Chapter 9
Case Study: An Assistive Technology Ethics Survey

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Abstract This chapter describes the online *N-Reasons Ethics and Assistive Technology* survey designed to address key ethical issues in assistive technologies. The survey was used to foster deliberation and focus discussions in a multidisciplinary workshop on assistive technologies. The survey focused on each of the four workshop topics (evaluation, sensing, networking, and mobility). This chapter thus begins with an overview of the survey design in Section 1 followed by the process that was used to establish survey content in Section 2. The results for the survey are presented in Section 3 followed by brief conclusions in Section 4.

A recent Peter Wall Institute for Advanced Studies (PWIAS) workshop on assistive technologies brought together a multidisciplinary group of experts to discuss some of the most difficult and seemingly intractable problems in

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assistive technology. As with any interdisciplinary project, productive and useful discussion can be difficult – hence a set of debatable issues were chosen as starting points to facilitate discussion in a multidisciplinary setting. A survey on ethics of assistive technologies was commissioned to identify these debatable issues. The survey was designed by a multidisciplinary group of researchers in assistive technology prior to the workshop. All workshop participants completed the survey, as well as members of the general public. The results of the survey provided data about which issues were non-controversial, and which issues were far less clear.

9.1 Survey Design

The Ethics and Assistive Technology survey addressed key ethical issues in assistive technologies and employed the N-Reasons experimental online survey platform developed by an the Norms Evolving in Response to Dilemmas (NERD) research team led by Dr. Peter Danielson at the University of British Columbia's Centre for Applied Ethics. This novel platform provides a means of engaging both the general public and experts in various ethically challenging issues and debates in two formats: 1) reason-based responses (described in greater detail below) and 2) the more conventional survey question formats (e.g., multiple choice, ranking) [1, 8, 2, 9, 6]. To date, the NERD research group has launched N-Reasons surveys on a wide variety of topics including research ethics, stem cell research, and robot ethics [9, 7, 5, 4].

The AT survey consists of five scenarios accompanied by one or more questions related to the various issues that each scenario involves. A total of fourteen questions are posed, each with the option to answer 'Yes', 'Neutral' or 'No'. Participants must select one of these responses and provide a reason, explanation or elaboration to move forward through the survey. The innovative feature of the N-Reasons platform is the opportunity participants have to vote for other participants' reasons instead of (or in addition to) providing their own (see Figure 9.1). The goal is to generate richer and more varied alternatives based on user-supplied contributions. The number of reasons the user chooses from (e.g., the "choice problem") is kept to a reasonable number by limiting content in three ways. First, by encouraging participants to use existing reasons rather than generating their own, the number of overall reasons is minimized and therefore more likely to result in identifiable trends or patterns. Second, running vote tallies for each reason are provided, which allows participants to factor in the valuation of the available reasons by other participants (e.g., no sums for decisions are displayed in order to make the reasons, as opposed to the 'Yes'/'Neutral'/'No' decision, salient.) The display ranking method used in the survey gives some weight to recent contributions in order to mitigate the primacy effect; this method is discussed in more detail in [4] and shown in Figure 9.1 below, where the third reason from the

top (with a vote of 1.0) is displayed above one with 2.0 votes. Finally, each participant can vote for multiple reasons so that there is no need to generate conjoint reason responses: "I agree with R#101 and R#111".

The NERD research group generally designs each new survey with a background empirical investigation. For this survey, we explored the effect of identifying reasons by either their author's pseudonym or merely by a generated number that represents the reason anonymously. The participants were divided into two groups with cohort 0 viewing only numbers (N = 46) and cohort 1 viewing pseudonyms (N = 51); see Figure 9.1. All participants viewed the same reasons; only the author's identifier (appended to each reason, as shown in Figure 9.1) was varied.

9.2 Survey Questions

Four topics were selected by a multidisciplinary working group in assistive technology at UBC prior to the workshop. They represent a set of topics considered not only highly relevant to assistive technology, but also intractable without multidisciplinary collaboration. The survey questions were designed to address each of the four workshop topics:

- **Evaluation:** How and why are assistive technologies being used, and what sensor technologies could provide accurate data to assess usage?
- **Sensing:** What ethical and privacy concerns might be raised by the vast amounts of personal data that computer-controlled assistive technologies can easily collect, and how might technologies incorporate features to address those concerns?
- **Networking:** How do assistive technologies impact the sense of self, agency, sense of privacy, and/or quality of life of users and the people in their social circles (family, friends, caregivers, others)?
- **Mobility:** How, if at all, can technological innovations improve or mitigate some of the ethical concerns surrounding powered wheelchairs and their potential for harm to the wheelchair user as well as to others in the environment?

Participants of the workshop were then asked to propose key issues and solutions to these particularly difficult problems.

To generate the survey questions, the NERD research group solicited input from the expert participants (the Advisory Committee to the PWIAS-ICICS workshop): each expert was asked to contribute scenario-based questions that they felt ought to be asked of the general public and which, in their opinion, represented key issues. After some initial feedback, the Advisory Committee was presented with an additional opportunity to comment on or revise the scenarios and questions. These revisions were then compiled and edited by the NERD research team to produce the final set of questions, which comprised

Home

your views

2. Sensing related scenario and survey question:

Sensing Scenario: Barbara has decided that she needs to provide greater supervision for her frail mother who is showing early signs of dementia. Barbara's mother does not want to leave her home, but has had a series of incidents that leave Barbara questioning whether her mother might inadvertently do herself harm (e.g. leaving the stove on, leaving food unrefrigerated). Barbara has a few choices in how she plans to cope with this situation. One option is to outfit her mother's home with sensors, which might include cameras that provide a live video feed and infrared sensors that detect (in real time) whether or not a person has entered a room. If her mother falls, for example, Barbara would be notified via email on her Blackberry. Alternatively, Barbara could move her mother into a full-time care facility. The reputable facility she has in mind has recently begun to monitor its patients and staff for potential acts of violence or aggression. Hence all residents must agree to be monitored in all common areas in order to live in the facility.

Please select the reasons closest to your own views on this question. You may also submit additional reasons. The most preferred are listed first.

☐ 109 (27.5/84)	**Neutral** because It depends on the type of sensors being used (video cameras, infrared, others), the security measures put into place to assure privacy is not violated, and on how the data is being analyzed before presented for human consumption. (**910**)
☐ 108 (17.0/84)	**Neutral** because it depends on what the patients (or their legal guardians) have agreed to. Some may feel the tradeoff in security is worth the loss of privacy, others not. Their autonomy to agree to terms that make sense to them ought to be respected insofar as they are capable of it, and if not their legal guardians should be the ones to make that call. (**972**)
☐ 11 (1.0/84)	**Neutral** because A question of Safety vs Privacy. If the person's mobility and independence have been assessed and they are not deemed safe especially for the bathing task then some sort of an easy to use alarm/audio system could be used to allow safe privacy. (**1804**)
☐ 2 (2.0/84)	**Neutral** because I do not feel that bedroom and bathroom monitoring should by any means be the "default". Suites could instead be provided levels of monitoring capabilities, which could be adjusted to match the needs of the residents. For those who are still mobile and mentally capable there could be simple touch pads to activate 2-way audio or 2-way visual. Those with mobility issues may be provided a remote for such a system (like the old "I've fallen" commercial); and lastly, those whose mental faculties have reached a point where monitoring may be necessary... would be a decision between the legal guardians of the resident and the facility. In all cases, audio contact should be attempted first, then video contact attempted if patient is unresponsive. Additionally, the frequency of video monitoring should be logged with timestamps, time/date/room that camera was on, and those should be made available to their legal guardian so they can assure their relative is not being spied on excessively. (**1578**)

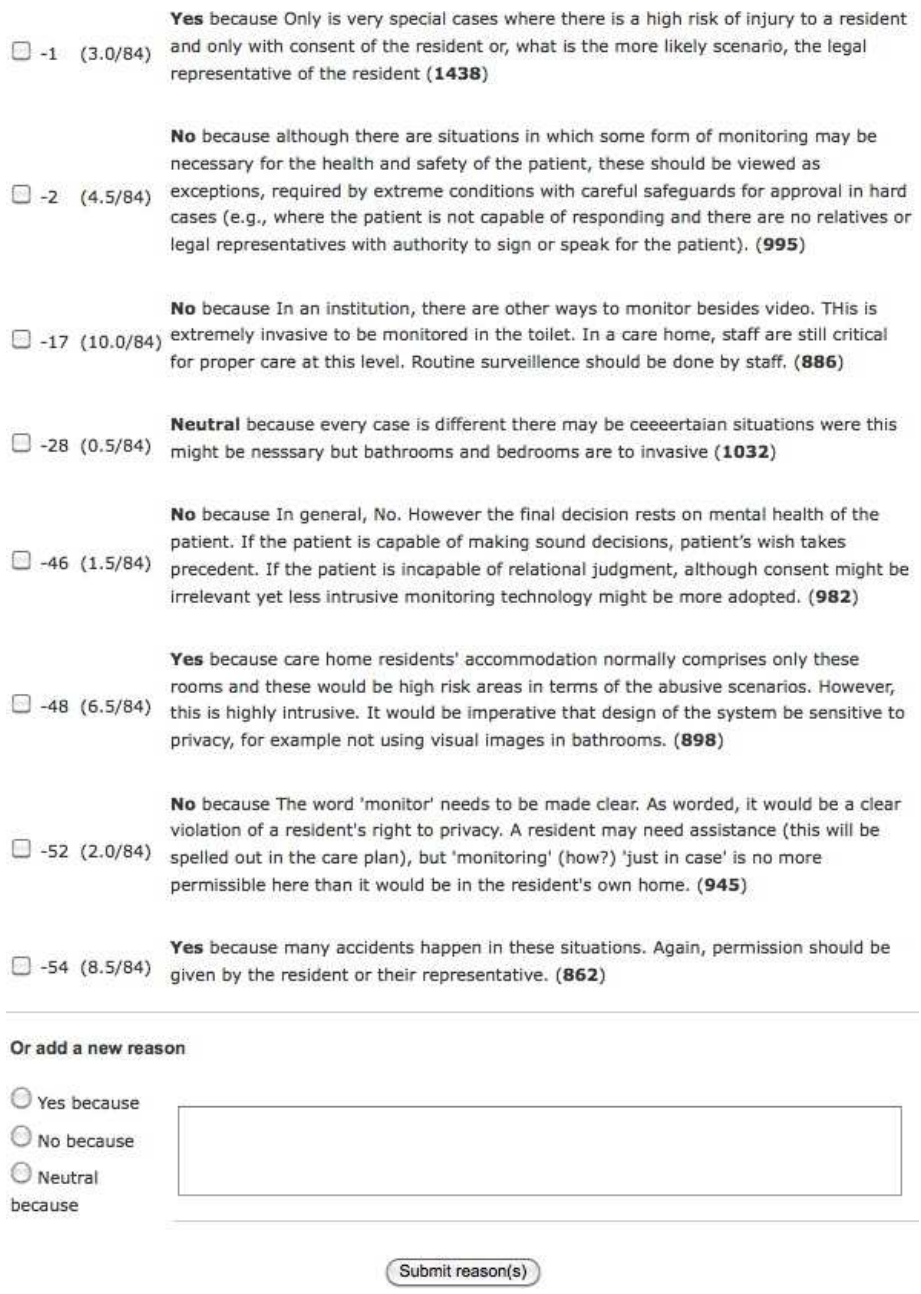

Fig. 9.1 N-Reasons survey visual presentation (from Cohort 0, who views reason numbers).

the AT Survey. In addition, a fifth scenario regarding athletic performance was added, given the timeliness of the workshop with the 2010 Vancouver Olympics.

The AT survey was formally launched to the general public three weeks prior to the workshop. The twin objectives of the survey were to identify 1) key ethical issues in assistive technologies, and 2) the most significant topics in each of the workshop theme areas. The survey scenarios and questions are presented in Appendix 1.

9.3 Results

A total of 97 people participated in the survey, including both the general public as well as researchers involved with the workshop. Survey results can be found online [3]; results for two of the five scenarios are reproduced in Appendix 2.

9.3.1 Aggregated Results

The survey produced clear qualitative outputs. While participants could choose from an often rich menu of reasons to support their decisions, their votes aggregate to a set of social decisions on the 'Yes', 'Neutral' and 'No' options. Figure 9.2 summarizes these results.

This level of aggregation allows us to characterize the answers to various questions in different ways. First, in questions 2A, 2B, 2C, 3A and 4B the 'Yes' answer is a clear majority choice. In contrast to these clear decisions, while question 1C has a bare majority 'Yes', nearly as many voted 'No' and no one voted 'Neutral'. We can characterize 1C as the most controversial question. In contrast, question 4C has a similar 'Yes' vote but with far fewer 'No' votes. Questions 1A, 1B, 2D, 2E, and 4A all had a plurality of 'Neutral' votes, and question 3B was almost evenly divided between 'Neutral' and 'No' votes. Question 5 was also quite controversial. Both Questions 1A and 5, two of the most most controversial questions, are presented in full in Appendix 2.

These rough characterizations based on aggregative votes should be qualified in two ways. First, they can be refined by considering to the additional information provided by the reasons participants voted for. For example, some 'Neutral' reasons protest the formulation of the question. Second, while we can characterize these distributions of answers as social decisions in the clearest cases (like the majority 'Yes' and 'No' cases noted) this is less clear in the plurality cases. Announcing a decision rule in advance would strengthen

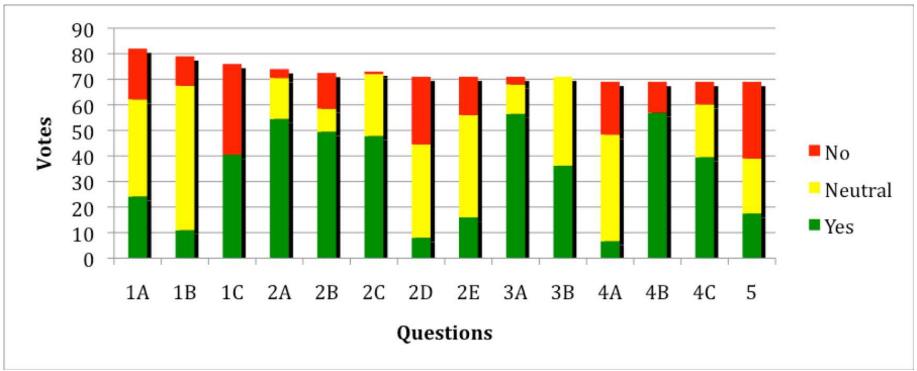

Fig. 9.2 Survey decisions by question. 'No' is the top dark shaded bar, 'Neutral' is the middle lightly shaded bar, and 'Yes' is the lower dark shaded bar.

these characterizations and move our device from survey to social decision procedure.

Evaluation Scenario: This scenario focused on obligations between a university and a student with a disability. Most survey participants stated that they would require additional information to determine the appropriate level of accommodation a university should provide to a student with a disability (1A, 1B). While most survey participants agreed that an occupational therapist should not consider cost to the university in deciding what assistive device the student needs, some survey participants disagreed (1C). However, despite disagreement, the most popular 'Yes' and 'No' responses both held in common that the occupational therapist's primary obligation is to the student.

Sensing Scenario: Survey participants most clearly agreed that in group homes, surveillance of residents always requires their approval (2A), and that in considering privacy of residents, raw data is more sensitive than data that has been read by machines and encoded into high-level characterizations (2B). Survey participants largely agreed that approval should also be required for in-home monitoring, as an integral part of respecting another person's autonomy (2C). The last two questions (regarding group homes) produced a variety of responses. For care facilities with residents who do not want to be monitored, the most popular response was that residents should not be removed, but rather accommodated as much as possible (2D). In considering whether monitoring of residents in bathrooms and bedrooms is acceptable, the most popular reason was 'Neutral', depending on the type of sensors being used, on the degree of data encoding and manipulation prior to human analysis of the data, and on security measures put in place to prevent violations of privacy (2E).

Networking Scenario: Survey participants agreed that social inclusion should be a design factor (3A), along with other relevant design factors (e.g., cost, environmental impact, maintenance) (3B).

Mobility Scenario: This scenario focused on a powered wheelchair user living in a group home. Survey participants expressed a wide variety of opinions in assessing whether the occupational therapist should be able to reduce wheelchair's maximum speed (4A); the most popular response was 'Neutral' due to a lack of information. However, an unambiguous majority of survey participants believed that the user should be able to set the wheelchair's maximum speed (4B), with many responses citing the need for autonomy and personal choice of risk level. Many survey participants agreed that the group home should be able to set and enforce speed limits on their property; others pointed out the necessity of increasing wheelchair speed outside of the facility (4C).

Enhancement Scenario: While the majority of respondents believed that Oscar Pistorius should not be able to compete with able-bodied athletes, the reasons behind 'Yes','No', and 'Neutral' responses varied widely (5). Reasons included the biomechanics of sprinting, comparison with other assistive devices, visibility of the prostheses, passivity of the device, Pistorius' skill, perceptions of fairness, and Pistorius' ability to inspire and attract viewers.

9.3.2 Self-documentation

The survey is "self-documenting," meaning that both the quantitative and qualitative results are generated by the survey itself, thereby making the analysis both rapid and accurate. Immediate results can be obtained and updated as more users complete the survey. The results of both the Evaluation scenario and the Enhancement scenario can be found in Appendix 2 and the results from all 14 questions can be retrieved directly from the *yourviews* website [3].

9.4 Discussion

9.4.1 Survey Design

Each of the NERD surveys is an experiment in a broad sense, dependent on having enough voluntary participants. In a stronger sense, however, NERD also experiments on new methods in most surveys, aiming to improve our platform incrementally. In this survey, we added voting for multiple reasons as

well as the modified popularity display ranking described above. We evaluate each of these innovations as a success. There were no complaints about the voting (as there had been in an earlier single vote survey) and our display method does mitigate the primacy effect as intended [4].

Finally, NERD conducted an experiment in the stronger sense of a random partition by dividing the population into two cohorts showing reasons identified by authors' pseudonyms or only by reason numbers. A preliminary analysis of this data suggests two small effects: first, those seeing authors' pseudonyms contributed more reasons; second, they contributed more votes of 'Yes' and less of 'No', while neutral votes remained about the same. We are presently conducting further experiments on ways of linking authors and reasons, which we hope will help explain these differences.

9.4.2 Survey Content

Some questions produced clear agreement (2A, 2B, 3A, 4B), while others did not. One particularly useful element of the survey was the exploration of the respondents' reasons behind the simple 'Yes', 'No', 'Neutral' vote. Agreement in assessment ('Yes', 'No', 'Neutral') was not necessarily synonymous with agreement in reasons. In some questions, participants agreed on the reason, yet came to different conclusions. In addition, in some questions with a high percentage of 'Neutral' responses, many respondents stated that the question did not address the proper issue. This was still quite informative, since respondents often provided their own assessment of the relevant issue. Consider question 1C, which falls into both of these categories:

> Suppose the University has in place an evaluation system in which a certified occupational therapist assesses the student's capabilities. Based on this assessment the needs of the student are determined and a recommendation is made to provide assistance. Should the occupational therapist consider the cost to the school when identifying assistance required for the student?

which elicited a variety of responses, including the following:

> **No** because the OT should make recommendations based on what is required of the student regardless of cost, but then someone OTHER than the OT should make a final decision that does take cost into consideration.
> **Yes** because the OT should make recommendations based on what is required of the student regardless of cost, but in high cost cases, also outline what can be achieved with a lower cost option and what limitations this places on the student. Then an informed decision can be made.

In this case, the reasons behind 'No' and 'Yes' both revealed that the respondents believed that the question missed the relevant issue. While the question had been designed to elicit a prioritization of the student's or the school's needs, the issue of who ultimately made the informed decision was

found to be more pertinent. Without the additional information provided in the reasons, 'Yes' and 'No' have far less meaning.

The results of the survey were incorporated into 'seed' questions to facilitate roundtable, small-group, interdisciplinary discussions in a) Evaluation, b) Sensing, c) Networking, and d) Safety and Mobility. Some of the questions with high 'Neutral' responses were useful in honing issues for discussion that would be of the most multidisciplinary interest. Some of the questions that did not have high 'Neutral' responses, and were particularly divisive (5), were used as 'icebreakers'. Ultimately, workshop participants were given the leeway, as was found useful in the survey, to pose and answer questions they felt were most relevant. The initial list of questions identified for each discussion session are listed in Appendix 3.

9.5 Conclusion

The AT Survey was successful in generating both qualitative and quantitative results in response to the issues associated with assistive technologies and which formed much of the discussion during the AT workshop. Rather than merely producing one type of data or another, the survey has provided a more comprehensive set of data upon which further analysis can be performed. It is possible to see from this approach that the issues involved are complex and include several factors to consider. In general there were a number of neutral responses in all but two of the questions (1C and 4B) which are difficult to interpret in standard surveys; however, given the structure of the N-Reasons platform, it is possible to more clearly understand what the participants are concerned with and why they choose such a response. Additionally, the survey addressed those subjects that the experts engaged in this field felt were the most important and relevant to other researchers and the general public.

Acknowledgements This research was partially funded by the Peter Wall Institute for Advanced Research and Genome Canada through the offices of Genome British Columbia. Thanks to the NERD team, especially Robin Avery for programming the N-Reasons platform, and our participants for their enthusiastic support.

Appendix 1: Ethics and Assistive Technology Survey

- **Evaluation scenario:** The University has purchased voice recognition software for students who have disabilities that make it difficult or painful to type. Jane is a student with this kind of disability and has been provided with the software but does not use it. She instead asks to be accommodated with a typist to whom she can dictate.

1A. The software the University purchased was chosen for its accuracy and performance but also for its high degree of customization. Jane has tried to learn the software once or twice but she quickly gave up, finding it too difficult to learn. Do you think that the University has an obligation to accommodate Jane with a typist in this case?

1B. There is a one-time cost associated with the software license which the University assumes will pay off over time. The cost of a typist is ongoing and dependent on a variety of factors such as the typist's availability and changing rate of pay. Do you think that Jane should be accommodated with a typist in this case?

1C. Suppose the University has in place an evaluation system in which a certified occupational therapist assesses the student's capabilities. Based on this assessment the needs of the student are determined and a recommendation is made to provide assistance. Should the occupational therapist consider the cost to the school when identifying assistance required for the student?

- **Sensing scenario:** Barbara has decided that she needs to provide greater supervision for her frail mother who is showing early signs of dementia. Barbara's mother does not want to leave her home, but has had a series of incidents that leave Barbara questioning whether her mother might inadvertently do herself harm (e.g., leaving the stove on, leaving food unrefrigerated). Barbara has a few choices in how she plans to cope with this situation. One option is to outfit her mother's home with sensors, which might include cameras that provide a live video feed and infrared sensors that detect (in real time) whether or not a person has entered a room. If her mother falls, for example, Barbara would be notified via email on her Blackberry. Alternatively, Barbara could move her mother into a full-time care facility. The reputable facility she has in mind has recently begun to monitor its patients and staff for potential acts of violence or aggression. Hence all residents must agree to be monitored in all common areas in order to live in the facility.

2A. Should residential facilities be subject to ethical guidelines for this type of surveillance of their residents, to ensure the residents' approval, at some level, of the intrusion on their privacy?

2B. If personal data collected from assistive technologies is encoded and read only by machines instead of people, is it less sensitive? For example, real-time data (like video) would not be stored. Instead, only higher-level information would be extracted from it (e.g., a time-stamped event such as "subject went to living room").

2C. Should Barbara ask for her mother's permission to install sensors in her home?

2D. Does the care facility have the right to remove current residents (who moved into the facility before monitoring was implemented) if they are unwilling to be monitored?

2E. Is it acceptable for the care facility to monitor residents in their bedrooms and bathrooms?

- **Networking scenario:** A university is built on the side of a steep hill. The university is deciding how to design access routes between buildings. One option is to build a series of long ramped paths, which can be used by everyone. The other is to build a staircase that goes up the middle of the hill for non-wheelchair users and a series of lifts which could only be operated with a key, and which could fit only a single wheelchair user and nobody else at one time.

3A. Should the social interactions of people using the potential access route be incorporated into the design of the university? In this case, should the design of the university aim to keep wheelchair users and non-wheelchair users on the same route?

3B. Should the university take into account the long term increased energy and maintenance costs associated with keeping wheelchair users and non-wheelchair users on the same route?

- **Mobility scenario:** Peter is a 30 year old intelligent man who has cerebral palsy with severe spasticity, which renders him unable to walk. He has limited fine motor control of one arm. In the past, he has tried a mouth switch and a head switch on a power wheelchair, as well as a standard joystick. However, therapists are reluctant to give him a power chair because he lives in a busy area of the city. Their fear is that he will either drive into a building or a person, or drive off the sidewalk and hurt himself. Currently, when he leaves the group home where he lives, he must be accompanied by an assistant who pushes him in a manual wheelchair. Peter has just been informed that a wheelchair manufacturing company is developing a prototype of a new power wheelchair that is maneuverable, accessible to a variety of user inputs (e.g., sip and puff, joystick), and has some safety features built in (e.g., bumpers to protect walls, furniture, etc. in soft collisions). Due to damage and liability concerns, the manufacturer is also planning to add a speed control function (accessible by a key code only) that determines the maximum possible speed.

4A. Peter's occupational therapist has recommended he try the new prototype wheelchair that includes safety features. The chair is outfitted with a 'black-box' that continuously records maximum speed, average speed, and number of collisions. After a 30-day probationary period, the therapist evaluates Peter's driving record. Based on the black-box data, the therapist decides that Peter can continue to use the powered wheelchair, but that the wheelchair's maximum allowable speed will be set to half its previous value. Is this fair?

4B. Should Peter be given the key code to his own wheelchair?

4C. Assume that Peter will not have access to codes on his wheelchair. Does his group home have the right to dictate that only wheelchairs with speed control functionality can be used in the facility?

- **Athletic performance scenario:** "Despite having both lower legs amputated as a child, South African runner Oscar Pistorius dreamed of one day competing in the Olympic Games. That dream was dashed in early 2008 when the International Association of Athletics Federations ruled him ineligible, claiming his carbon-fibre prosthetics gave him an unfair advantage over able-bodied competitors. Pistorius appealed to the Court of Arbitration for Sport, which overturned the decision just in time for the Beijing Games. Unfortunately, the athlete known as Blade Runner fell seven-tenths of a second short of the Olympic qualifying time in the 400 metres." [10].

5. Should Oscar Pistorius be allowed to compete with able-bodied athletes?

Appendix 2: Results of Question 1A and Question 5

Question 1A: The university has purchased voice recognition software for students who have disabilities that make it difficult or painful to type. Jane is a student with this kind of disability and has been provided with the software but does not use it. She instead asks to be accommodated with a typist to whom she can dictate.

The software the university purchased was chosen for its accuracy and performance but also for its high degree of customization. Jane has tried to learn the software once or twice but she quickly gave up, finding it too difficult to learn. Do you think that the university has an obligation to accommodate Jane with a typist in this case?

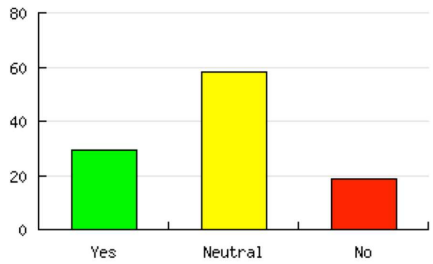

Fig. 9.3 Responses for Question 1A.

Table 9.1 Participant reasons generated by Question 1A (unedited)

Score	Reason
(22.8/84.5)	**Neutral** because not enough information is provided about Jane's difficulty with the software or the university's efforts to help her use it effectively. I don't want to waste time speculating on either, I prefer fuller information in the question. I don't think the university should accommodate someone who has not made an honest effort to participate, but there is no way of telling that.
(15.8/84.5)	**Yes** because Jane should be given a typist in the interim with encouragement to try modifying the software to improve success. In the long run she could be more independent if she found something that worked for her beyond a typist.
(12.5/84.5)	**No** because more can be done to make the software usable for Jane. E.g., the university could offer a customization session. The typist approach will likely be very expensive long-term, and the most cost-effective option should be used (taking into account all costs, not just financial ones - Jane's frustration should be counted as a cost).
(10.2/84.5)	**Neutral** because I am not sure how well the software performs. If it is well designed in terms of usability and demonstrates robust voice recognition then Jane should be strongly encourgaged to persevere and not be given a typist unless she really has made a lot of effort.
(7.0/84.5)	**Neutral** because Jane should be given a typist in the interim with encouragement to try modifying the software to improve success. In the long run she could be more independent if she found something that worked for her beyond a typist.
(5.3/84.5)	**Yes** because this may be a difference between U.S. and Canadian law. Under U.S. law, the university must provide an effective accommodation for Jane, and as everyone who has used voice recognition software knows, it does not work well in some contexts, especially for someone who does not articulate uniformly.. The reason given above does not state what more can be done, other than a customization session which will not be effective if Jane does not articulate uniformly.

Question 5: "Despite having both lower legs amputated as a child, South African runner Oscar Pistorius dreamed of one day competing in the Olympic Games. That dream was dashed in early 2008 when the International Association of Athletics Federations ruled him ineligible, claiming his carbon-fibre prosthetics gave him an unfair advantage over able-bodied competitors. Pistorius appealed to the Court of Arbitration for Sport, which overturned the decision just in time for the Beijing Games. Unfortunately, the athlete known as Blade Runner fell seven-tenths of a second short of the Olympic qualifying time in the 400 metres." [10]

Should Oscar Pistorius be allowed to compete with able-bodied athletes?

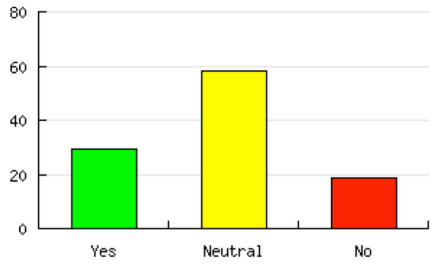

Fig. 9.4 Responses for Question 5.

Table 9.2: Participant reasons generated by Question 5 (unedited)

Score	Reason
(19.5/71)	**No** because with prosthetics, the biomechanics of sprinting are significantly different than without prosthetics. A 400m with prosthetics is a different sport than a 400m without.
(10.3/71)	**Neutral** because because it is not clear whether Pistorius' prothesis is an "external device or piece of equipment" like a spring loaded shoe or whether it is an integral part of his body. Would an athlete with an artificial internal hip or knee joint be restricted from participating? Is it because the prosthesis is external and visible that we are considering discriminating agains Pistorius? Wouldn't we want the most current technology in an internal knee joint for an athlete? Why not in an external prosthesis also? Or, do we view the prosthesis as we would a wheelchair which is clear advantage for some running events over natural runners, i.e. it is an external device that is not part of the person? This is the reason given above for a Yes answer (acook), but its indeterminacy really supports a neutral stance.
(9.0/71)	**Yes** because there is as yet no evidence that the prosthetics give him an unfair advantage. This is obviously a grey area - few would argue that he shouldn't be allowed to compete with no prosthetic at all, but most argue that he shouldn't be allowed to compete if his prosthetics were fuel-powered. A fully passive prosthetic is roughly equivalent to the introduction of the clap skate in speed skating - some skaters were faster with the clap skate than the conventional, but the top athletes were initially faster with the conventional skate. It would be very difficult to design a passive prosthetic which would confer any significant advantage over an intact athlete.
(8.0/71)	**No** because although I'm sympathetic to Pistorius's goals, there's no principled way to draw a line between Pistorius's blades and other assistive devices that would clearly give an unfair advantage.
(4.8/71)	**Neutral** because I do not know enough about the speeds achievable with the prosthetic limbs compared to able bodied athletes. I assume they do not infer an advantage and so should be allowed. However, if the prosthetic limbs, on average, increase performance then their user becomes a different class of athlete and should compete in a separate competition.
(3.5/71)	**Neutral** because in the same way that there is restrictions on swim suit designs, racket designs, there also has to be restrictions and rules for prosthetic design used in competition so it is not a greater advantage to have a prosthetic limb.

(2.5/71) **No** because even a passive prosthetic can provide an unfair advantage over other athletes. Where do we draw the line between Pistorius's blades and a bicycle fitted for amputated legs? What about spring-loaded shoes on able-bodied athletes? Should those be allowed? It seems that the best response at this point is to disallow all prosthetics which could potentially offer performance enhancements. One significant consequence of saying "no" here is questioning where the line of prosthetic enhancement ends (e.g. shoes).

(2.5/71) **Yes** because agree with john. also, perhaps Pistorius is a black swan compared to his peers. now if all amputee runners began to post times better than olympics runners, than this would clearly be a different class. but the reality is that they are not even close and Pistorius just happens to be that good

(2.0/71) **Yes** because we are speaking about a game. But then all able-bodied runners wshold be allowed to use carbon-fiber prosthetics, ... to be fair.

(2.0/71) **Yes** because it is not clear whether Pistorius' prothesis is an "external device or piece of equipment" like a spring loaded shoe or whether it is an integral part of his body. Would an athlete with an artificial internal hip or knee joint be restricted from participating? Is it because the prosthesis is external and visible that we are considering discriminating agains Pistorius? Wouldn't we want the most current technology in an internal knee joint for an athlete? Why not in an external prosthesis also? Or, do we view the prosthesis as we would a wheelchair which is clear advantage for some running events over natural runners, i.e. it is an external device that is not part of the person?

(1.3/71) **Neutral** because The restriction should be based on how much the artificial parts enhance the performance of an athlete for a specific event. It's an inexact scientific assignment. It's clear that as science advances super mechanical parts will become available and no one argues athletes fitted with such parts should be allowed to compete.

(1.0/71) **No** because the right judges in such cases are those sponsoring the competition.

(1.0/71) **Yes** because the Court Of Arbitration For Sport is the supreme sports court. (CAS said the IAAF failed to prove that Pistorius' running blades give him an advantage)

(1.0/71) **No** because his goal was to demonstrate that the accident did not affect his ability to run. He does not need to compete with professional athletes in order to do this.

(1.0/71) **Yes** because it's inspiring for other amputees and it would attract a large viewing audience. Fairness is all relative, and we actually make the rules so that the competition is interesting. Clearly, the blades do give an advantage to Oscar (I'm very familiar with this technology) and eventually prostheses or exoskeletons will enable Oscar and other athletes with physical "disabilities" to outperform their intact counterparts. As this happens, the Olympic committee will have to be creative in coming up with new rules that meet the spectators' expectations that the competition be both "fair" and all-inclusive. Perhaps separate categories could be created, each having their own technology-based rules. It may be that NASCAR could serve as a model for some future Olympic events.

(1.0/71) **Neutral** because I do not know enough about the issue.

(0.5/71) **No** because no maybe he should try olympics for the disabled

Appendix 3: Small-Group Discussion Questions in the PWIAS-ICICS Workshop

- **Evaluation**
  1. What devices, methods, and protocols can assist researchers and clinicians in measuring how, when, and under what circumstances AT is being used? Should users make these determinations?
  2. What devices could be designed and implemented to bypass self-reporting? What best-practices might prevent violations of privacy if self-reporting is eliminated?
  3. What novel devices and methods for collecting data can be used to evaluate the impact of AT? What do we mean by impact?
  4. What novel devices, algorithms, and methods could non-intrusively detect/predict abandonment?
  5. How does device novelty affect its knowledge translation? Where in the pipeline from academic research to end-user use does knowledge translation fail, and why?
  6. When is AT appropriate? What user circumstances determine if AT should be used? When a device is abandoned, what determines whether a replacement device is required?
- **Sensing**
  1. How does a user's specific circumstance (type of disability, social network, use of AT) influence what type of data should be gathered?
  2. What level of security is required for user data? What privacy standards should be enforced? What are potential consequences of breaches?
  3. How much user benefit is required to overcome a loss in privacy (e.g., utility of Google mail often outweighs privacy concerns)?
  4. How much control should users have over their sensor data? Why are specific types of sensor data more acceptable from a user's point of view than others?
  5. Ubiquitous sensing technologies may require additional computing, storage, and communications infrastructure. How could this burden be mitigated to prevent potential derailment of new AT?
  6. Ubiquitous sensing may be a deterrent for some people, but if designed well, could be desirable (e.g., an iPhone-based application for route finding via wheeled mobility). When is such technology desirable, or detracting, from the user's point of view?
- **Networking**
  1. How does level of customization of AT affect a user's sense of agency? Are 'generic' technologies less beneficial / useful?
  2. How should concerns about agency impact technology design and use?

3. How can AT be designed to physically prevent or deter violations of a user's privacy or personal space?
4. Novelty and a steep learning curve can be significant barriers to the adoption of AT. How does switching to a new type of AT impact a user's sense of self?
5. How can novel technologies be designed to integrate seamlessly into the physical and social environments of the users and their surroundings?
6. To what end can sophisticated technologies be made user-friendly for people who are unfamiliar with computers, etc. (e.g., the elderly)?
7. What best-practices can ensure that devices are made from a need-based pull, as opposed to a technology-push?

- **Safety and Mobility**

1. What design practices can make AT more easily and reliably customizable to individual users?
2. What factors determine when mobility AT is warranted for a specific individual?
3. Under what circumstances should information recorded about the safety of a person's previous mobility behaviors be used to restrict or enhance the future capabilities of their mobility AT?
4. What best-practices in device and algorithm design could make mobility AT more robust to obsolescence? Given the high cost of mobility AT, what technologies would be required to make mobility AT modular and upgradeable?
5. What infrastructure should be developed to enable people who use mobility AT (e.g., Segways that may not be operated on sidewalks, powered wheelchair restrictions in group homes)?
6. How much control should group home residents have over their powered mobility AT? What other mechanisms could assure safe driving without sacrificing user autonomy?

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