MAPPING INTERIOR SPACES

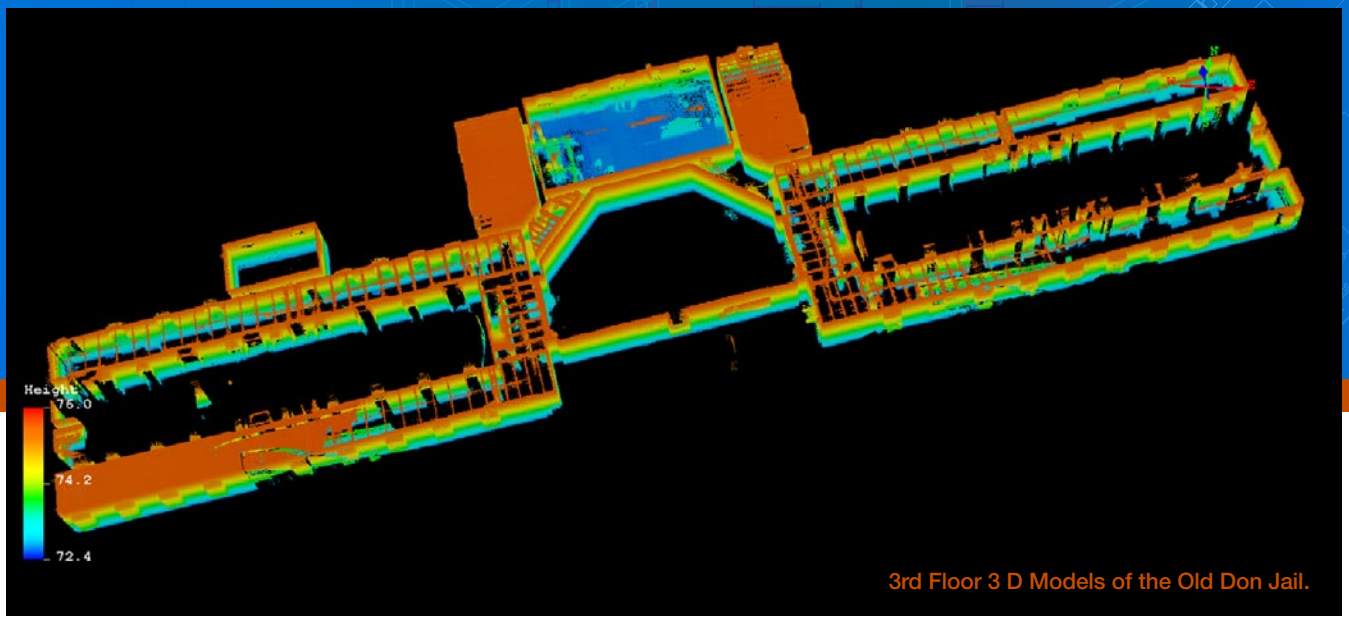
with Speed, Ease & Accuracy

The TIMMS Cart is equipped with a laser scanner, camera, indoor positioning, GPS, operator console, and complete workflow.

New technology quickly delivers interior geospatial data to cross discipline groups for multiple purposes, such as Situational Awareness and Building Information Modeling.

Documenting the precise order and condition of indoor structures and their contents has always been a time consuming and expensive task. For outdoor environments mobile mapping, or the creation of accurate geospatial information from a moving platform, has proven to be the most cost-effective and productive way of acquiring quality infrastructure data, but because it relies heavily on receiving GPS signals for positioning information, and because GPS signals typically do not penetrate building materials, obtaining the localization required for effective mobile

>> By Peter Canter and Andrew Stott



3rd Floor 3 D Models of the Old Don Jail.

mapping *inside* has been impossible… until now. Trimble's new indoor mobile mapping solution (TIMMS) integrates active and passive sensors and an intuitive user workflow to enable true indoor GIS capability, making mobile mapping for interior environments not only possible, but easy, quick, and cost-effective.

Indoor Mobile Mapping vs. Traditional Survey

Mapping an indoor space has traditionally been accomplished using the "Total Stations" approach, which is time consuming and costly. A tripod, laser and camera are set up to capture measurements and images at various locations. The equipment is moved and set up again–many, many times in fact–until all perspectives of the room are captured. While this method delivers high accuracy with relatively low capital costs, it has several significant problems: it is labor intensive, requires a lot of equipment in order to cover large areas, and produces many datasets which all need to be merged. These challenges significantly raise the complexity, cost, and time to completion. This conventional static method, when applied to surveying an existing building, takes approximately one week of field time to cover 100,000 square feet of indoor space. With the indoor mobile mapping solution now available, it takes just one day.

Operation of TIMMS is straightforward; a single walk-through, at normal walking speed, of an interior space delivers full 360 degree indoor coverage. Maps and models of thousands of square feet of indoor space are captured in minutes, entire buildings in a single day. The system is highly maneuverable and can be moved in and around furniture and other obstacles, making even complex, busy spaces effortless to complete. Once the walk-through is finished, software can be used for the production of accurate interior maps, spherical maps, videos, and 2D or 3D models.

"As is" maps and models, multi-purpose 2D or 3D building data and design data is quickly produced with high accuracy. Comparisons of distances measured in laser scan data sets by the indoor mobile mapping solution and those measured in real life with a tape reveal that this technology obtains relative accuracy to within plus or minus one inch.

Application

There are a large number of instances where this type of indoor mapping capability is desirable–including instances where it is critical and life-saving. Consider for example situations where people must quickly and efficiently enter and operate in a building they are unfamiliar with (for example, a firefighter who is required to enter a burning building to rescue a trapped family). The building's design, layout and contents are all unknown, yet getting in, finding victims, and getting out fast is paramount: in fact it's life or death. Or imagine a solider operating in a hostile urban environment, facing adversaries one building at a time, block after block. Knowing how to enter and move within these buildings, with speed and confidence, is again a critical factor for success and survival. Both of these situations require that personnel have Situational Awareness (SA) to be effective, and SA is conditional upon having accurate and reliable indoor base map information.

Situational Awareness

Dimensionally accurate visual 2D and 3D layouts and models dramatically assist human decision-makers faced with operating in new and unfamiliar environments by making them fully aware of an environment *without ever having been in it*. They allow personnel to visualize the inside, to map it, and when combined with location based services (LBS), to locate assets, hazards, and specific interiors. Personnel can determine their optimum path inside *prior* to having ever entered the building. The tie to indoor LBS is notable–TIMMS provides the context necessary for LBS to be effective. Without a base map indoor, the effectiveness of LBS is severely limited.

Indoor base maps also aid commanders and tactical decision-makers by enabling them to accurately visualize environments where personnel need to be deployed, making it possible to rapidly and effectively deploy, re-deploy and re-direct forces. "At-risk" personnel can be prioritized and situations can be quickly and effectively responded to, thereby saving lives.

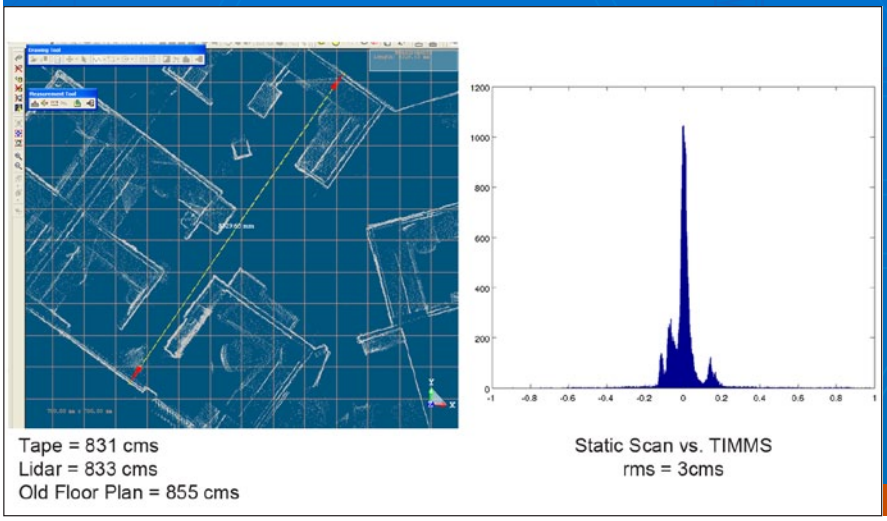
The interior maps created can be integrated into more widely acquired

regional GIS databases–completing the effectiveness and usefulness of the data and further enhancing SA. Without this SA, the first responders and military personnel described above are ill-prepared for the task before them. With it, they are fully prepared, with a plan and a path.

Building Information Modeling

The building construction industry has radically different purposes than first responders and military personnel, but the benefits it can realize with interior map information are just as significant. The term Building Information Modeling (BIM) is used throughout industry to describe the process of generating and managing building data during its life cycle to increase productivity in building design, construction, and maintenance. Typically, the Building Information Model encompasses building geometry and plans, spatial relationships, geographic information, and quantities and properties of building components.

Until now, professionals involved in BIM had a choice of acquiring quick but limited 2D data (floor plans) of interiors and interior structures, or acquiring more detailed but also more time-consuming 3D LIDAR data. Indoor mobile mapping eliminates this difficult compromise; both sets of data are collected at the same time, in a single pass, at low cost, and with 3-5 centimeter accuracy. Conventional plans and draftsman's drawings will remain for purposes they are best suited for, but they will now be created with more "as is" information from the indoor mobile mapping systems and will become the vehicle of choice for conveying building information to design teams, to general contractors and subcontractors, owners, managers, etc.



TIMMS achieves centimetric accuracy.

The benefits of 3D models are substantial in this context; they give the ability to assess alternative design and construction schemes, identify and resolve geometric conflicts in advance of construction, optimize the sequence of construction, and demonstrate the scope of work to sub bids through increased clarity.

Data Examples

The Old Don Jail is a provincial jail for remanded offenders in the city of Toronto, Ontario, Canada. The jail closed however in 1977 and is now being renovated and redeveloped into administrative offices.

Having been originally constructed in the mid 1800s, the jail is a historic site and as such, very little BIM information is available. TIMMS was deployed to collect interior map data for possible use in planning the renovation and new construction. The project has demonstrated the multi-purpose aspects of TIMMS data.

Models of the Old Don Jail

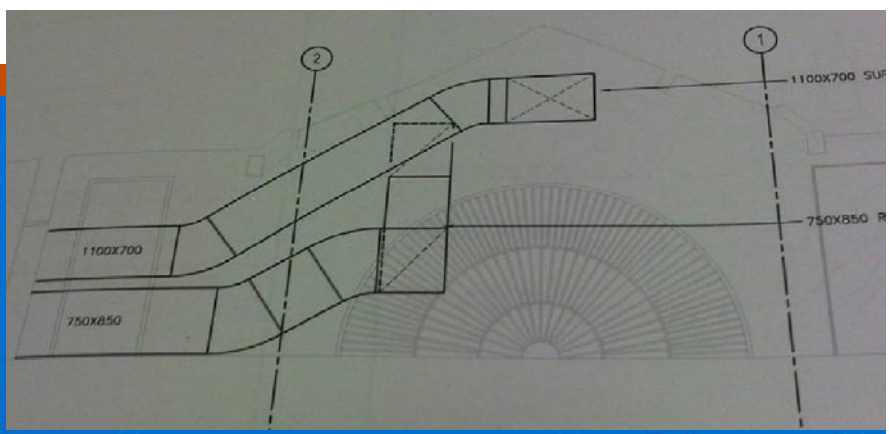
The data for the 900 square meter 3rd floor was collected in 40 minutes, followed by one hour of processing time. Ultimately, the objective for such data is to see where future mechanical and electrical interfaces can be placed. This can help to ensure the renovation is efficiently planned. Here, in the attic of the jail, all ceiling beams and joists are clearly observed. The level of detail is ideal for use in routing ducts in the renovation.

The Warden's residence within the jail was located above the attic in the upper most part of the building. This area is going to be remodeled into a multilevel space with mezzanine. The TIMMS generated point cloud (see image) is an excellent example of 3D models with cm level accuracy and detail.

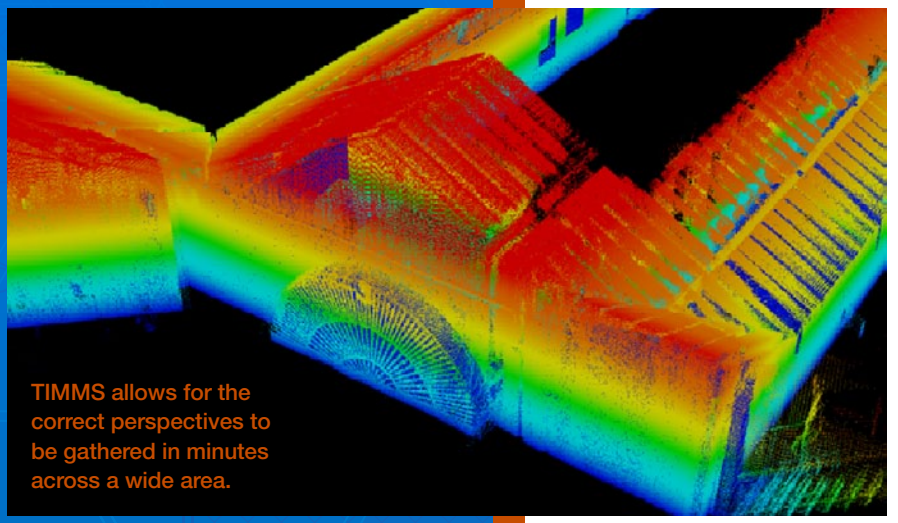
Facility Management

In order to maximize the financial performance of an organization, the operation of its leased and/or owned facilities must be streamlined. This is at the core of "facility management"– supporting and improving the effectiveness of an existing building over the many years of its entire life, or its "operational phase". Accurate indoor map data is critical to this undertaking.

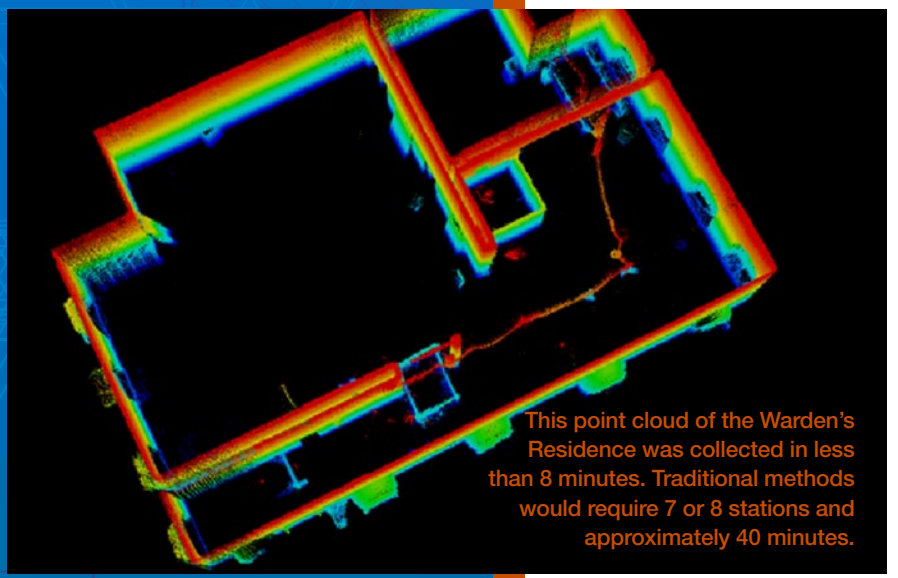
Indoor mapping provides the underlying information necessary for organizations to operate their facilities with maximum effectiveness and employee comfort–all while dramatically reducing costs–by enabling such facility



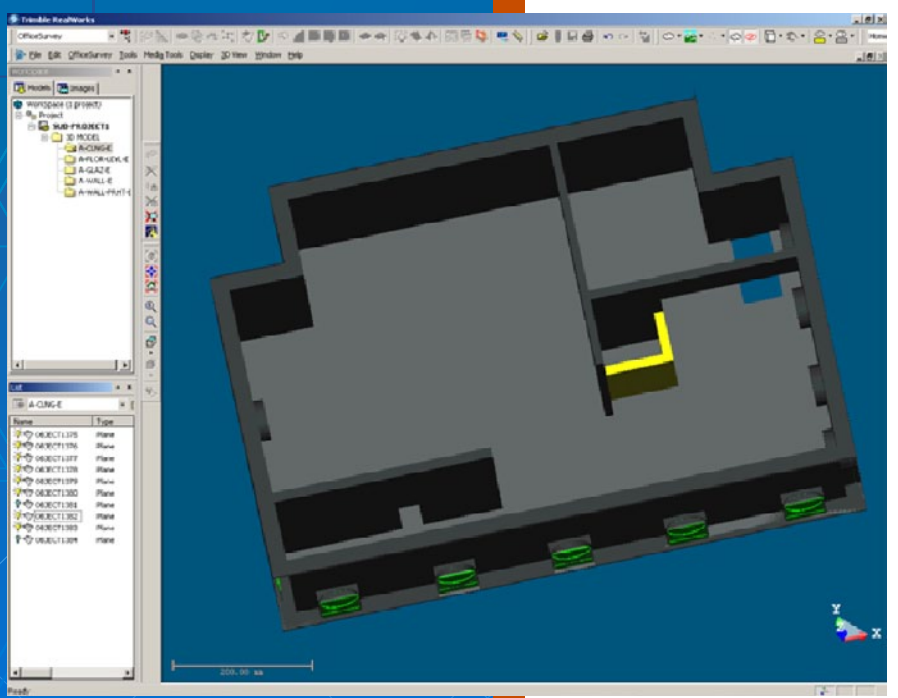
Data illustrates the proposed ducting installation.



TIMMS allows for the correct perspectives to be gathered in minutes across a wide area.



This point cloud of the Warden's Residence was collected in less than 8 minutes. Traditional methods would require 7 or 8 stations and approximately 40 minutes.



3D model from TIMMS. Static method could also work but may not be justified for this room alone. With TIMMS the whole building is acquired in a day, models are created where needed.

management applications as renovation planning, safety and emergency procedure planning, and space optimization. By effectively optimizing space using the wide area perspectives acquired by TIMMS, businesses will have new information to help minimize their lease and building ownership costs. They can do this by identifying facilities that can be combined, others that can be eliminated, and by enabling effective expansion within existing locations without acquiring more space.

Accurate indoor spatial data also enables building management to run "what if" scenarios so they can effectively plan for new equipment, more employees, different production processes, etc.

Conclusion

Until now, mobile mapping has been limited to outdoor environments where satellites for positioning purposes are in view. TIMMS has overcome this hurdle and made mobile mapping a reality for indoor spaces as well, with all of the associated benefits including speed, ease, high accuracy (3 to 5 cm) and lower cost.

Here we have explored just a couple of typical applications for this technology, but its potential is enormous, if still unknown. As a matter of history, the advent of pioneering technology ushers in changes no one could have predicted (think of the Internet and map use by the general public). Indoor mobile mapping offers benefits to a vast multitude of people, yet it is possible its greatest impact has not even been imagined yet–its future is certain to be exciting.

Peter Canter is Director, Advanced Mapping and Imaging Systems at Applanix Corporation and is responsible for new business development and overall product direction for indoor mobile mapping. Peter obtained his master's degree and post-graduate degree in geography and GIS. He has over 30 years of worldwide experience in navigation, positioning and mapping.

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