycleurope. Skeppshult should also be mentioned in this context.

Secondly, there is a variety of research and development expertise in our universities of technology, universities and institutes.

Thirdly there is expertise in functional design, for example at Umeå Institute of Design at Umeå Center for Interaction Technology, and University College of Arts, Crafts and Design which has a department of industrial design.

Fourthly, there is strong public interest in better cycles. The Swedish Road Administration has editorial responsibility for traffic safety and can no doubt be an important player in the task of developing safer cycles for older and also younger people. Many others may have an indirect interest, such as the local and national agencies in charge of city and traffic planning, healthcare agencies and so on.

However it is a prerequisite that these capable bodies collaborate. This should be possible within the framework of a broad research and development programme.

4 Conclusions

It is quite clear that today's cycles are burdened with many shortcomings from an age perspective. So many negative viewpoints emerged in the group discussions that one might ask why the participants continue cycling. It must signify that the benefits of cycling itself outweigh the disadvantages of the bike. If a person has cycled for their whole life, they want to continue as long as possible.

The results also indicate that there is a lot of room for improvements. In some measure, these relate to fundamental problems to do with seat height, forward-leaning riding position and overly high step-through, as well as a long list of components which can be improved ergonomically and functionally.

It is interesting that requirements for better comfort and better safety seem compatible in terms of design. A design which gives better comfort also seems to give better safety.

The conditions for successful development work do exist in Sweden. However, collaboration between the various necessary skills is crucial. This can take place within the framework of a research and development programme.

Appendix 1
What do elderly people think about cycles? Three group discussions with active cyclists

1 Purpose, participants and organisation

1.1 Purpose

The purpose was to listen to how elderly cyclists see cycle design, starting with their need of and requirement for ergonomics and comfort; safety and risk of injury; manoeuvrability and handleability.

The discussions related to the **advantages and disadvantages** of existing cycles as well as what **improvements** should be possible, particularly those which mean a person can continue cycling even at an advanced age.

1.2 Groups

The discussions were held on three occasions during October 2007. Two of the groups came from the Swedish Association for the Promotion of Cycling, totalling 11 people (excluding the discussion leader). All were regular cyclists since childhood, use a cycle for both necessity and pleasure and regularly take part in excursions with the Swedish Association for the Promotion of Cycling. With one exception, all were 60+.

The third group consisted of long-distance cyclists, six people (excluding the discussion leader). They were between 63 and 70 years of age. The majority had made annual long-distance trips for the past couple of decades.

The distribution by gender was 40% women and 60% men.

- **Manoeuvring**, in other words, starting and attaining steering speed, manoeuvring the cycle at lower and higher speeds, braking, changing gear, stopping randomly at things like crossings and then starting again, dismounting, pushing the cycle, riding on slippery roads, uneven road surfaces, in the dark, in winter and so on.
- **Handling** the cycle; in other words, taking it from the garage or cycle basement, taking it in lifts, up and down stairs. Also, parking it for shorter or longer periods, locking it and so on.
- **Management** of baggage, cycle helmet, lights, servicing and maintenance.

The role of the discussion leader was to maintain a focus on the cycle's comfort, safety and ergonomics so that the participants' viewpoints in these respects came out, but without controlling things to the exclusion of other

things which the participants found relevant. The important thing was to try and clarify participants' genuine needs for any improvements.

The discussions lasted approximately 2 hours per group.

2 Results

The following is a summary of the participants' opinions. They were relatively unanimous, both between participants within each group, and between groups.

They were gender differences, but these were mostly manifested in the women wanting more of the same things as the men, for example even lighter cycles, even lighter controls in terms of handling.

2.1 Manoeuvring

Difficulty with start-stop-start-stop

It was a largely unanimous view that cycles need to be simpler to mount and dismount. The discussion participants observed that suppleness decreases with age.

The step-through on so-called gents' cycles, or unisex cycles, is too high. Modern materials should make it possible to combine a low step-through with torsional rigidity. Smaller wheels (24 inches or less) should make it simpler to design lower frames with a lower step-through. Furthermore, the discussion participants questioned the particular profiling of gents' and ladies' cycles. Different frame designs for different fields of application are one matter; the outdated differentiation based on gender is something else. Essentially, it is more a case of choosing the right size of cycle (see below).

Furthermore, the **sitting position** was considered too high. **The saddle is positioned too high** for comfortable stopping/starting, a frequent action in urban traffic (for example at crossings and traffic lights). After stopping, it should be possible to remain seated with both feet on the ground and then start again. Starting and stopping would then be much simpler, according to the discussion participants.

The saddle position on conventional cycles is due to the crank being located vertically right below the saddle, which is then placed high up so as to adequately extend the legs for pedalling. With a simple **adjustment of frame geometry**, the crank can be moved forward diagonally between saddle and handlebars. The saddle can then be lowered, meaning that starting and stopping is possible whilst sitting on the bike.

A low saddle – the cyclist can sit with feet placed on the ground. Note the position of the crank (Rans Fusion)

A minor test with such a cycle model was conducted during this project to illustrate the effect of things like starting and stopping. This is reported in Appendix 2 (*Low seat height – opinions of older cyclists following test-riding of a Crank Forward model*).

Other ideas which emerged were a **folding support wheel** at the moment of starting and at extreme low speed, which folds up again at higher speed. Three-wheelers, but lighter and with a different approach than the current offering, were another idea (see below).

Comfort and adaptation of the cycle to the cyclist

The participants reported difficulty in choosing **the right size** and **adapting the cycle** to individual requirements. Cycles are often too large, and there is a limited offering for short people. Service on the part of dealers to find the right size should be more professional, as should checking of the correct distance between saddle and handlebars to find a comfortable riding position. **A help system for checking** frame size, setting handlebars, saddle, pedals etc. should be produced.

Furthermore, the opportunities for **varying the settings** should be better. Many people want a more upright riding position at the start of the season which they can subsequently lower. Also, during a cycle ride, a person may wish to change the saddle height or distance to the handlebars. Quick-release connections for adjustment of saddle height are often too stiff to use.

It should be possible to set both saddle and handlebars **without tools**. It would also be good to be able to adjust saddle height and handlebars **whilst cycling**. It would then be easier to find an optimum setting.

The **saddle** itself is a persistent concern. This concerns riding position and anatomy. A narrower saddle is more comfortable for a forward-leaning riding position, whereas for an upright riding position and broader one is preferable. Anatomical differences between individuals are significant in regard to whether one or the other saddle is comfortable. Men and women have different preferences. There is a wish for **better opportunities to try** different saddles for a while and be able to return the ones which prove uncomfortable. Another wish was for a **greater range** of different types of saddles.

The **riding position** itself is far from comfortable, particularly on longer rides, in the experience of the discussion participants. It stresses hands, arms, neck and shoulders – as well as buttocks. A more upright riding position, possibly with back support, was discussed.

Braking – anti-lock

It is too easy to lock the front wheel with the front brake. The participants reported various incidents with locked front wheels. **Anti-lock** brakes should be produced, particularly in regard to the front brake.

It is not particularly easy to **brake and simultaneously give a signal** with one or other arm. Technological solutions for this should be sought.

People's hands weaken with age. Often, the gear lever requires **too much hand strength**. Better power transfer is needed in the controls. Controls which are individually adjustable according to hand strength?

Maintenance-free brakes are desirable. One problem with rim brakes in the winter is wear on the rims and brake pads.

Foot brake. Stated as mostly a case of habit. However, a footbrake is less effective if it only applies to the rear wheel. A footbrake acting on both wheels?

Gears – easier controls and automatic gears

The older a person gets, the **greater the need for gears**, particularly light ones.

As with brake levers, gear changes often require **too much hand strength**. Better power transfer is needed, preferably with individual adjustment. **Standardisation** was desirable for changing up and down (particularly

concerning gripshifts, since some models go anti-clockwise to change up whilst others change down).

Automatic gears are very interesting according to the participants, particularly if the automatic element can be disconnected when the person wants to exert themselves. It should also be possible to set an optional combination of speed, pedal revolutions (cadence) and pedal force when gear changes take place.

Stepless gearing was also of interest. This would make it easier to find optimum combinations of cadence and pedal force.

Better rear view

The **rear view** is a problem. With age, it becomes more difficult to turn one's head.

It is difficult to find an effective **position** for a rear-view mirror on conventional cycles; these often require a shift of concentration. Rear-view mirrors should be produced which can be placed in the cyclists field of vision.

Transmission

A **belt** instead of a chain was discussed for simpler maintenance, as was a **shaft drive**.

Rotary pedalling was called into question. Why not pedal up-and-down instead of in a circle? There were a number of variations on this in the infancy of the bicycle.[13] Modern prospects for such designs may be better as there are new materials and components, better manufacturing precision etc. The advantages and disadvantages in terms of ergonomics and transmission may be interesting to look into, according to some discussion participants.

Additional power on inclines and into headwinds

Electrically assisted cycles were very interesting, not least for those who often cycled on uneven terrain. However batteries and motors should not be so heavy or bulky as to destroy the feeling of cycling under muscle power.

There is rapid development within the field, particularly concerning energy-efficient, light and easily charged batteries.

Lighting and visibility

Integrated lighting on the cycle with automatic switching on and off was a wish, as well as integrated reflectors.

[13] The Svea Cycle, Göta and Variabel, see also http://www.cykelhistoriska.se/svea.htm.

Wintertime

Some discussion participants had experience of **studded tyres** and were very positive. But it needs to be simpler to change from summer to winter tyres. Two sets of wheels as part of the deal?

One idea which was put forward were tires which could be set from summer to winter road conditions. Folding tyres?

Winter wear-and-tear on the cycle is great with salt and particles from car traffic, which makes a number of discussion participants garage their cycles. Cycles which need less maintenance (see below)?

Balance – three-wheelers

Three-wheelers can be an alternative in winter time or when a person starts having balance problems. However, the three-wheeler always involves increased weight and is cumbersome to manage on stairs and when storing. Is it possible to make **narrower three-wheelers**, with sufficiently good tipping stability? For example, a cycle which works as a three-wheeler at low speeds but as a two-wheeler at higher speeds?

However, three-wheel models on the Swedish market are so much associated with bikes for the elderly, according to the discussion participants, that they cannot make any greater inroads on the market. There are also the other imperfections regarding riding performance, weight, handleability and so on. To have a chance on a wider market, a three-wheeler must take an entirely different approach.

2.2 Handling, storage etc

Normally, particularly in urban areas, the cycle is stored indoors and must be carried on stairs and out through doors and gateways. This is chiefly due to the risks of theft and vandalism. Sweden numbers amongst the countries with the most cycle thefts, in relative terms.[14]

However, the cycle's susceptibility to wind and weather is also a reason for indoor storage.

Almost all participants stored their cycles in doors overnight.

[14] In an international crime victimisation survey, Sweden and Holland came in first place where it concerned the number of people who had suffered cycle theft (van Kesteren J, Mayhew P, and Nieuwbeerta P. Criminal Victimization in Seventeen Industrialised Countries. Key findings from the 2000 International Crime Victims Survey. Research and Policy report no. 187. The Netherlands, Ministry of Justice, 2000).
An estimated 140,000 cycles are stolen annually (of which half are reported to the police).

Cycles too heavy

The older the person, the heavier the cycle becomes. In all groups, **weight** was emphasised as a decisive handling factor. Many cycles weigh 15-20 kilos. Handling is therefore an unnecessarily energy-consuming aspect. The weights should be reduced to 10 kilos or less. The development of aluminium frames, especially in terms of the manufacturing industry should make it possible to produce lighter, low-cost cycles.

The importance of weight to the cycle's riding properties was brought up in all groups (for example on inclines, when accelerating etc).

The cycle has **parts which stick out** and snag on clothing (or when starting/stopping). These should be removed. Protruding pedals can be made foldable, swivelling front wheels lockable for example.

The **portability** of the cycle and centre of gravity etc. should be borne in mind for frame geometry and design in general. A couple of the older discussion participants reminded us that things like carrying handles had been seen before on some cycles.

Furthermore, it is easy to dirty one's clothes when handling. **Cleaner** cycles would therefore be desirable, for example enclosed chains, "self-cleaning" materials and so on.

Folding cycles would simplify handling in tight spaces and indoor storage. Can cycles be constructed which are both good to cycle, easy to fold up and light in weight? Another advantage presented was that folding cycles can be taken on to trains and buses, thereby significantly increasing the radius of operation. As is already known, opportunities for taking a normal cycle on public transport are very limited in present-day Sweden (unlike most other EU countries).

Better weatherproofing. One reason for taking the cycle indoors is that most cycles cannot cope with long-term outdoor parking. There is a wish for more use of anticorrosion materials in cycles, better sealing of bearings, more effective chain protection and so on. A belt instead of a chain?

Simpler and more effective locks and anti-theft devices

It would not be necessary to take cycles indoors quite so often if locks were more effective and simpler. They are difficult and time-consuming according to the discussion participants. Often double locks are required, one of them to secure the cycle to a post or similar.

It may be interesting to compare with the development of car locks and anti-theft devices. Modern cars have door locks which can easily be controlled

remotely, electronic locks which are very difficult for unauthorised people to force, alarms and so on. All this has reduced car theft quite appreciably.

Many ideas can be taken from there. The discussion participants discussed **"steering locks"** which make the cycle impossible to balance, or **"pedal locks"** which lock the pedals, crank arms or crankshaft.

Other ideas related to keyless **remote-control** of the cycle's fixed lock. Or personalised locks which opened with, say, a fingerprint.

Alarms which react to vandalism or theft were also a wish which some discussion participants put forward.

Current locks are **heavy**, particularly U-shackle locks. More efficient locks need not mean heavier locks. On the contrary.

Management of **cycle helmets** and other accessories which must be securely locked is a time-consuming action when parking the cycle. Better solutions are desirable.

On the whole, anti-theft protection and its management must be improved, not least of all concerning components such as wheels and so forth. It should also be difficult to steal wheels, saddles, lights etc.

2.3 Handling baggage etc

Baggage

Saddle bags **integrated** with the cycle yet simply removable, were desirable. Most of the participants reported problems taking bags on their cycle. Heavier bags affect the directional stability and manoeuvrability of the cycle often in unaccustomed ways which are difficult to predict.

One discussion participant brought up an idea about **mouldable** cycle bags, small and flexible when empty but expandable to accommodate the contents.

The cycle helmet

The cycle helmet is important from a safety point of view; indeed it is the cyclist's only protection should an accident occur. Nevertheless, comfort and handleability are poor. The cycle helmet's **strap and clip** need to be much better, according to some participants. They are difficult to adjust, fiddly to handle and uncomfortable to wear.

Servicing and maintenance

Cycles need regular maintenance in order to function well. Gears must be adjusted, brake pads changed, wheels aligned – and the chain cleaned including gear wheel and gear rim.

This is a major problem, according to the discussion participants who discussed various measures to deal with it.

Firstly, the cycles should be made as **maintenance-free** as possible right from the start (see the number of ideas above). For example, **more maintenance-free wheels** would be of interest. Why do there have to be three dozen steel spokes per wheel, which need adjusting and which rust?

Secondly, **self-servicing**, should be simpler, reducing the need for special tools for example.

Thirdly, the system with workshops should be tightened and relationships between cyclists, cycle and **service and maintenance improved**. This is of interest particularly to elderly people and those who are not so technically-minded.

The multifunction cycle – eventually

An idea for a multifunctional design was put forward. Can a light, adaptable design be produced which, dependent on need, can sometimes be a **rollator**, sometimes a **cycle** and occasionally a **wheeler case**?

Appendix 2
Low seat height – opinions of older cyclists following test-riding of a Crank Forward model

1 Background and purpose

A viewpoint put forward by many in the group discussions was that the sitting position on a conventional cycle is too high (Appendix 1). The saddle is too high for comfortable stopping/starting, a frequent action in urban traffic. It should be possible to stop the cycle with both feet on the ground, sit there and then start again. Starting and stopping would then be much simpler, according to the discussion participants.

Views were also conveyed on a lack of comfort with the forward-leaning riding position of normal cycles. Hands and arms as well as the buttocks are thereby stressed.

A cycle has existed for some years which was designed to reduce these drawbacks; the Rans Fusion. It was introduced in 2004 by the American Rans company under the Crank Forward concept.

Quite simply, this means the crank has been moved forward so that the person cycles with their legs further forward instead of straight down.

A so-called Crank Forward cycle = low saddle, legs forward, upright riding position

This has two advantages. One is that the saddle can be lowered. The other is that the riding position is more upright. This design can be said to combine the advantages of the conventional cycle and the recumbent cycle but without their drawbacks. The cycle can be made lighter, easier to handle and more flexible than equivalent recumbents. Rans has subsequently developed a whole range of Crank Forward models.

A small-scale test-ride was conducted with a Rans Fusion to highlight the concept with views from a couple of older test cyclists. Two such bikes, recently imported direct from California were borrowed from the owners, who kindly made them available for the test-ride.

2 Procedure

The test-ride took place in Malmö. Two cyclists participated, a man and woman both 65 years of age. The woman is an active cyclist who cycles for an hour a day on average. The man cycles shorter stretches several times a week.

The two test cyclists, Mona Johansson and Christer Håkansson, Skanör, with one of the two test Rans Fusion cycles

The test cycling mostly took place on cycle lanes, accompanied by test leader Jan-Inge Ljungberg and one of the cycle owners, Tadeusz Kaplan.

The cycling contained a lot of stopping and starting at signal-controlled crossings and many sharp turns. The surface quality varied from good asphalt to poorly maintained and rough roads with cavities and loose gravel on the asphalt. There were sections with kerbstones at the beginning and end of cycle paths. They were also some inclines and downhill stretches. The weather was clear and cold with a stiff breeze.

After cycling, the test cyclists were interviewed about the advantages and disadvantages of the cycle with the emphasis on the comfort, ergonomics and safety associated with actions such as mounting the cycle, starting, manoeuvring at lower and higher speeds, turning, stopping/starting at, say, junctions, riding on different surfaces and so on.

3 Results

3.1 Starting

It was easy to sit on the saddle because it and the frame are so low. A normal ladies' U-frame cycle was actually easier to mount, but the test subject found this action easy enough. Both test subjects climbed aboard the cycle by swinging one leg behind the saddle and over the rack. It is also possible to straddle the rack from behind and then sit in the saddle. Once in place, the rider sits stably with both feet placed on the ground.

One of the test cyclists sitting on the saddle, both feet on the ground without problems

3.2 Riding

Geometry and riding position mean that the weight distribution is displaced somewhat from front wheel to back wheel, compared to a normal cycle. The steering is thereby lighter. Following a certain amount of familiarisation, this was found to be an advantage by the test cyclists who thought that the cycle was easy to ride and manoeuvre. The turning radius is about the same as a normal cycle and once a person is more familiar with the cycle, very

tight turns can be negotiated (apart from anything else, it is very easy to put a foot out on the ground if required).

At the same time, the relatively long wheelbase and front-fork geometry gave good directional stability. However the weight distribution may be somewhat disadvantageous on gravel and slippery road surfaces as the cycle, according to one of the owners, wants to go straight on.

Comfortable when stopped. Here we see the other test cyclist, sitting on the saddle waiting for a green light

As anticipated, both test cyclists found it was much simpler to stop/start than a normal cycle. It was simply a matter of braking, remaining seated and placing one or both feet on the ground at a red light or stop sign. The female test cyclist did not have to get off, as she does with her own bike. Or, as the male cyclist normally does, lean the bike right over and balance with one leg on the ground. By being able to remain seated, it was also much easier to get started again after stopping.

Rans Fusion is not a cycle for standing up and cycling. However, on inclines this is no drawback as, according to the test cyclists, the rider can press back into the special saddle and go for it with the help of the handlebars. Moreover, it is a matter of gearing.

In the case of strong braking, the more rearward sitting position is a plus, as there is not such a great risk of flying over the handlebars as with a normal cycle. In the case of a fall, it is an advantage to be feet first. The fall height is lower than a normal cycle.

3.3 Comfort

Because of the longer wheelbase, front-fork angle and fork offset, the cycle was found to be very comfortable on bumpy roads.

A broad, comfortable saddle. An upright sitting position requires a broader saddle. It is made from a light plastic material, covered with a permeable rubbery material which dries easily after rain, and has a shock-absorbent filling. The saddle can be adjusted from a fully horizontal position and inclined forward

The saddle was found to be very comfortable. As a result, one of the test subjects did not need to stand up after a while to relieve the discomfort from the saddle, which she normally does with her own cycle.

The upright riding position was also found to be comfortable, with no major stress on hands and arms. The cyclist sits at the same height as traffic with a good view and it is easy to look back.

3.4 Miscellaneous

Due to its low weight, the cycle was easy to lift.

The appearance of the cycle was also discussed. It was found to be exclusive and sporty and perhaps not something one would associate with a cycle for elderly people. But that was no disadvantage; quite the opposite.

Appendix 3:1
"Better cycles for older people" seminar

The seminar, which took place at SPF's Stockholm premises on 16/10/07, dealt with three themes:

- **Need** for cycles designed according to the needs and requirements of elderly people. What is currently on offer? How is it adapted to the needs of elderly people for comfort and ergonomics, need for safety, handleability and manoeuvrability?
- **Opportunities** for developing the cycle in terms of function, technology, materials and design so that it suits older people better?
- How to **start** a development? What players are there? What opportunities are there to start a development in which industry, research and public interests collaborate?

The participants each gave a prepared 10-minute talk as per the programme below. These contributions were documented on some sheets which had been handed out in advance. The talks were given in series of about four, after which a longer discussion took place. The next series was then run with subsequent discussion.

Programme

1 Needs and requirements of elderly people

The need for physical activity from a transport economics perspective	Peter Lamming, (formerly of the National Institute of Public Health)
Injurious forces in cycle accidents	Gunnar Carlsson, Director of Traffic Safety, SPF
Falling injuries amongst elderly cyclists	Per-Olof Bylund, Accident Analysis Group, Norrland University Hospital
What do elderly people think about bikes? – results from group discussions	Leif Lundgren, Swedish Association for the Promotion of Cycling

Discussion

2 Opportunities to develop better cycles for older people

Opportunities to start developing cycles along new lines	Mats Westerberg, Peppar (industrial design)
Design development potentials	Oskar Juhlin, Ergonomidesign
Functional requirements of older cyclists	Per Kågeson, Nature Associates
Discussion	
Cycles for older people – market trends for elderly people's cycles	Claes Alstermark & Roger Lindahl, Cycleurope Sverige AB
The optimum older person's bike	Lars Viebke, KTH Department of Vehicle Engineering
Three wheelers and electrical assistance – an alternative for elderly people?	Bo Dellensten, Svensk Cykling
Why active elderly people in the US choose recumbents	Frederik van den Walle, HPVS
Discussion	

3 How do we start the development?

Better cycles for older people – The role of research in cycle development	Hans-Erik Pettersson, the Swedish National Road and Transport Research Institute and Chalmers University of Technology
Discussion – how do we get the development moving?	Concept – a cycle for elderly people?? Manufacturers, importers, distributors… Just a market issue…? Role of state, research, organisations etc?

Appendix 3:2
Need for physical activity from a transport economics perspective

Peter Lamming, formerly of the National Institute of Public Health

In Beijing, prior to the 2008 Olympics, cycle paths will have been created in the large square where previously there were multilane roads. On a private initiative, a whole chain of bike hire shops has been set up. Noiseless electric mopeds and low speeds are improving the traffic.

In Sweden, the governing parties have always prioritised the development of car driving. Pedestrian and cycle traffic is estimated to diminish by 4% into 2010, whilst car traffic is anticipated to increase by 29%.

The greenhouse effect is influenced by car exhaust gases and is detrimental to the environment. Cycle traffic makes up 10% of journeys, but only receives 1% of the funds (SEK 23 billion) which the state and municipalities invest in the road network each year.

There are increasing numbers of healthy elderly people in our country. Soon, one in five inhabitants will be a pensioner. We have become strongly dependent on passive transport systems, in which we actually sit still. Not only the environment is bearing the brunt, people are too. Among the consequences are obesity and personal injury. Half the population is not physically active enough and that is proportionally greater amongst the elderly contingent who have a passive lifestyle. This is gradually leading to human suffering and great cost to society. Physical inactivity is estimated to cost SEK 22 billion each year.[15]

[15] Picture caption: Your health is important. Benefits of physical activity include: prevents stress, improves sleep, reduces pulse and blood pressure, self-monitoring, combats dementia. Dose: 30 minutes a day. Sitting still costs society SEK 6 billion per year.

The significance to public health is considerable:

If a further 8% of the population chose to walk or cycle each day, researchers estimate a reduction in deaths from cardiovascular disease of up to 7%. Furthermore, “active transport” is extremely environmentally friendly.

If 1% of car journeys were converted to walking and cycling, petrol consumption would be reduced by 55 million litres per year.

The opportunity for elderly people to choose an active life is largely dependent upon there being a supportive environment in their immediate surroundings. This may be footpaths and cycleways, on the development of new tools to stimulate increased physical activity. Walking poles are one example.

The municipalities have a key role in facilitating a vital choice for the individual. This can take place through investment in footpaths and cycleways and through equality in the composition of the urban transportation committees. Far more women cycle and walk. Men sit in cars. Queues of cars contribute to obesity. This development is not being prioritised by today’s social planners. A change of attitude is needed.

Few political initiatives should be so cheap and effective from a public health perspective as the opportunities for people to make “active transport

choices". An accessible and safe infrastructure for "active transport" would combat injuries and deaths in traffic, reduce car queues and noise and contribute to more efficient energy use. The Swedish parliament agrees that increased physical activity has long-term positive effects and this is now one of 11 goals for Sweden.

It is time to fulfil this goal and bring to the fore the rights of elderly people to an active life.

Appendix 3:3
Thoughts on the need for "cycles for older people" and injury factors in cycle accidents

Gunnar Carlsson, SPF

We older people are increasing in numbers, getting healthier and getting richer and we want to maintain that mobility required by an active life. The car will be a most important means of transport, but the cycle will also be important not least for environmental, health and cost reasons.

In 1977, the Swedish parliament decided that Vision Zero would be the guiding light for its traffic safety work. The Vision is for the transport system to be designed so that no people are killed or permanently injured. Vision Zero requires shared responsibility. The system designers (legislators, road managers, vehicle manufacturers etc.) should design the system so forgivingly that road users who take responsibility by following the traffic rules will not die or sustain lasting injury if they should meet with an accident. Furthermore, it will be adapted to the most vulnerable group of road users.

We older road users are best at observing the traffic rules which are most important to safety, i.e. driving sober, wearing seat belts, not driving faster than the speed limits, using crossings etc. Despite the fact that we are the best at taking our part of the shared responsibility, we are the worst affected when it comes to accidents. The following table illustrates this:

Killed/100 injured. 2004-2006

	Age		
	18-64	65-74	75+
Car drivers	1.32	2.27	4.90
Cyclists	0.88	4.80	8.50
Pedestrians	2.66	6.41	10.34

The increased risk of death in accidents to us older people is due to our increased frailty and that increased risk is particularly pronounced for pedestrians and cyclists. This becomes even clearer if the risk to the elderly is standardised for the risk to the young. The age-dependent risk increase then becomes greatest for the cyclists.

Standardised mortality risk. 2004-2006

	Age		
	18-64	65-74	75+
Car drivers	1	1.71	3.70
Cycles	1	5.43	9.62
Pedestrians	1	2.41	3.89

This simple analysis shows that there are very strong traffic safety reasons for attempting to produce a cycle which is less dangerous to us elderly people.

Injuries in accidents arise through forces acting the human body as a result of overly rapid changes in the body's speed - either a sudden stop as in the case of single-vehicle accidents or a sudden stop and/or acceleration in the case of collisions. In a given accident situation, the size of these forces depends upon the kinetic energy of the people and vehicles involved.

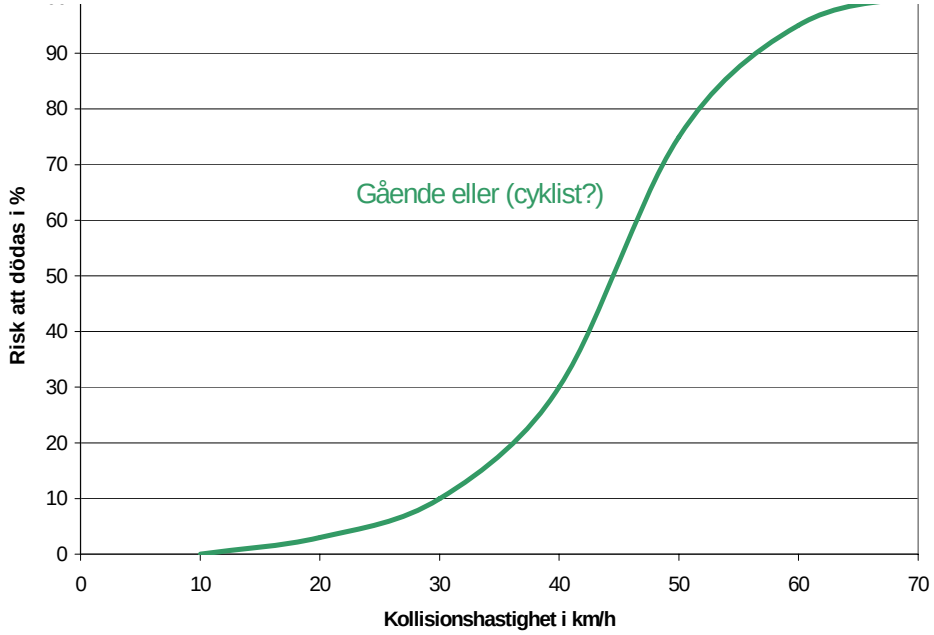
A single pedestrian who takes a fall has a kinetic energy upon impact which is so small that the forces almost never lead to fatal injuries. The kinetic energy upon impact is due largely to the fall height, but also the speed of the pedestrian. The small number of fatal injuries affect almost exclusively very old people.

A single cyclist who comes off their bike has a kinetic energy of around two to three times that of the pedestrian. The contribution from the speed and fall height are estimated to be of the same scale. The energy of impact is so great that in many cases a fall is fatal, particularly if the cyclist was not wearing a helmet. Around 20% of cyclists who die are killed in single-vehicle accidents and the elderly are probably overrepresented in this group.

In the case of a collision between a car and a cyclist or pedestrian, the energy in the collision is much greater due to the car's greater weight and speed. If an ordinary car is driving at 50 km/h, the car's energy is 150-200 times greater than that of the pedestrian and approx. 70 times greater than that of the cyclist. The kinetic energy is squared due to the speed which means that if the car's speed is 30 km/h instead, then the car's energy is "only" 60-70 times that of the pedestrian and approx. 25 times that of the cyclist.

In a collision between a motor vehicle and a cyclist or pedestrian, the only way to avoid the death of the unprotected road user is if the speed of the colliding vehicle is sufficiently low. There are a number of research results indicating how the risk of death to a pedestrian when struck depends on the speed of collision (see Figure 1).

Figure 1. Approximative risk of death in a collision between a car and a pedestrian. Risk of death as % Collision speed in km/h



The relationship in Figure 1 is based on an analysis of pedestrian accidents and comprises an important foundation to the design of traffic environments in which cars and unprotected road users inhabit the same highway environment. A death risk of 10% is accepted which means that 30 km/h is accepted as a "safe" speed for both pedestrians and cyclists. At the same time, Vision Zero involves adaptation of the road traffic system to the most vulnerable road users. Important questions are then whether the correlation also applies to cyclists and elderly people or whether the requirement for speed adaptation by motorists should be set even lower than 30 km/h? These issues are commented upon below:

1. Is the correlation in Figure 1 also applicable to cyclists?

A cyclist carries two to three times greater energy than a pedestrian in a collision with a car. To compensate for this, cars should drive more slowly than 30 km/h. However, this distinction is very small, approx. 0.3 km/h, due to the car's much greater total energy.

If only the energy is considered, then 30 km/h should be sufficient for cyclists too. At the same time, we know that the body's available energy if we cycle instead of walking leads to approx. 20% of cyclist fatalities dying in single-vehicle accidents. This shows that the force in falling from a bike is so great as to be fatal. We should also note that half of cyclist fatalities are elderly (65+) and that 90% of these were not wearing a helmet. A fall

caused by a car may therefore lead to fatal injury, particularly for an elderly cyclist. To reduce the number of collisions, speed should be reduced to below 30 km/h. If it were reduced to 20 km/h for example, there would be an estimated 40% reduction in collisions.

2. Is the correlation in Figure 1 also applicable to elderly pedestrians and cyclists?

The increased frailty which appears in the above tables shows this to be a major problem. This would be very clear if the fatal accidents upon which Figure 1 is based could be differentiated by age. It would then be apparent that the left-hand side of the curve, i.e. deaths in lower speed collisions, very largely related to elderly people.

The conclusion concerning elderly people is that the requirement for a "safe" collision speed should be set below 30 km/h.

Appendix 3:4
Preliminary analysis of injuries amongst elderly cyclists

Per-Olof Bylund, Accident Analysis Group, Disaster and Emergency Medical Centre , Norrland University Hospital, Umeå

Ulf Björnstig & Britt-Inger Saveman , Surgical Unit, Umeå University, Umeå

Background

Since 1985, the Accident Analysis Group at Norrland University Hospital has been keeping a record of injuries from Accident and Emergency and other clinics dealing with emergency injuries. Based on this register of injuries, an analysis has been made of elderly cyclists' injury mechanisms and injury panorama.

Definitions

The severity of injuries has been graded according to the Abbreviated Injury Scale (AIS).

AIS 1 = Mild injury – e.g. minor cuts, bruises, broken fingers

AIS 2 = Moderate injury – e.g. concussion, lower arm fractures

AIS 3-6 = Serious, severe, critical injuries – e.g. fractured femur, cerebral or pulmonary haemorrhaging. (In this compilation, these injuries are stated as serious).

Results

During the 10 year period 1997-2006, a total of 5,987 cyclists were treated for injuries arising in connection with a cycle crash. Almost one in 10 (466; 8%) were aged 65 or older. In the 65-84 age group, the proportion of women was higher (56%), whilst the men dominated in the age of 85 or older (72%) (see Table 1).

Table 1. Distribution by age and gender

Age	Men	Women	Total
65-74	115	156	271
75-84	77	89	166
85+	21	8	29
	213	253	466

Type and location of injuries

Fractures of the arm/hands and legs/foot were common and accounted for 86% of all fractures. Almost one in 10 (8%) suffered a concussion or more serious brain injury (see Table 2).

Table 2. Distribution of different injury types (the most serious injury)

	Head	Neck	Thorax/ abdomen	Arm/ hand	Back	Leg/ foot	Total
Fractures	10	1	14	**95**	3	**79**	202 (43%
Cuts/soft tissue injury	52	1	14	42	8	58	175 (38%)
Sprains	-	1	-	22	-	18	41 (9%)
Brain injury*	**36**	-	-	-	-	-	36 (8%)
Other injuries	-	-	2	7	-	3	12
Total	98 (21%)	3	30	166 (36%)	11	158 (34%)	466 (100%)

**Concussion or more serious brain injury.*

Mechanism and severity of injury

Two out of three (307; 66%) cyclists were injured in single-vehicle crashes (e.g. running into a pothole, riding into the kerb, coming off due to slippery road surface or loose gravel) and 43 (14%) of these suffered serious injury. Almost one in five (87; 19%) were injured when mounting/dismounting their cycle, of which 25 (29%) were seriously injured. In the case of mounting and dismounting, reasons given for the incidents included: snagged on clothing, tripped, mounted wrongly, lost balance.

Mechanism of injury and care level

Amongst those who were injured when mounting/dismounting, almost half (41;47%) of the 87 people were admitted to hospital. Just over one quarter (27%) of all medical care days required related to mounting/dismounting.

Mechanism of injury and injury type

In total, 47 people sustained hip and femoral injuries, 19 (40%) of these occurred when mounting/dismounting. None of those injured in connection with mounting/dismounting sustained brain injuries (see Table 3).

Table 3. Mechanism of injury and injury type

Mechanism of injury	Fracture	Cuts/soft tissue injury	Sprain	Brain injury*	Other injuries	Total
Single-vehicle crash	133	116	25	27	6	307
Mounting/dismounting	**51**	25	7	-	4	87
Collision with another vehicle	17	31	5	9	1	63
Miscellaneous and unknown	1	4	4	-	-	9
Total	202	176	41	36	11	466

**Concussion or more serious brain injury*

Conclusions

In the present preliminary examination of injured cyclists aged 65+, it may be observed that mounting/dismounting a cycle is an action which causes a high number of serious injuries. This group of injuries also places a great burden upon hospital care in relation to the total number of injuries occurring in connection with cycling. An improvement in cycle design to make mounting and dismounting easier would therefore be of great value.

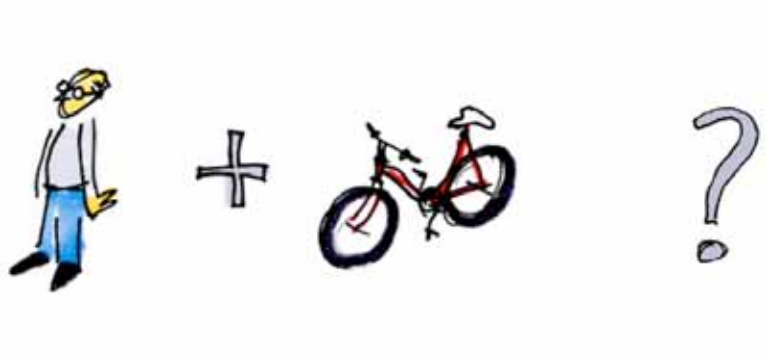
Appendix 3:5
Starting to develop cycles along new lines

Mats Westerberg. Peppar (industrial design)

I work as an industrial design consultant and am often involved in the development of new ideas in conjunction with various companies, which may make anything from dish brushes to machines. I also teach on the subject of creativity in various universities. You're now going to get a five-minute course in creativity and what to do if you want to find new concepts for a cycle for elderly people.

Nobody really knows how the brain works, but a simplified picture is that in the right half the brain, we produce ideas. It's completely disinterested in whether good or bad ideas come up; it's only interested in continually thinking up new ideas. Some inventors, artists and improvisational musicians are good at using that right half of the brain - lateral thinking. They have the ability to bring things forth before they've reflected on whether they're good or not.

In the left half of the brain, logical thinking takes place. 1+1=2. It's common for engineers and scientists to think in this way. The left half of the brain concentrates on finding the right answer and isn't satisfied until it's 100% correct – vertical thinking. Effective creative thinking is based on switching between the different halves of the brain.



Producing lots of new ideas

If, say, we want to concentrate on making a bike safer because of cyclists' balance problems, we can come up with lots of different and more or less daft solutions. As an aid to finding different solutions, we can ask ourselves questions like:

What's the dearest, heaviest, cheapest, most awkward… solution you can come up with?

What ideas would a child, a Japanese person, a boxer, a carpenter, a ballet dancer... be able to come up with?

Another way is to use logical sources of inspiration which have good balance, such as a blue-tit, a carrot, a fence post, an air balloon, a boat.

Or use illogical sources of inspiration like a golf ball, a camera, a peanut, a seal.

We can morph things to free up our thinking – make a number of stages between an existing product and a source of inspiration.

Changing an existing cycle

To develop what's already there, a good method is to concentrate on an important part of the design and then duplicate it, remove it, replace it with something else, turn it upside-down, enlarge it, reduce it...

Finding the source of the problem

If a person has back pain, then one solution is to take painkillers. But to find a lasting solution, the answer may be to change beds, begin exercising or undergo surgery. In the same way, we can try to find underlying problems in order to find a solution to the fundamental problem.

If there is a problem with elderly people injuring themselves more easily when they fall than younger people, then perhaps a lasting solution is a changed diet, protection developed specially for elderly people, different cycle technology, preventative fall training, other methods of transport than bikes…

If we get down all the ideas which come up by asking these sorts of questions, we get a range of different solutions.

Producing the best idea

We then switch to the left half of the brain to evaluate and see whether there any ideas which are of interest to develop. This is why there are various methods of assessment, but most people find it easy to decide if an idea is good or not once hatched. Then we go on producing new ideas and chopping out bad ones - switching between right and left brains until our guts, the development group, the customer, says that this is really good. It's no more difficult than that.

I hope this has provided a little insight into how to think and develop ideas.

Appendix 3:6
Design development potentials

Oskar Juhlin, Designer, Ergonomidesign AB

What is an elderly person's bike from a design perspective?

Historically, products for elderly people have often been dreary things with somewhat improved functionality. There are several reasons for this: Previously, there were very few sales channels for aids direct to elderly people and these products were often bought in by someone who would not be using them or someone who was holding a budget. All this meant that these products were previously only sold on price and basic function. Design, expression, image and personality were seldom given the space they deserved. Things were actually so bad, that in discussions/assessments with this user group, these "soft" issues would sometimes not be asked about. The previous generation of elderly people were not even used to having a choice of something as rudimentary as colour.

Times have moved on now. The generation which is old now and in need of improved products will not except bland, dismal choices. This generation is used to expressing its personality, group affinity or image with the products they surround themselves with. This will also very largely apply to a future "old person's bike". A large proportion of this new older group probably doesn't want to be associated with products for the elderly at all. If we want to pin it down, we can say that if they want a car that is easy to step into, they will buy a high off-roader rather than a Golf plus.

Obviously, there will be a need for unobtrusive alternatives as well but the important thing to realise is that we are talking about a range of improved cycles based on a concept which works extra well when we are a little older.

So how should such a cycle be designed?

The cycle concept may perhaps be constructed so that (for a manufacturer) it can easily be changed in order to generate a basic range covering the necessary physical requirements. In other words: how many varieties are required in order to include the target group's range of physical needs?

A cycle concept may also be more exclusive and work really well for 60-70% of the group, if one can envisage complementing this with a further concept which covers the remaining 30-40%.

The whole thing hangs on how big a target group one sees for the cycle and how well the design can include the physically most demanding users

without losing functionality for the less demanding ones. A comparison can be made with extreme racing bikes, where there is often an upper weight limit stated for the user. This is in order to offer light bikes for light cyclists. An extreme but clear example of a concept which excludes some in order to be better for others.

Parallel with an examination of the group's physical needs, the soft values can be assembled by using interviews to close in on the identities/styles required in order to best serve the group. On this basis, the range can then be created which fulfils both physical and psychological requirements of the product.

It's just a matter of taking pause and thinking through what makes you choose the products you choose. Would I start making choices in a completely new way if I was a bit less mobile? Certainly, I would change my choices from a functional perspective, but from an aesthetic point of view? Personally, I guess I would go for the most sporty elderly person's bike.

Looking at an elderly person's bike in this way, there is really great development potential from a design perspective. I'm sure it's also possible in this way to come up with entirely new types of cycles and accessories. The only limit is imagination:

- The Boules racer.
- The Grandkids transporter.
- The City cruiser.
- The Shopping cruiser.
- The Training bike.
- The Pet transporter.
- The Food carrier.
- The Elegant cycle.
- The Gadget bike.
- The Crutch bike.
- The Coffee bike.
- and so on.

The choices are just as personal regardless of whether we are older or younger; if only we get the chance to choose. I don't think this is a problem, so much as an opportunity.

Appendix 3:7
Functional requirements of cycles for older people

Per Kågeson, Nature Associates

Older people have less strength, balance and reaction capacity than younger people and are therefore more fragile. The functional requirements set for "cycles for older people" should be based on these conditions. In order to persuade the target group to obtain and use cycles for older people, it is important that these as well as functional requirements are also aesthetically attractive and not needlessly expensive.

Cycles for older people must be:

- comfortable
- light and easy to manage
- protective against accident and injury
- designed so that a person can carry lighter items of baggage
- aesthetically attractive

Comfort

The cycle must not subject arms, shoulders or lower regions to strain. The cycle should be easy to steer without straining hands and shoulders. It would be advantageous to design the cycle so that arms and shoulders were not stressed but used only for steering. The saddle or seat should be designed so that men (who are often affected by prostate trouble in later life) do not have problems. The sitting position should be comfortable. It must be simple to mount and dismount from the cycle and put feet down on the ground as required. By means of a rain-protective front which also reduces air resistance. At the same time, weight and cost increase.

Ease of cycling

Many elderly people have impaired lung function and/or heart problems. Bringing down the air resistance and creating a gearing to allow an even pace is therefore important. At the same time, the gearing system must not be too complicated or difficult to manage. An electrical auxiliary motor may be considered, if it and its battery do not noticeably counteract other functional requirements. Low wind resistance can be obtained by means of a low and somewhat reclined sitting position. This latter factor may however increase the balance problem if the cycle does not have more than two wheels. On the other hand, an overly reclined riding position can make it

harder to get out of the cycle or (regarding the rake) place strain on the neck.

Preventing accidents and injuries

The most important injury-preventing action is to design the cycle so that it is easy for cyclists to maintain their balance. Three or four wheels can contribute to this, but make the cycle heavier and more difficult to move and transport (see below) four wheels need not mean that the cycle is designed like a cycle car. It is also possible to consider two rear support wheels which are placed so that they always reach the ground. With more than two wheels, a safety belt can also be considered to prevent the cyclist from being thrown from their vehicle in a collision.

Elderly people need equipment to facilitate their view all round. An older person's bike may therefore need to be equipped with rear-view mirrors.

Easy to move and transport

Some elderly cyclists need to take their cycle indoors in order to prevent damage and theft, others may want the opportunity to take theirs in a car or on public transport. It should therefore be light and not very bulky. As everybody is aware, this functional requirement easily comes into conflict with the one for safety and comfort. An important design issue is therefore whether, through material choices and clever technical solutions, it is possible to do away with some of this contradiction. Wheelchairs are often collapsible. For cycles, such a move is complicated by the fact that the propulsion mechanism is more complex. Choice of lightweight construction materials can be cost drivers, which has to be noted as a limitation when the aim is to produce a cycle which will be economically available to many people.

Appearance and acceptance

There are already stable three-wheeler cycles for older people on the market. However, there is little demand which May be partially due to the cycles' "clichéd" appearance. It is thus important to make the design of a cycle for elderly people attractive, preferably slightly sporty in nature.

Baggage

It may be expected that many elderly people will use their cycle in conjunction with shopping trips or want to use it in other contexts to transport lighter items. Such loading adds increased instability on the traditional bike, particularly if the handlebars are used for hanging carrier bags, but also when using a rack. Cycles for older people should therefore be designed so that baggage can be placed in a way that contributes to a low centre of gravity and good balance.

Target conflicts

It is easy to see that functional requirements give rise to target conflicts. Low weight flies in the face of good balance and simple handling. Choice of light construction materials can to some extent bridge this conflict, but risks making the cycle expensive. An important task should therefore be establishing the extent to which such material choices are actually cost drivers or whether the relationship of light cycles being expensive is due more to their being manufactured in relatively small runs.

Since people may have somewhat different requirements of a bike for elderly people, different models should be considered which are optimised for somewhat differing functional requirements.

Appendix 3:8
Cycles for older people

Market trends for cycles for older people

Claes Alstermark & Roger Lindahl, Cycleurope Sverige AB

Trends and history

|Historically, cycles for older people have been mostly to do with offering a low step-through to make it easier to mount the cycle and start cycling.

Furthermore, the issue is more comfortable components, such as saddles, handlebars and so on.

There may also be adjustability, simple adjustment of the heightened angle of the handlebars etc.

These bikes often come under the City and Classic segment.

However, through surveys we know that today when people reach a mature age, they like to regard themselves as much younger than their actual physical age, so within our segment, we talk not so much about age as about advantages/differences between the various types of cycles.

There is also an incredibly strong trend today amongst young people wanting a classic “hammock type” bike; which means that we’re not just opting to steer that type of cycles towards elderly people.

Within the Cycleurope group, our fellow subsidiary Monark Exercise has for many years made three-wheeler cycles for disabled people but which naturally also work well for elderly people requiring the third wheel.

However, we are seeing a growing trend within the cycle industry for cycles to be made for a special target group. The Netherlands is a pioneering country in that respect with its mums’ bikes and so on.

In Sweden, cycles have not been marketed in this way to any great extent, but we would like to get involved and create this.

We also have a number of projects under way which should make things easier for elderly people; perhaps the most interesting being the electrically assisted cycle in which battery life and other technical solutions are in rapid development right now.

Other interesting fields are the cycle's load capacity, safety in the form of automatic lights, stepless or automatic gear hubs and a better chainless drive system.

Improved comfort

- Frame
  - Aluminium → lower weight
  - frame geometry → sitting position
- Front forks
  - Springing to reduce vibrations
- Handlebars/handlebar post
  - Improved setting capabilities
  - Ergonomic grips
- Saddle
  - Improved design in regard to human physiology
  - Materials
    - · Gel for increased comfort
    - · Water-repellent material, which does not absorb rainwater

Safety

- Lighting
  - Sensor control in respect of light strength and movement, for automatic switching on/off
  - Hub dynamo
  - Low-power diode rear light
- Reflectors
  - Modern reflectors which meet the highest standards (ECE Rules class 3, IA for front and back reflectors or IV A for side reflectors) in regard to reflective capacity
- Safety standards
  - The cycles should meet the requirements of the new safety standards (SS-EN 14764 Cycles for general use)

Components

- Gear hub
  - 3, 4, 7, 8-gear hubs with footbrake
  - New stepless gear hub

Electrically assisted cycles

Appendix 3:9
The ultimate cycle for older people

Lars Viebke

Training and experience: KTH, within mechanical engineering, design with fibre composites and mechatronics and cycle prototype development, recumbents, three-wheelers (chiefly tadpoles), auxiliary motor systems (chiefly BionX), long-distance cycling.

The ultimate cycle for older people is presented as an answer to a number of choices for different technical solutions, based on what I believe/consider to be most suitable:

Two-wheeler or three-wheeler? Three-wheeler, but with capability to lean when turning

This is to facilitate stability at low and high speed, plus limited width in combination with a relatively high centre of gravity and at the same time a natural cycle feel.

The tilt automatically locks at low speed and can be manually locked even at higher speeds such as in the case of slippery roads or if the cyclist has poor balance.

Having the wheel pair at the back (known as a delta trike) gives the best stability and at the same time scope for a parcel box between the wheels. Rear-wheel drive and a freehub on both wheels instead of a differential.

Two-wheeler or three-wheeler?

Upright or recumbent? Semi-recumbent, large saddle with separate back support

Back support tilt adjustable 70° from the horizontal. Like a Giant Revive, for example.

Seat height sufficiently low for both feet including heels to easily reach the ground, but at the same time not so low that the cyclist has problems getting out of the saddle.

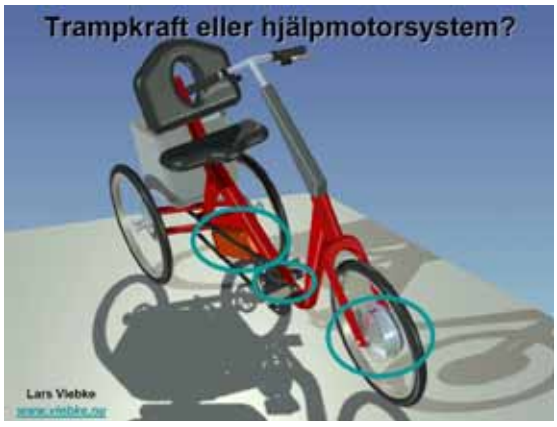
Frame with low step-through.

Upright or recumbent?

Just pedal power or auxiliary motor system?

Traditional auxiliary motor system (250W, approx. 10Ah battery, lithium-ion technology or similar) on the front hub, which assists up to a maximum of 25km/h when pedalling but also *low-speed function without pedalling* which can assist at walking speed (max 5km/h), to aid with starting or pushing the cycle.

Pedal power or auxiliary motor system?



Metal or composite?

Traditional construction of *welded aluminium*, to restrict the price.

Possible use of hydroforming technology.

Even a reasonable time into the future, fibre composite (load-bearing construction of continuous carbon fibres) means unduly high production costs.

Metal or composite?

Customer price?

Currently at least SEK 20,000; within the near future with longer runs and cheaper battery technology, approx. SEK 10,000.

Appendix 3:10
Three-wheelers and electrical assistance – options for elderly people?

Bo Dellensten, Svensk Cykling

Electrically assisted two-wheeler cycles

As we age, our muscle mass diminishes - we aren't able to do as much as we could when we were young. If we are not physically active, we become even feebler; this can be set straight by starting to exercise, but age-related muscle loss cannot be checked.

Considering that people of over 70 complete the Vasaloppet ski race and Vätternrundan bike race, we should not exaggerate the consequences of this ageing effect.

It is perhaps more common that, during their working lives, elderly people have relied on motorised transport and thus neglected their fitness. So, when they want to walk or cycle a longer stretch for some reason, they find they can't cope with more prolonged physical exertions.

Many come to the conclusion that they are too old to cycle and store the bike in the basement for good.

In that situation, an electrically assisted cycle can be of use in slowly building up fitness again. And electrically assisted cycle works so that an electrical motor helped drive the cycle. It does 50% of the work, but note that the electrical motor is only activated when the person begins pedalling. When you reach 25 km/h, the motor cuts out and cyclists wanting to cycle at 25 km per hour or faster must rely on their own pedalling power.

Because the motor is giving assistance, it is very easy to cycle at an even pace even for people whose fitness is poor or whose stamina is limited due to age.

As fitness is built up, a person can tolerate going faster and faster and eventually switch over to a normal bike if they wish.

Electrically assisted cycles have an operating radius of 20 to 40 km depending on the terrain and how much the electric motor is used. On level ground and downhill, the motor can be turned off and battery power saved. There are also electric cycles on which the motor can be switched on so as to charge the battery on downhill slopes.

As a rule, the batteries on electrically assisted cycles are lithium-ion type or nickel-metal hydride and can be charged up a large number of times. Charging is simple; the battery pack, which is quite often removable, is simply connected to a normal electrical socket using its accompanying cable.

Three-wheeler cycles

Occasionally, some elderly people are affected by dizziness. This creates a feeling of uncertainty and often leads to those affected not daring to continue cycling. It can actually lead to them becoming afraid to go for a walk alone and they can be transformed into passive stay-at-homes if they do not have someone to go out with.

In that situation, there is an alternative to the rollator: three-wheeler cycles. These cycles are not so common in the shops and most have never actually seen one, but they are produced by at least two Swedish cycle manufacturers, Skeppshult and Monark Exercise in Vansbro.

The cycles normally have 24 inch wheels and are designed in principle like enlarged three-wheelers for children, that is, one wheel at the front and two at the back. There are also models with two front wheels and one rear wheel.

The advantage of these cycles is that the person does not need to maintain their balance. If they become tired, they can stop and apply the handbrake to get their breath back whilst sitting on the cycle and then after a while, continue pedalling.

The disadvantage of these cycles is that they have a relatively high centre of gravity and since they cannot lean over on curves it is not possible to cycle as quickly with them as the person may then lose their balance and fall off. However, these cycles do not lend themselves to very high speeds, so as far as I can judge this is no great problem.

Nevertheless, there is a disadvantage in sitting relatively high (albeit lower than the normal bike because the wheels are smaller than on traditional two-wheelers) considering that people with balance problems may feel disinclined to sit high up.

There are three-wheeler so-called recumbents in which the person sits lower and which therefore have better balance and which mean quicker cycling. Unfortunately, no such cycles are manufactured in Sweden and very little importing takes place. In practice, none are available on the Swedish market.

Electrically assisted three-wheeler cycles

Three-wheeler cycles can be equipped with an electric motor to give assistance. Elderly people with balance problems and little energy can obtain a three-wheeler cycle with an electric motor which works along the same principles as two-wheeler electrically assisted cycles. Conventional-type electrically assisted three-wheeler cycles are available on the Swedish market through Swedish manufacturers and cycle shops.

Appendix 3:11
Why active elderly people in the US choose recumbents

Frederik Van De Walle (B)

Works as a designer in the automotive industry (Scania CV AB), with broad experience of the Belgian and Dutch (recumbents) cycle world as a sportsman, a researcher and even a little bit as a cycle manufacturer.

Background

Recumbent; a type of cycle involving cycling whilst sitting in a more or less reclined chair which supports the entire back. This is a largely unknown phenomenon in Sweden. Despite this, the history of recumbents goes almost as far back as a modern "upright" cycle. It has never spread very widely but is nonetheless known as a fully legitimate cycling alternative in countries with a strong cycling culture, chiefly the Netherlands. There, it is regarded as an effective and comfortable cycle most use by those who cycle distances. The recumbent is not an uncommon sight in the US, where it is most popular amongst elderly users; the principal theme for today. But first, I'd like to tell you a little about the origins of the recumbent.

Competitions influence technological development

Today's cycle became a success when, with pneumatic tyres, it proved faster in competitions against the highwheel during the 1890s. Cycle development might have taken a different course in 1933, when unknown French amateur cyclist Francis Faure beat the majority of world records including the main attraction, the one-hour record. He cycled on a recumbent which is faster than the normal cycle due to its lower air resistance. However, success was very short lived for the recumbent. The establishment behind competitive cycling, which had already been one of the world's greatest sports for over 40 years, was interested in different things than promoting the fastest technological solution. Following an exciting vote in the International Cycling Union, UCI (58 to 46 votes), new rules came out in 1934 defining how a cycle should "look". These excluded the recumbent.

With no support in competitions, the recumbent was quickly forgotten. These are the same rules which drew attention not long ago when Graeme Obree (1993) and Chris Boardman (1996) improved on the one-hour record for advanced competition cycling with an altered arm position. Both records were disallowed after the rules were changed to exclude their solutions.

Actions which may be good for the sport, but which may not have been particularly helpful to a broader technological development of the cycle.

Science

During the late 70s, American researchers began experimenting with alternative cycles with only one purpose: to go for a record outside the rules. They tried everything they could think of and then some, and many universities took part in the experiment. This new movement, named IHPVA[16], culminated in Freddy Markham (USA) successfully taking the prestigious DuPont Prize 1986 for being the first person to cycle faster than 65 mph or 104.6 km/h entirely under his own power[17]! Twenty years later, as a 49-year-old, which for a professional cyclist is nothing short of *pensionable age*, he won the Dempsey-MacCready Prize ($18,000) by cycling 86 km/h... for a full hour![18]

I bring this up for three reasons. One, it has been scientifically demonstrated by a good margin that today's UCI racer is not the fastest or most efficient solution. And from that, one can reasonably draw the conclusion that there is a lot of room for technological development in general for the cycle. Two, because the cycle which Markham used in 1986, named Gold Rush, is the basis for an entirely different development than high-performance. Three, that a "pensioner" in the US is the world's fastest cyclist!

Pensioners and recumbents

The 1986 record bike Gold Rush has an aerodynamic cowl. Without an aerodynamic cowl, the cycle was not in the least extreme. The sitting position more or less resembles that of a Harley-Davidson motorcycle and was very comfortable. The Gold Rush cycle was the start of a minor industry which today sells recumbents to thousands of Americans, often slightly older ones. I took a quick survey by e-mail and Internet and asked older American recumbent cyclists to tell me why they rode recumbent cycles[19].

[16] IHPVA, International Human Powered Vehicles Association, was the association which arranged the competitions and collated the knowledge in scientific publications.
[17] The current absolute official UCI world record at 200 m with a racing bike is 73 km/h by Curt Harnett (CAN) on a 250m wooden track (1995).
[18] The current absolute official UCI world record for distance over an hour with a racing bike is 49.9 km/h by Chris Boardman (UK) also on a 250 m wooden track (2000).
[19] See for example,
http://www.bentrideronline.com/messageboard/showthread.php?t=32851

Comfort cycle

I received responses from 25 people aged 61 to 92 and many more who gave their views[20]. The responses I received were unequivocal: the main reason for cycling a recumbent is the comfort! Around half stated they still generally used a normal cycle for short trips and the other half said that if there was no such thing as a recumbent they would be unable to cycle at all due to medical problems. They had joint pain, bad backs and knees, impaired balance etc. Several also stated that it was not uncommon for American doctors to prescribe that a patient should start using a recumbent.

Users feel safer because they know a head-on collision does not mean they will be thrown forward head-first, and a better centre of gravity means that hard braking is less dangerous. In addition, around one third use a three-wheeler recumbent because they had balance problems or because they were afraid of falling off. Some used an electrical auxiliary motor to cope with inclines.

Ergonomically, it is easy to understand that a reclined cycling position with the feet slightly in front of the body is better. The upper body is supported by a seat instead of the arms and pressure on the upper body is thereby entirely relieved. The bottom is supported by a large area instead of a small (and for many, painful) saddle. The seat height can be lowered to safer fall heights and the ground is more easily reached by the feet. All this increases comfort considerably and also increases availability for many elderly people.

American cycling culture

I asked not only why they themselves ride a recumbent, but also why they think the recumbent is popular amongst elderly people. What I established from all their responses can be summarised as follows: the US has a leisure and fitness cycling culture. People cycle because it is good for their health and because it's fun. This means that competition bikes have high status and cyclists would prefer to look like Lance Armstrong [21]. Elderly people are said to be less trend-sensitive and more easily convinced of the recumbent's advantages – they have a greater need, although they risk ending up lower on the status ladder due to their unconventional choice. The recumbent also has disadvantages. Recumbents today are more often than not expensive, difficult to buy and more often than not rather inconvenient to transport.

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[20] And over the years I have been able to follow many discussions on mailing lists and Internet forums. The "recumbent cycle community" was one of the social groupings which began to use the Internet very early.

[21] In case this has lost you. Lance was the one who won the world's toughest cycle race, the Tour de France, seven times in a row.

This was not states as a major problem for active pensioners who have enough time and are willing to put money into their health and hobby.

Away with pigeonholed thinking

Age is relative. One recumbent cyclist tells of an 80-year-old on a road racing bike who was faster than him and who subsequently said, upon seeing his recumbent, "when I get old, I'm going to buy one of those!". Personally, I cycle with an ordinary road racing bike, having cycled a recumbent for 10 years. Needs change over time, with location and person. The recumbent cycle in all its forms is not a must, however at the same time this wonderful solution should not be withheld from those who have greatest need of it. The message is simple[22]: by considering the cycle for different needs, there is great potential to gain on efficiency and ergonomics. Cycling is becoming more attractive, even more fun and more enjoyable for many more. If you've experienced a really good cycle which is a perfect fit, you know what a release it is.

The cycle, even the recumbent, is far from fully developed. Imagine if there were the equivalent investment in cycles that there currently is in the development of future cars. What results could it yield? It would be very exciting at any rate...

[22] If you've studied the history of technology a little, you'll know that the development of technology is controlled by much more than a few rational arguments. But that is where visions begin to grow …

Prohibited from winning: Francis Faure on his recumbent during the brief period when he was allowed to compete with the world elite of the day (1933-34)

Freddy Markham in his Gold Rush at the end of the 1980s

Freddy Markham 20 years later, the world's fastest cyclist is a pensioner (retired professional cyclist)

The same sort of cycle as Gold Rush. A real comfort bike which started a movement that changed cycling in the US

Giant Revive. A sitting bike which is easy to cycle, very accessible and a nice utility bike

A European recumbent, the Challenge Fujin; the rider lies more reclined and the bike is optimised for achieving high-performance. Weight only 8 kg

Larry Varney, editor of the Internet newspaper bentrideronline.com, resting on his trike

Appendix 3:12
Better cycles for older people

The role of research in cycle development

Hans Erik Pettersson

Swedish National Road and Transport Research Institute and Chalmers University of Technology

Many years ago, some research was carried out at VTI regarding cycle geometry. My memory of this project was that we could demonstrate how to construct a cycle which was impossible to ride. The expert in vehicle dynamics involved in the project pointed out that theoretically, it was not possible to cycle. I checked again with our expert in vehicle dynamics whether it was still true that cycling is not actually possible, but it turned out that certain advances have been made and now there are simulation programmes which can cope with the difficult art of cycling.

Well, vehicle dynamics and vehicle design and not really my field, so I'll point out some other areas of research which I believe are essential to work with in order to increase cycling, and where knowledge is probably needed in order to appropriate the information to improve cycle design, above all for elderly people but for everybody's benefit.

One area where knowledge is obviously needed relates to ergonomics and particularly the ergonomic requirements set by the limited capacity for movement of elderly people. It is very possible that this knowledge already exists in significant measure and the important thing is to compile it so that it is usable for the cycle industry.

An important knowledge base for the work of designing new and better cycles must surely be a description of how the needs of road users look both qualitatively and quantitatively. We have, dare I say it, very good information on the extent of car traffic and how it is distributed in both time and space. Concerning cycle traffic, the position is exactly the opposite. We lacked measurement methods, which means that we have very vague perceptions of what, when and how people cycle. Travel habits surveys by SIKA and VTI give us a rough idea of what the cycle traffic work looks like on the national level, but the solution offered by these measurements is too poor to use as the basis for planning and control of cycle traffic on a local level. There is obviously a need here for better measurement instruments.

Sales figures relating to cycles certainly give a good picture of the demand for various cycle types, but I doubt this gives any idea of what demand is like in various age categories.

Travel habits surveys and sales figures probably give a passably good picture of cycling on the national level, but better methods and a better definition are required if the description is to provide knowledge on how the situation is on a local level and for different age groups. The big problem with these descriptions however is that they describe cycle transport needs under current conditions. To obtain knowledge about a more unbiased need, we must permit ourselves to carry out surveys of a more explorative nature in which we can describe envisaged future scenarios for road users to decide upon. Seminars of the type we are taking part in here may be one way to go forward; another may be focus groups, in which the points of view of road users can be obtained. There is a need for method development here too.

Even though presumably most of us participating in this seminar are enthusiastic about cycling, it cannot be concealed that cycling is an unsafe way of getting around. The counterargument is normally that cycling is so good for the general health that the overall health effects are positive. It is possible that this is the way things are, but I have never seen quantitative data which describes this and we should perhaps produce this before we impulsively attempt to get our older population to abandon their cars and sit on bikes.

Regardless of what the net effect on health is, it is of course necessary to work to improve safety for cyclists and not least of all for elderly people who probably have a significantly greater risk of injury than younger people. In-depth studies of cycle accidents, including single-vehicle accidents, should probably be able to contribute new designs of cycle to reduce the risk of injury.

Where it concerns reducing the risk of injury, the most easily available measure is to generate the conditions for increased helmet use. How should cycle helmets be designed in order to be more attractive for older people to use, what convenient way is there for cyclists to avoid carrying around their cycle helmets when they have arrived at their destination? Trivial questions maybe, but probably of major importance to cycle safety.

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