Measuring, Sampling, Logistics & Technology

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This preliminary material has been prepared as part of on-going research by Hunarch Consulting into the spatial correlates of wheelchair and scooter use in buildings and facilities.

Research into the population of occupied wheelchair and scooter and their spatial correlates, highlights the fascinating and challenging nexus between measuring, sampling, logistics and the measuring and data capture technology. An effective methodology is impossible without a pragmatic reconciliation of these factors.

It is fascinating because of the range of sophisticated measuring technologies that are now available that tantalizingly seem to offer ease and accuracy of measurement and motion capture. It is challenging because it is not easy to find a balance between all of the factors and because the technologies do not live up to their apparent promise.

If the targeted sample size is too large, the measuring will be prohibitively expensive and prolonged: if it is too small, it will be unreliably representative. If the measuring regime, systems and technologies used are inexpensive, a striving for a larger sample size will be more feasible: if they are expensive then the smaller the sampler will need to be for feasibility.

If measuring equipment is not portable it will be unsuitable for fieldwork, and may necessitate participants attending a central venue. This increases the difficulty of attendance for potential participants, and therefore diminishes the likely pool of them. This increases the risk of not achieving target sample sizes, the prolongation of the recruiting and measuring program, or increase costs if greater incentives have to be offered to attract participants.

If measuring equipment apparatus is too expensive, it will be unaffordable for fieldwork. If measuring equipment is less sophisticated, it may be more affordable, but may be less accurate.

Criteria for selecting appropriate measuring equipment included:

- Accuracy of data recording, conversion and processing
- Speed of data recording, coversion and processing
- Minimum intrusion upon participants and their vehicles
- Minimum reliance upon human judgment (observations, recordings, self-reports by participants)
- Minimise number of measuring personnel required (for measuring and equipment set-up
- Maximum naturalism of trial settings
- Automation of data conversion and processing
- Preference for data recording techniques that do not restrict the number of notations that can be made
- Maximise preservation of complexity of measured, deferring simplification until later stages

- Maximum portability of equipment and driving skills trials
- Provision for participation by drivers in their own vehicle
- Maximum use of equipment and services that are readily and widely available

The measuring strategies initially proposed for the Australian Government research comprised of:

- Measuring stationary occupied wheelchairs (including heights)
- Measuring the splaying of elbows during manual wheelchair propulsion, and
- Recording travel paths of wheelchairs and scooters in mock passage layouts

Various options for measuring and tracking travel paths were considered: as separate exercises, as pairs, and all together.

A wide range of devices was investigated.

Measuring and tracking devices

Devices investigated included:

- Digital height measuring bars
- Digitising drawing devices[8]
- Tape measures linked to a host computer for data transfer direct to a database.
- Infrared linear measurers
- Robotic systems
- Sonic sensors and trackers
- Photogrammetry[3]
- Stereo-videogrammetry[4]
- Piezo cable mats[7]
- Coupled surveillance style video photography linked direct to computer for frame editing and replay
- Laser scanning devices[2]
- Infrared safety curtains[6]
- Electromagnetic tracking system[5]
- Infrared tracking systems

All of these are deficient in one or more of the following requirements: portability; affordability; accuracy; and retention of data identity.

The inaccuracy is due the inherent complexity of form of occupied wheelchairs and scooters: no device is able to capture all of the key points: there will always be many that are occluded from the scanning or measuring device. Furthermore, except for the photographic technique, outlines only are recorded, without a record of the identity of different parts of the outline. With electro-magnetic scanners, the metal of many wheelchairs pose a significant doubt about their accuracy.

The optimum devices and techniques currently appear to be simple manual ones. They are not only very inexpensive and portable, but appear to be the most accurate of all of the systems investigated. In its Australian Commonwealth research, for measurements of stationary occupied wheelchairs and scooters, Hunarch Consulting used large sheets of paper upon which to trace vertically-projected key points of the occupied wheelchairs. This is identical technique to that used by Robert Fenney and Associates for the British Standards research. For recording travel paths in its Australian Commonwealth research, Hunarch Consulting used large sheets of corrugated paper.

However, the efficiency of the manual methods, and the accuracy of data transfer, can be improved by complementing them with some of the above devices. For example, data transfer of wheel track impressions on corrugated paper can be achieved with photogrammetry. Similarly, data transfer of projected points on the drawing sheets can be greatly expedited by using an electromagnetic tracking stylus.

In relation to reach ranges, one promising system is sonar tracking. However it is expensive. Another system is an electromagnetic tracking system, however it is adversely affected by proximity to metallic objects[9]. A simpler technique that has been used for recording reach ranges is comprised of tracings made on paper with a pen held within or attached to a persons hand: the paper is aligned vertically, horizontally or obliquely.

Weight

Weight measurements were not required for the Australian Government research. Where this is required in research, there is a broad range of flat-bed platform scales available. However, inquiries are being made into weigh-in motion technology.

Weigh-in motion technology is the technology used in roads for measuring the weight of road vehicles as they travel over the roads. The main component is a cable, or cables over which the vehicles travel.

Two systems that appear to have promise are piezo-electric cable and fibre-optic cable systems[1].

The advantage of weigh-in motion systems would be that wheelchair and scooter users could simply drive over a cable, or mat of cables, rather than have to negotiate a flat bed platform scale. The result would not only be far greater weighing speed but also less imposition upon the wheelchair and scooter drivers.

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