Standing on the shoulders of giants: attacking the meta-problems of technical AAC research

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Abstract

Augmentative Alternative Communication (AAC) policy suffers from a lack of large scale quantitative evidence on the demographics of users and diversity of devices.

The 2013 Domesday Dataset was created to aid formation of AAC policy at the national level. The dataset records purchases of AAC technology by the UK's National Health Service between 2006 and 2012; giving information for each item on: make, model, price, year of purchase, and geographic area of purchase. The dataset was designed to help answer open questions about the provision of AAC services in the UK; and the level of detail of the dataset is such that it can be used at the research level to provide context for researchers and to help validate (or not) assumptions about everyday AAC use.

This paper examine three different ways of using the Domesday Dataset to provide verified evidence to support, or refute, assumptions, uncover important research problems, and to properly map the technological distinctiveness of a user community.

1 Introduction

Technical researchers in the AAC community are required to make certain assumptions about the state of the community when choosing research projects that are calculated to make the most effective use of research resources for the greatest possible benefit.

A particular issue is estimating how easily technical research can achieve wide scale adoption or commercial impact. For example, (Szekely et al., 2012) uses a webcam and facial analysis to allow a user to control expressive features of their synthetic speech by means of facial expressions. Such work is clearly useful, but it is difficult to assess its potential commercial impact without also knowing what proportion of currently available AAC devices include webcams and how that proportion is changing over time. Similarly, corpus based approaches such as (Mitchell and Sproat, 2012) could potentially be brought to market very quickly, but that potential can only be assessed if we also have some awareness of the range and popularity of AAC devices that either have space for such a corpus or the internet capability to access one. Unfortunately, even though there are a range of AAC focused meta-studies in the literature (see, for example, (Pennington et al., 2003; Pennington et al., 2004; Hanson et al., 2004; Alwell and Cobb, 2009)) they give little information on the technical landscape of AAC.

This paper examines three issues of interest to technical researchers in AAC, each from a different stage in the research lifecycle. It then shows how the Domesday Dataset (Reddington, 2013) can provide evidence to support, or refute, assumptions, uncover important research problems, and map the technological distinctiveness of a user community.

This paper is structured as follows, Section 2 introduces the Domesday Dataset and discusses the context it is used in in this work. Section 3 examines the issue that little is known about the prevalence of equipment within the AAC user community, and because of this lack of information it is difficult to establish baselines, or contexts. We

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show how the Domesday Dataset can allow researchers to ground their assumptions in empirical data.

Section 4 examines a cultural shift in AAC technology. The arrival of the iPad and other tablets in the field has caused a great deal of change and it is unclear what the long term implications will be. We believe it is important to provide hard data on the direct economic changes that have occurred in the marketplace. The Domesday Dataset allows us to examine the number of physical devices purchased before and after the tablet explosion.

Section 5 examines the issue of transferability. It is assumed by many AAC professionals that the ability for AAC users to transfer page sets between different devices is a significant issue for AAC users. This section first shows how we can derive some context information from the Domesday Dataset and goes on to discuss the sociotechnical context of the problem space.

2 The Domesday Dataset

In 2013 the Domesday Dataset was created to aid formation of AAC policy at the national level. The dataset records purchases of AAC technology by the UK's National Health Service between 2006 and 2012; giving information on make, model, price, year of purchase, and geographic area of purchase for each item. It was formed by submitting freedom of information requests to every NHS (National Health Service) trust asking for details of all AAC devices provided since 2006. The requests required the year of purchase, make, and manufacture of each device. The full details of the construction are reported in (Reddington, 2013).

At the time of writing, the Domesday Dataset contained details of 9,157 purchases from NHS Trusts. (Reddington, 2013) estimates that the trusts that have responded cover approximately 90% of the UK population. All versions of the dataset are held online and licensed under an Open Data Commons Attribution License. The dataset meets the requirements for three star linked open data according to (Berners-Lee, 2010). A sample of information appearing in the Domesday Dataset is given in Table 1. The dataset was not only intended to shape UK policy and research, but also as a snapshot for international researchers: allowing comparison of manufacturers, types of aids, budgets, and prevalence within a tight geographical domain.

There are, of course, caveats to consider before using the Domesday Dataset. Firstly, for privacy reasons, it is presented with no connection to any other element of AAC provision: it is impossible to match equipment with a particular user.

Secondly, the NHS does not have the complete information: information from AAC manufacturers shows that only 44% of sales and 38% of the spend were by the NHS. Even with complete data from the public bodies, researchers would be forced to extrapolate the information, perhaps confirming the trends by means of another research methodology. This work makes the assumption that the relative frequency of AAC purchases and trends in the UK are reflected in the dataset. We are careful not to over-analyse this information, but we do note that having a complete list of NHS purchases, even if they only cover 44% of a county's purchases, is vastly more detailed than any previous record of AAC provision. Potential problems with the dataset underrepresenting tablet sales are discussed in Section 4.

3 Research Granularity

Little is known about the prevalence of equipment within the AAC user community, and because of this lack of information it is difficult to establish baselines, or contexts. Perhaps worse, when researchers propose solutions, they must also make a range of assumptions about the applicability of their work to the wider AAC audience. We can, for example, imagine an innovative new model for AAC not being successful because it requires a consistent internet connection from the device, which perhaps only 5% of users have. The majority of AAC research is devoted to building up a library of case studies to show the benefits of AAC for user groups. This focus on social issues in AAC research is laudable, and vital for the overall area; however, researchers working in the assistive technology field would be more effective if they could answer direct questions about need, capability and technology. For example, a researcher who must choose between supporting a project that reduces errors in word-prediction using eye-gaze by 20%, or a project that makes Step-By-Step devices more responsive and intuitive to use for children, faces a difficult choice without evidence. If the researcher could check that in a particular geographic area there were 45 eye-gaze systems and nearly 600 Step-by-Steps, then that

Purchase year	Manufacturer	Model	Num.	Unit Price	Total Price
2006	Liberator	E-Tran Frame	1	£120.00	£120.00
2006	Servox	Digital Electronic Larynx	2	£520.00	£1,040.00
2006	Ablenet	Armstrong Mount	1	£190.00	£190.00
2006	Ablenet	Big Mack	6	£84.00	£504.00
2007	Inclusive	Switchit "Bob the Builder"	1	£49.00	£49.00
2007	Cricksoft	Crick USB Switch Box	2	£99.00	£198.00
2007	Sensory Software	Joycable2	1	£49.00	£49.00
2007	Dynavox	Boardmaker	1	£209.00	£209.00
2007	ELO	LCD Touch Monitor	1	£419.00	£419.00
2008	Ablenet	iTalk2 Communication Aid	2	£95.00	£190.00
2008	Attainment Company Inc	Go Talk(unknown type)	4	£130.00	£520.00
2008	Aug. Communication Inc.	Talking Photo Album	2	£18.91	£37.82

Table 1: Extract from the Domesday Dataset, taken from (Reddington, 2013) (Geograpic information held seperately)

might influence the decision[1] (at a higher level this is, of course, the calculation that one expects funding bodies to make when awarding the grants that allow projects to even begin). Having quantitative manufacturing data also supports much more general estimations of research impact, as well as helping research groups evaluate possible commercial partners.

Even within the United States, which is the major market for manufacturers, and the most active area for AAC research, the complexities of its healthcare system, differing state legislation, and disability culture make estimation difficult. Even the strong efforts that have been made (Matas et al., 1985; Bloomberg and Johnson, 1990; Binger and Light, 2006; Huer, 1991) give estimations of need and use, but none that can be expected to give the granularity that technologists need for their investigation, or even to frame research questions.

3.1 What Domesday tells us

To illustrate the use of the Domesday Dataset for technical researchers, we give some simple results regarding the popularity of various types of AAC device. Table 2 shows the list of most common 'high tech' AAC purchases by the NHS in Scotland, ordered by the number of units purchased between 2006 and 2012. Table 3 gives the same table for purchases in England. Both tables are based on a relatively open definition of 'high tech' AAC: these lists include only devices that can produce a range of different utterances, and allow those utterances to be selected by icon, or keyboard. As a result they do not include such devices as, for example: Big Macks; Digital Electronic Larynxs; Jelly Bean Twists; Step–by-Steps; MegaBees and many others, which are included in the Domesday Dataset. As discussed in Section 2 we do not advise the direct quoting of these figures without first being familiar with the caveats discussed in (Reddington, 2013). The figures should be considered comparative only.

Rank	Model	Units
1	Lightwriter (SL35/SL40)	37
2	GoTalk (all types)	34
3	iPads and iPods	15
4	Springboard Lite	12
5	Vantage Lite	6
6	SuperTalker	6
7	Dynamo	6
8	V Max	5
9	Tech/Speak 32 x 6	4
10	Liberator 14	4
11	C12 + CEYE	4

Table 2: The 11 most common 'high tech' speech aids purchased by the NHS in Scotland 2005-2011

Some of the more counter-intuitive results from Tables 2 and 3 include the general absence (with the notable exception of the iPad/iPod) of touch screen devices. Indeed, both the Lightwriter and the GoTalk range comfortably sell more than twice as many units as their nearest touchscreen rival.

A more sobering result to consider for researchers in technical AAC is the popularity of

[1] In either direction of course, depending on the weighting given to a variety of other factors.

Rank	Model	Units
1	Lightwriter (SL35/SL40)	77
2	GoTalk (all types)	74
3	iPad/iPod/iPhone	29
4	Springboard Lite	27
5	V Max	11
6	Dynamo	10
7	SuperTalker	7
8	Vantage Lite	6
9	Tech/Speak 32 x 6	6
10	Chatbox	5
11	C12 + CEYE	4

Table 3: The 11 most common 'high tech' speech aids purchased by the NHS in England 2005-2011

devices that are less obvious targets for customisation and improvement. The GoTalk and Tech/Speak ranges are solid favourites for a particular section of the market and part of their appeal is that they are relatively 'non-technical'[2] and are much easier for users and staff to get to grips with: this appeal is somewhat in tension with advanced features like automatic generation of content and voice banking. It is entirely possible that technical research would have more impact if it focuses on making high-capability devices more acceptable to existing users rather than increasing the already impressive capability of existing devices.

Another aspect of interest is the speed at which the AAC market changes with respect to the existing landscape. The Dynavox Dynamo, for example, is a popular device in both tables, but it has been discontinued for some time. Section 5 explores some of the issues that this situation can raise. Finally we consider that there are some systems that we would have expected to appear in these lists that are absent: for example, Dynavox's Xpress and Maestro or Tobii's MyTobii, and Liberator's Nova. Speculating on why some products become more popular is beyond the scope of this work; however, we do consider it an area for future interest.

This section has shown that examining the Domesday Dataset at even the most basic level identifies a range of factors that can help contextualise the technical landscape for researchers in AAC. To return to the examples given in the introduction, we can see how it would be simple for (Szekely et al., 2012) to use the iPod and iPad's position in the marketplace as evidence for the potential of their work and we can see how corpus based approaches such as (Mitchell and Sproat, 2012) can use the range of AAC devices with internet connections to inform the design process. We note that as the data covers a five year period it is possible to examine 'fashions' as purchases rise and fall and even map the gradual spread geographically.

4 Tablets and other animals

This section examines the extent to which the introduction of tablet-based AAC has altered the user community at the technical level and discusses how this data can be used by technical researchers.

Since 2010, when Apple released the iPad, there have been major upheavals in the AAC market, caused by the explosion in tablet computing. From an engineering perspective, the iPad only suffers in comparison to existing devices in terms of ruggedness; however, at potentially one quarter the price[3], it is comparatively replaceable. From a software perspective the iPad gives many 'cottage industry' developers for AAC a low cost way to enter the market. Such developers already include Alexicom, TapToTalk, AssistiveWare, and over 100 others. Such developers are well placed to take advantage of the platform's underlying hardware.

Apples's position as a top-tier technology giant, along with the iPad's position as the dominant tablet platform can be seen as a serious change to the AAC industry as a whole. However, for many working within the AAC community, it is unclear what the long term implications will be. Apple represents the most successful of a large group of companies such as Samsung, HP, and (via the Android operating system, and the purchase of Motorola) Google (Weber, 2011) that have invested heavily in tablet technology. It is conceivable that one or more manufacturers will develop a 'ruggedised' tablet for military or medical use. Such a tablet, particularly if using the Android operating system, which has a large group of dedicated AAC developers (Higginbotham and Jacobs, 2011), would open a 'second front' from the point of view of the existing manufacturers, as it would

[2]For example, neither device has a LCD screen, instead they have buttons with printed icons

[3]Based on estimates from (Reddington, 2013)

remove many of the perceived weaknesses of the iPad (fragility, waterproofing, volume).

The picture is muddied greatly because neither the major AAC manufacturers nor Apple release reliable sales figures. This results in the uncomfortable situation for users, professionals, and researchers alike, that we are simultaneously being told that "The iPad is simply the flavour of the month at the moment and it is just the effect of hype" and "The major manufacturers simply can't compete at any level other than eye-gaze".

Of course, the issue of the overall effectiveness of tablet-based AAC must be paramount for the general AAC community, and there is a large amount of research resources investigating this. This paper simply attempts to provide some hard data on the technical changes that have occurred in the marketplace since 2010.

4.1 Domesday on tablet AAC

If we assume an average lifespan of four years per device, then Table 2 and Table 3 can be considered to give a reasonable approximation of the relative popularity of AAC devices currently active in the UK AAC community. As discussed in Section 3, touchscreen and other high-capability devices are not dominating the market, but we can deduce that Apple devices have a strong market share compared to devices with similar capabilities. In Table 2 and Table 3 iPads and other Apple devices are shown to be approximately even in terms of units shipped with established touchscreen systems such as the Springboard Lite. It would be difficult to argue that Apple devices were not a major part of the AAC landscape.

A factor in these estimations must be the relatively recent explosion in table computing. If we limit our data to only purchases since 2010 (as shown in Table 4), we see that Apple devices dominate the sector and we would expect that when the Domesday Dataset is extended in 2014, we shall see that Apple devices have achieved the position of market leader in terms of AAC devices in use.

4.1.1 Other tablets

We note that, other than some appearances of the FuturePad Windows system (running Grid 2 software and predating the tablet explosion), there are no tablet purchases in the dataset that are not an Apple device. This is a somewhat unexpected find: the Android app store shows hundreds of thousands of downloads (worldwide) for AAC applications for the Android platform. Some potential explanations for this tension are discussed in the following section, but we consider this an area for future research.

4.1.2 Potential understatement of tablet sales

Section 2 discussed some caveats about information in the Domesday Dataset, in particular that it only examines purchases in the medical sector and is understood to cover less than half of the AAC market. We note here that these caveats may disproportionately affect tablet computing purchases. For example, the relatively low cost of tablet devices means that there is a growing possibility that the paradigms used by service providers are no longer fit for purpose. Whereas previous paradigms may have involved users waiting two years for a £7000 communication aid, with £3000 worth of support and training, the same users may now, out of desperation, opt to pay out of their own pocket for a £700 tablet with 'app'. In terms of the goals of this paper, such situations artificially depress the recorded purchases of tablet devices, and in terms of the goals of the AAC community, the choice of a 'better device later or cheaper device now' may not be to the long term benefit of users, or society.

Moreover, we can also imagine situations where tablet devices are already present in an AAC user's life before they become used as a dedicated device. In the same way that family members often 'hand down' older phones to parents or children when they upgrade, we have anecdotal evidence of situations were "Chris can try an app on Steve's old iPad while he is at university and then we'll buy Steve a new one if that works". Such practices would again artificially depress the number of purchases recorded.

In this work we concentrate on only the reports of purchase of physical tablets. Although the Domesday Dataset does contain app purchases where they have been recorded by the NHS, the wide range of AAC applications, both free and paid for, and their transferability between devices mean that only the most vague of comparisons could be made.

Even without these caveats, it is clear from examination of the Domesday Dataset that, in the UK at least, Apple devices like the iPad have become a large part of the technical AAC landscape and we note that their level of hardware and strong developer communities make them attractive tar-

Rank	Model	Units
1	iPad/iPod/iPhone	25
2	GoTalk (all types)	10
3	Lightwriter (SL35/SL40)	10
4	Springboard Lite	6
5	EC02	6
6	C12 + CEYE	3
7	SuperTalker	2
8	Dynavox Maestro	2
9	Powerbox 7	2
10	S5	2
11	Dynavox (type unknown)	2

Table 4: The 11 most common 'high tech' speech aids purchased by the NHS in England 2010-2011

gets for researchers building prototype AAC devices.

5 Transferability of data

It is assumed by many AAC professionals that *transferability*, the ability for AAC users to transfer page sets between different devices, is a significant issue for AAC users. Unfortunately there is no previous academic research to support this in general or estimate the size of the problem space. This section first shows how we can derive some contextual information from the Domesday Dataset and goes on to discuss the sociotechnical context of the problem space.

We can examine the set of devices purchased in the years 2006-2012 and check to see if they were still available to purchase in 2012. From this we can estimate the lifespan of each device to extract the set of devices that are 'irreplaceable' in the sense that the same model cannot be purchased in cases of loss.

A large proportion of the devices listed in the Domesday Dataset are no longer available to buy[4]; however, they are still in service and, in some cases, still in manufacturer's warranty. The resulting set of irreplaceable devices is large and this information supports a need for more research.

These irreplaceable devices contextualise a space in which a range of sociotechnical issues at the social and economic level have special resonance with the AAC user community (for work examining the reliability of AAC devices and their likely length of time before needing repairs please see, for example, (Shepherd et al., 2009; Ball et al., 2007)).

As discussed in (Reddington and Coles-Kemp, 2011; Coles-Kemp et al., 2011), the custom utterances and user history on a device form not only a large part of the user's way of interacting with the world, but often, their memories and sense of self.

It is recognised by manufacturers that this data is precious and many manufacturers of electronic AAC systems offer the functionality to back up the devices to external storage. However, in the event of irrecoverable hardware failure, such backups are only generally useful if the user's replacement device is of the same model as the existing device (in some cases, manufacturers can transfer backups between different models of the same manufacturer). If it is the case that an AAC device's functional lifespan is longer than the device sales lifespan, then it is also the case that massive information loss must occur when a range's devices reach the end of their lifespan and users are shifted onto other devices.

Moreover, because AAC device backups are not held in a common format, it is difficult for AAC users to transfer sets of pages between devices at all. If a user wishes to switch from, say Proloque2go to Dynavox, then the only way to transfer potentially key parts of their identity and memory between the devices is for the user, or care staff, to laboriously recreate systems by hand. This results in users having difficulties 'trying out' new systems, and the occasional sight of a user with two AAC devices: one that is failing but has the full range of utterances, and a more modern device that may be clearer and more effective, but which does not yet have all the necessary utterances. Finally, the lack of a common format stands as a barrier to the deployment of a truly 'open source' page and symbol set that could be used across formats and developed independently of hardware manufactures.

It is the author's position that this shows a clear and present need for not only a standardised format for transferring sets of pages between devices but also that this standardised format be open and accessible to researchers. We consider these to be a counterpart of the work in (Deruyter et al., 2007); however, where (Deruyter et al., 2007) focused on increased interoperability between AAC and mainstream technologies, we argue in favour

[4]The Domesday Dataset has examples from major manufactures that include the DV4, the Dynamo, the Vanguard, the Springboard, and many others.

of increased interoperability between the devices themselves. The work is perhaps philosophically closer to the work of (Lesher et al., 2000b; Lesher et al., 2000a), which seeks to produce universal standards of logging of AAC utterances for research purposes. We argue that a standardised format would also allow technical researchers to develop their prototypes to interface directly with a user's existing systems. This would produce a much more seamless way of testing innovations, without the need to introduce users to dedicated equipment or a specialised app for testing a particular innovation in AAC technology.

6 Discussion

Research in AAC policy and technology suffers greatly from a lack of large scale quantitative evidence on the prevalence of devices, and the demographics of users. This work has shown that the Domesday Dataset can be used at the research level to provide context for researchers and to help validate (or not) assumptions about everyday AAC use. This work examined three different issues of interest to technical researchers in AAC, each from a different stage in the research lifecycle. It provided a case study in using the dataset to gain an understanding of the level of technology currently deployed in the UK AAC community, and exposed a number of open research questions.

This work also gave an analysis of the impact of the explosion in tablet computing on the AAC technological landscape. We provided evidence that Apple devices are already a significant part of the AAC community and that we expect their presence to grow as older devices phase out of the market.

Finally we considered how the Domesday Dataset suggests that product function lifespan may be longer than the product sales lifespan in AAC technology and discussed the consequences of this from a sociotechnological perspective. This work has pushed the AAC research agenda in a direction more attractive to larger studies, commercial manufactures, and quantitative research to support the traditionally qualitatively focused field. The range of possibilities for AAC research includes: more accurate estimates of populations of AAC users, and levels of AAC use; the ability to evaluate the potential impact of research prototypes and methodologies; and the ability to examine those sectors of the AAC industry that have been most successful at delivering improved functionality to users.

6.1 Future research agenda

At the more fundamental level we hope that this work encourages public debate about where the trade-offs lie in terms of targeting technical research in both AAC and the wider intellectual disability field. It is the author's position that stakeholders at all levels in AAC should be involved in debate on the areas of focus for research resources.

Moreover, we believe that an open format for transferring sets of pages between devices is needed, and that such a format will improve both user experience, commercial competition, and research effectiveness. We would welcome further work.

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References

Morgen Alwell and Brian Cobb. 2009. Social and communicative interventions and transition outcomes for youth with disabilities a systematic review. *Career Development for Exceptional Individuals*, 32(2):94–107.

Laura J Ball, David R Beukelman, Elizabeth Anderson, Denise V Bilyeu, Julie Robertson, and Gary L Pattee. 2007. Duration of aac technology use by persons with als. *Journal of Medical Speech Language Pathology*, 15(4):371.

Tim Berners-Lee. 2010. Linked data. Personal website ('http://www.w3.org/DesignIssues/LinkedData.html'), Jun.

Cathy Binger and Janice Light. 2006. Demographics of preschoolers who require aac. *Language, Speech, and Hearing Services in Schools*, 37(3):200.

Karen Bloomberg and Hilary Johnson. 1990. A statewide demographic survey of people with severe communication impairments. *Augmentative and Alternative Communication*, 6(1):50–60.

L. Coles-Kemp, J. Reddington, and P.A.H. Williams. 2011. Looking at clouds from both sides: The advantages and disadvantages of placing personal narratives in the cloud. *Information Security Technical Report*, 16(3):115–122.

Frank Deruyter, David McNaughton, Kevin Caves, Diane Nelson Bryen, and Michael B Williams. 2007. Enhancing aac connections with the world. *Augmentative and Alternative Communication*, 23(3):258–270.

EK Hanson, KM Yorkston, and DR Beukelman. 2004. Speech supplementation techniques for dysarthria: a systematic review. *Journal of Medical Speech Language Pathology*, 12.

Jeff Higginbotham and Steve Jacobs. 2011. The future of the android operating system for augmentative and alternative communication. *Perspectives on Augmentative and Alternative Communication*, 20(2):52–56.

Mary Blake Huer. 1991. University students using augmentative and alternative communication in the usa: A demographic study. *Augmentative and Alternative Communication*, 7(4):231–239.

Gregory W Lesher, Bryan J Moulton, Gerard Rinkus, and D Jeffery Higginbotham. 2000a. *A universal logging format for augmentative communication*. Citeseer.

Gregory W Lesher, Gerard J Rinkus, Bryan J Moulton, and D Jeffery Higginbotham. 2000b. Logging and analysis of augmentative communication. In *Proceedings of the RESNA Annual Conference*.

Judy Matas, Pamela Mathy-Laikko, David Beukelman, and Kelly Legresley. 1985. Identifying the nonspeaking population: A demographic study. *Augmentative and Alternative Communication*, 1(1):17–31.

Margaret Mitchell and Richard Sproat. 2012. Discourse-based modeling for aac. In *Proceedings of the Third Workshop on Speech and Language Processing for Assistive Technologies*, pages 9–18, Montréal, Canada, June. Association for Computational Linguistics.

Lindsay Pennington, Juliet Goldbart, and Julie Marshall. 2003. Speech and language therapy to improve the communication skills of children with cerebral palsy. *Cochrane Database of Systematic Reviews*, 3.

Lindsay Pennington, Juliet Goldbart, and Julie Marshall. 2004. Interaction training for conversational partners of children with cerebral palsy: a systematic review. *International Journal of Language & Communication Disorders*, 39(2):151–170.

J. Reddington and L. Coles-Kemp. 2011. Trap hunting: Finding personal data management issues in next generation aac devices. *Proceedings of the second workshop on speech and language processing for assistive technologies*, pages 32–42.

Joseph Reddington. 2013. The Domesday dataset: linked and open data in disability studies. *Journal of Intellectual Disabilities*, 17(2):107–121.

Tracy A Shepherd, Kent A Campbell, Anne Marie Renzoni, and Nahum Sloan. 2009. Reliability of speech generating devices: A 5-year review. *Augmentative and Alternative Communication*, 25(3):145–153.

Eva Szekely, Zeeshan Ahmed, Joao P. Cabral, and Julie Carson-Berndsen. 2012. Winktalk: a demonstration of a multimodal speech synthesis platform linking facial expressions to expressive synthetic voices. In *Proceedings of the Third Workshop on Speech and Language Processing for Assistive Technologies*, pages 5–8, Montréal, Canada, June. Association for Computational Linguistics.

Tim Weber. 2011. BBC News - Google to buy Motorola Mobility, last retrieved September 2011.