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House of Representatives Standing Committee on Infrastructure and Communications
PO Box 6021
Parliament House
Canberra ACT 2600

8 July 2015

Dear Chairperson Prentice,

We are extremely grateful for the opportunity to respond via a public submission to the House of Representatives Standing Committee on Infrastructure and Communications' Inquiry into the Role of Smart ICT in the Design and Planning of Infrastructure.

We understand the Committee wishes to inquire into and report upon the role of smart ICT in the design and planning of infrastructure, in particular:

a. Identifying innovative technology for the mapping, modelling, design and operation of infrastructure;
b. Identifying the new capabilities smart ICT will provide;
c. Examining the productivity benefits of smart ICT;
d. Harmonising data formats and creating nationally consistent arrangements for data storage and access;
e. Identifying international best practice in the use of smart ICT in the design and planning of infrastructure;
f. Considering the use of smart ICT in related fields, such as disaster planning and remediation; and
g. Considering means, including legislative and administrative action, by which government can promote this technology to increase economic productivity.

In our submission we will describe the value that digital design technology can provide to the Australian Government as it considers the role of smart ICT in infrastructure. It is our view that this technology, specifically Building Information Modelling (BIM), is a powerful tool and process that provides meaningful answers to the full range of issues raised in this Inquiry, and should play a critical role in the government's thinking going forwards in how it plans to develop pathways to productive and sustainable infrastructure for Australians in the 21st century. This submission is necessarily a summary only of the value BIM can generate for Australia, we at Autodesk remain available to provide further information or meet with officials face-to-face to follow up our submission in more detail at any time.

Infrastructure Delivery Challenges

Throughout the world, major building and infrastructure projects tend to be characterised by time delays and cost overruns. This poor performance by the architectural, engineering and construction (AEC) industry is due to a variety of underlying causes including fragmented industry structures, adversarial contractual relationships, lack of collaboration within project teams, and poor management of project supply chains and information. A recent study has shown that major capital projects worldwide have a 60 percent failure rate in terms of meeting cost or schedule targets.

These challenges come at a time when new capital projects are critically needed to support growing populations and economies. Project delays and cost overruns put increased financial pressures on

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those charged with delivering capital projects. This is particularly true for infrastructure projects, where some estimate the gap between the demand for critical infrastructure and the capabilities to fund that demand is as much as US$30 trillion.

To overcome these challenges, a range of issues must be addressed—many of them beyond the scope of this paper. The important perspective that Autodesk offers is that 25 percent of infrastructure project costs are tied to change orders, requests for information (RFIs), rework, and design clashes that are not found until construction begins due to a silo approach to project delivery. But the AEC industry is showing progress in improving their productivity and reducing these project costs through the use of Building Information Modeling (BIM).

What is BIM?

BIM is a model-based process for planning, designing, building, and managing buildings and infrastructure. For centuries, projects have been designed and documented using hardcopy paper drawings, sometimes supplemented by physical small-scale models of the project. With the advent of computer-aided design (CAD) systems, people used software programs to create digital versions of the 2D drawings, changing labor-intensive drafting into more efficient electronic documentation. But the output from CAD-based design is still drawings.

Today, these drawing-based approaches are being replaced by BIM. BIM is a model-based process that relies on a digital representation of the physical and functional characteristics of buildings or infrastructure. In BIM processes, these intelligent, 3D project models serve as the principal means for communication between project activities and collaboration between project teams, as well as the foundation for advanced analytics, simulation and visualization to optimize designs to achieve desired outcomes. This model can be shared between the design team (architects, surveyors, civil and structural engineers), then handed to the main contractor and subcontractors, and finally the owner/operator. Each team adds discipline-specific data to the project model. This reduces information losses that traditionally occur when a new team takes 'ownership' of the project, and provides more extensive lifecycle information to owners.

The 'I' in BIM

The power of BIM lies in information and what can be done with that information. At any point in the lifecycle of the project, the information is available and up-to-date, helping teams reduce time-consuming errors and rework. The model and the information it contains is actionable or computable, enabling the models to be used for analysis and simulation to guide a design team's decision-making.

Project teams can explore "what-if" scenarios to test alternatives and optimise constructability. Models can be used to assess the sustainability of a project by incorporating social, political, environmental, cultural, and economic information. High-end in-context visualisations such as still renderings and movie files that are engineering-accurate can be generated from the model to support public outreach efforts.

The models can also be used in subsequent processes, such as costing, construction simulation and planning, digital fabrication, or automated machine guidance operations. Eventually, the models can be used for commissioning, operations and maintenance, facility management, and to support future renovations and upgrade programs.

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BIM helps all organisations working on a project coordinate and communicate more seamlessly. With all project team members working on the same project model, knowledge transfer is streamlined, leading to improved accuracy and reduced rework. The 3D nature of the model and the wealth of information it contains helps to better convey design intent from the office to the field, reducing changed orders and field coordination problems.

Why BIM?

BIM processes and software can help project teams better manage and deliver complex projects.

- Intelligent models help teams track cost and schedule information to mitigate project risks.
- Data sharing and collaboration help maintain data consistency and allow all project stakeholders to work on the same project with less chance for miscommunication.
- Model-based design helps teams optimise designs early in the process, using simulations and analyses to more quickly and accurately predict project outcomes. This helps designers compare the results against many criteria and proceed with greater confidence, knowing that viable alternatives were identified and evaluated.

BIM can also help governments improve their capacity to deliver building and infrastructure assets by getting more projects in the pipeline funded and approved.

- BIM helps attract private investment by using model-based planning to predict performance (such as the traffic flow on a highway), simulate construction processes, and experience the asset in a digital environment. This provides greater predictability and clarity about the project—helping to increase confidence of potential investors.
- To get more projects in the pipeline, governments must shorten the time needed to gain public support and regulatory approvals. Negative feedback from public stakeholders can stall projects and communicating with 2D paper plans often leads to even greater confusion and frustration. Model-based visualisations enable teams to generate compelling visualisations that helps the public 'see' the advantages of proposed projects at the early stages of the approvals process and avoid potential community engagement issues prior to construction.

BIM Benefits for Government

Current users of BIM, report significant project benefits, including reduced conflicts and changes, improved project quality, lower cost of planning approvals, and reduced timeframes for delivery of projects. This in turn assists in driving better delivery of services. The use of BIM also drives efficiency by the adoption of an open and collaborative engagement environment by both government, stakeholders and contractors. These themes align closely with the Australian Public Service ICT Strategy 2012-2015. In addition the benefits of BIM for public capital projects and owners are equally compelling:

- **Cost and time savings**: Matching the experience of private sector owners, one of the main benefits of BIM for government owners is reduction of costs and compression of schedules during the development and construction of a building or infrastructure project. The collaborative processes at the heart of BIM take advantage of the talents and insights of all project participants (designers, engineers, contractors, and so on) to optimise project results, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction. The most significant savings can be gained during the construction phase, by reducing rework through clash detection and visual analysis of BIM models. The result is a

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project that meets the budget, schedule, and needs of the government owner.

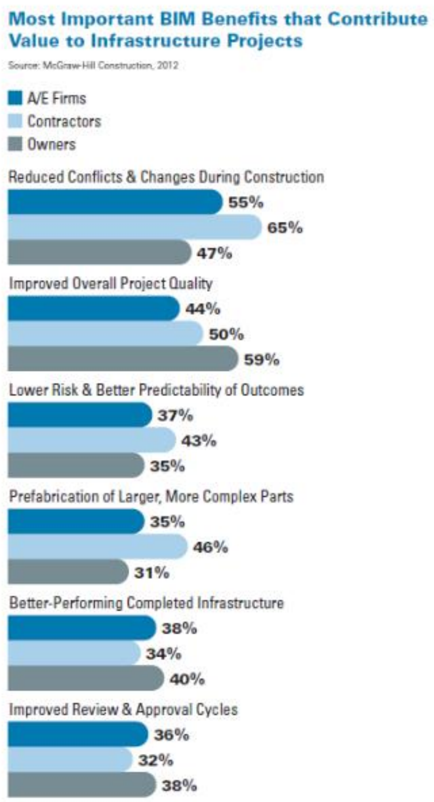
- **Transparency**: Because the BIM process contains such rich and accessible data, government stakeholders will have much greater visibility into how the project is evolving and being built. If the government owner is working with multiple contractors and design teams, this transparency can help ensure that all the stakeholders are coordinated and the project is on track.
- **Stakeholder and public acceptance**: Some government-driven projects, particularly infrastructure projects, can be very complex—with many different stakeholders and diverse public bodies keenly interested in the project. BIM processes and model-based project visualisations can provide greater visibility for all those stakeholders, leading to greater understanding and acceptance of the project, and an easier approval process.
- **PPP attractiveness**: An increasing number of global Public Private Partnerships (PPP) financiers and donors are requiring the use of BIM in their projects to ensure best value for their money, and to help clarify and stabilize the return on investment (ROI) they generate over the lifetime of a project. Therefore, a government that embraces BIM—be it through standards, policies, or mandates—is better able to attract potential partners and investors.
- **Operations and maintenance**: Cost savings during planning and construction are only one element of the entire lifecycle of a complex building or infrastructure project. When using BIM for design and construction, teams can add data needed for operations and maintenance to the project models. Once the capital project is complete, government owners can utilise these data-rich models ongoing life-of-project savings through improved management of the physical asset throughout its operating life of many decades.

Infrastructure and BIM

By some estimates, over US$50 trillion dollars[1] is needed in global infrastructure investment through 2030 to keep pace with projected GDP growth around the world. This staggering number emphasises the gravity of our global infrastructure challenge. In response to this and other industry and economic factors, the Australian Government has committed to funding a large spend on critical infrastructure projects of up to AUD70 billion over 7 years.

Given the pressures on local and national governments to meet this challenge and close the gap between infrastructure need and financing, there is considerable attention being paid to ideas and innovations for creating more and better infrastructure for less cost. These approaches could close the gap without sacrificing future infrastructure needs or putting undo financial pressure on people and economies.

Some of the approaches are systemic in nature, requiring overarching changes in laws, policies, or government and industry procedures. These include: enabling the use of non-traditional financing and delivery tools such a public/private partnerships (PPPs), encouraging private sector and direct public superannuation fund investment into infrastructure investment, restructuring industry-standard project contracts to promote time/cost savings, and reducing the need for the amount of future projects by making the most of existing infrastructure.



[1] Organisation for Economic Cooperation and Development (OECD), "*Strategic Transport Infrastructure Needs to 2030*", 2012

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Other approaches are targeted directly at the actual planning and delivery of an infrastructure project. These include: using integrated infrastructure planning to advance the right projects and reject the wasteful ones, speeding up project approval processes, and streamlining project delivery with modernised approaches and technology. This is where BIM can play an important role—helping to transform the planning and delivery of an infrastructure project to achieve higher productivity and quality at less cost.

Avoiding Rework and Increasing Productivity with BIM

One of the most important aspects of project delivery (beyond safety) is delivering a project on time and on budget. But numerous studies show upwards of 25 percent of project costs are tied to change orders, requests for information (RFIs), and design clashes that are not found until construction begins, increasing costs and threatening schedules.

There are many causes of rework, but one key contributing factor is looking for conflicts or missing information using tradition 2D construction drawings. The documentation set for a large infrastructure project can contains hundreds or even thousands of sheets of paper or electronic drawings with millions of pieces of information. Finding and resolving issues in this manner is challenging, at best. Factor in a change in design scope and it multiplies the challenge dramatically, maybe even exponentially.

Better planning, collaboration, and communication is needed between project teams (designers, contractors and owners) during all phases of the project (from planning to construction) to avoid rework and increase productivity. This leads to early detection and better understanding of conflicts and the ability to resolve them *before construction*, which can significantly reduce project costs associated with rework.

The use of BIM workflows and technology on infrastructure projects has been shown to significantly reduce rework. McGraw Hill's 2014 report on The Business Value of BIM in Australia and New Zealand cites that the top benefits of BIM are:

1) Reduced conflicts and changes during construction (i.e. rework avoidance)
2) Reduced errors
3) Improved collaboration

Improving Infrastructure Design and Delivery

With BIM, the entire process of developing and executing infrastructure projects can be streamlined—from early planning and initial surveying through to environmental assessment, community consultative processes, design, construction, and maintenance. The associated efficiency gains can help stretch limited infrastructure investment dollars further, increase construction capacity, and deliver better performing infrastructure

Integrated Infrastructure Planning

The planning process is meant to define community needs and determine what systems are required to fulfill those needs. This is a critical step in ensuring that infrastructure is delivered effectively, and requires balancing varying interests and priorities. This means carefully developing long-term capital budgets to include deferred maintenance projects and new investments that support growth, and

> One of the most powerful ways to reduce the overall cost of infrastructure is to avoid investing in projects that neither address clearly defined needs nor deliver sufficient benefits. Choosing the right combination of projects and eliminating wasteful ones could save $200 billion a year globally. Project owners must use precise selection criteria to ensure that proposed projects meet specific goals, develop sophisticated methods for determining costs and benefits, and evaluate and prioritize projects—in a transparent and fact-based way—by their potential effects on the entire network, instead of looking at individual projects in isolation.
> McKinsey & Company, *Infrastructure productivity: How to save $1 trillion a year*, 2013

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funding projects that will help reduce vulnerabilities that regions may face as a result of natural or manmade events. An immense amount of information must be gathered, sorted, analysed, and understood in order to do this properly and make decisions that balance economic, social, and environmental needs.

BIM supports this more holistic planning, design and delivery by enabling advanced modeling, visualisation, simulation, and analysis of proposed or existing systems. Planners can use BIM's intelligent model-based approach to add sustainability, economic, and other community objectives to the infrastructure model, and therefore take into account (and optimise) these factors in an integrated fashion. By using BIM, government officials and community stakeholders have an opportunity during the planning process to look at the 'future community' and consider how best to coordinate infrastructure systems, public facilities, and land use to maximize collective benefits.

Example: Several years ago, U.S. engineering firm Parsons Brinkerhoff was working on several major public and private infrastructure projects in downtown Seattle (including the retrofit of the Alaskan Way Viaduct). This led the firm to develop a fully integrated and adaptable 3D city model of downtown Seattle by combining Geographic Information System (GIS) and utility data, laser survey information, and aerial and land photography of the cityscape. Based on the variety of datasets it incorporates, this model can be adapted to suit the specific need, location, and project—enabling a range of assessments and "what-if" scenarios that can inform project decisions and policy development. For example, the Seattle Housing Authority's Yesler Terrace project is using the model for planning, design, and photorealistic visualisations of a new mixed income and multi-use community to replace aging public housing.

Planning, Design and the Role of Big Data

Similar to integrated infrastructure planning, teams involved in early planning or proposal stages of a specific project can use BIM software to combine GIS, satellite imagery, and laser scanned data into a visual, 3D model/environment. With the explosion of the availability of Big Data it is critical that governments and planners take advantage of the benefits and the role that it plays in the decision-making process. Uniquely, BIM platforms can take advantage of this data due to the ability to aggregate, visualise and provide analytics to assist in making more informed decisions in a project context. BIM and data modelling is then used to analyse alternative designs in the context of all the existing conditions of the infrastructure project to predict performance. By designing more rapidly and more efficiently in a real context, designers make fewer mistakes and reduce project risks. Project teams also have a better means of communicating design intent (either within their design team or to the client or owner) so that everyone is on the same page.

BIM enables designers and contractors to work together early in the process—relying on an intelligent and integrated 3D project model to assess options and optimise potential construction approaches. By virtually modeling a complex infrastructure project in 3D, it is easier for teams to understand what is being designed and observe in a digital environment ways to improve the design. The model can also be used for project coordination, making sure project elements fit together and can be built within the constraints of the existing environment (physical, environmental, legal, and so forth).

In addition, vast amounts of design information is lost between different project phases and design disciplines using traditional building practices. By using an intelligent 3D model as the basis for design and construction, BIM enables information continuity—improving collaboration and coordination throughout the project and between the project stakeholders.

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<u>Example:</u> Engineering, architecture, environmental and construction services provider GHD Australia recently tendered for the project to revitalise Sydney's Central-to-Eveleigh rail corridor, and BIM modelling was a critical part. Key challenges in the project included design over a complex existing rail corridor, design options for heavy rail, commercial and residential buildings, construction staging, and cross collaboration with both local and global design and engineering teams. The use of big data was also used in building a 3d virtual model of Sydney. Demographics and statistical analysis were used in the 3d model to validate design proposals, engineering concepts and potential construction staging. The 3d model and associated visualisations would also be used to involve and engage with the communities impacted by the project.

Evaluating Options

Project teams can use intelligent 3D virtual project models to explore in-context "what-if" scenarios with clients and project investors—testing alternatives and simulating real-world performances to better understand cost and scheduling. BIM can also be used to assess the sustainability of a project by incorporating social, political, environmental, cultural, and economic information.

The models can also be used to provide the public with more accurate visualisations of the options—showing them what the project and design options will look like from their neighborhood for example, or how the project will impact driving routes while under construction.

<u>Example:</u> Norwegian Public Roads Administration (NPRA) is embarking on a road improvement project through the municipality of Fet and over the Glomma River. Multiconsult AS used BIM to develop conceptual designs and simulations for the project, resulting in 17 possible road alternatives, including tunnels, interchanges, and eight different designs for the new bridge across the river. The firm combined digital terrain models of the project area (encompassing approximate 30 square kilometers), 2D and 3D data representing existing structures, railways, and water bodies, as well as design data for the various road alignments, bridge designs, tunnels, and interchanges. Multiconsult also used these models to develop project animations to present its conceptual designs in the context of the existing environment, which helped better communicate the firm's proposals to its client and other project stakeholders. To read more about the project, click <u>here</u>. To see the project animation, click <u>here</u>.

Project Communication and Approvals

BIM also helps improve communication and transparency of infrastructure projects. In the past, physical small-scale models and artist renderings helped clients, investors, and the public better understand a project. Today's intelligent 3D models—and the ability to virtually walk or fly through these models and see the project in the context of the actual terrain, buildings, structures, and roads around the project—is a much richer way to communicate a project. A single model can scale from a project site, to a neighborhood, to an entire city if so desired to understand regional impacts of local projects.

Using a 3D model to investigate the project and/or produce highly-visual project renderings increases the understanding of everyone, but particularly non-technical stakeholders who may find it difficult to visualize a project based on tradition 2D drawings. By using BIM, miscommunication, design errors, and risk are mitigated. The ability to use the model to simulate nearly all aspects of the project improves and expedites project decision-making.

<u>Example:</u> Development firm DLF is building Cyber City Gurgaon—a planned community in India. Cyber City is India's largest integrated business district, complete with dedicated infrastructure. BIM is helping DLF communicate and market the project to stakeholders and prospects. DLF commissioned the creation of a virtual model of city that was used to generate a series of animations

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and renderings that showcase the benefits of the development's new highway, dedicated metro line, and pedestrian walkways. The visualizations helped various stakeholders and the general public better understand the project, encouraging early input and support. The team also used renderings and animations to help present the preliminary engineering design concepts to DLF officials and other groups for approval. Click here for more information on the project, or here to see the animations.

Construction

Traditionally, at the end of the design stage of a project, the construction firm receives 2D plan sets, which by their very nature have limited visibility of the engineering data that went into creating those plans. These flat document sets become the primary interface between builders and designers and owners. This inhibits collaboration and leads to uncoordinated project documentation, which can create expensive rework for contractors on competitive bid projects and increases project risk. Owner organizations are plagued with issues caused by this drawing-based project communication.

By contrast, model-based BIM processes capture and use information throughout the design and construction phases of infrastructure projects. With BIM, the design model is available earlier in the project to better inform preconstruction planning for activities such as staging, sequencing, scheduling, quantity take-off, and estimating. Given access to the model, contractors can produce more accurate bids by evaluating various coordination activities, such as temporary roads, location of material, and other logistics prior to breaking ground.

The model is also the primary tools for virtual, cross-discipline project coordination—helping to dramatically shrink those infrastructure project costs that are tied to change orders, RFIs, and rework during construction. More efficient construction is also facilitated by the BIM process, as schedule and cost data can be added to the model to support construction simulation ('4D modeling') and cost project management ('5D modeling').

3D project models also enable the use of automated GPS machine guidance technologies during construction. Using design information from the model in heavy equipment helps improve precision and accuracy, and greatly reduces construction time, fuel, and material waste while increasing the safety of people working on the project.

<u>Example:</u> Expected to open in 2019, Sydney's North West Rail Link will be the first fully automated transit rail system in Australia. It is poised to change the way people in one of Sydney's fastest-growing regions think about transportation. Residents—who have the highest car ownership rate in Australia—will have a quick, convenient, and comfortable public transit option. SMEC, a professional services firm focused on major infrastructure, is leading the design effort on several elements of the AU$8.3 billion project: operations, trains, and systems and surface and viaduct civil work. The lead client in the public-private partnership, the New South Wales Government, mandated the use of Building Information Modeling (BIM) on the project. The North West Rail Link will feature eight new stations, 4,000 commuter car parking spaces, and twin 15 km tunnels, which will be Australia's longest rail tunnels. Projects of this size and complexity require farsighted management—and proactive attention to the smallest details. Large teams from multiple disciplines, including architects, civil engineers, and structural engineers, are contributing to a fast-paced design process. Everything from conduits to pipes to ducts needs to fit together during construction. Even relatively minor coordination issues could lead to delays and higher costs. The rail link requires a more total use of BIM than prior SMEC projects. The team quickly began to view BIM as a process that connects all aspects of a project—not simply a technology or software tool. The team turned to Civil 3D software for the roadwork, earthworks, rail line, and water and sewer components. Revit software supports the architectural and structural design process. The various design models come together as a

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federated model in Navisworks Manage software. Autodesk Vault helps enforce design management processes and version control.

Operations and Maintenance

Beyond design and construction, infrastructure owners—especially governments—can use the rich information coming from BIM processes for more efficient operations and maintenance. Accurate final as-built data and the inclusion of maintenance and operations data in the project model are some of the leading benefits of BIM during post-construction.

Owners and operators benefitting from rich, detailed information about a particular asset is intuitively obvious. However, owner/operators are usually responsible for a wide array of interconnected and often interdependent assets. BIM facilitates improved management and analysis of project-level information, which can be used in large-scale integrated asset management workflows.

Example: BAA, the owner/operator of London's Heathrow Airport, used BIM to create Heathrow Map Live, a web-based application that allows users to view geometry and information relevant to their business activity. All the information—including infrastructure and building models, drawings, H&S files, operation and maintenance manuals, and asset maintenance information—is stored in a central GIS database. Integrated building models can be viewed in context with the airfield infrastructure. Commercial areas are linked to a property database enabling instant themed views such as revenue and occupancy. This give the airport's planning and capital teams, and its maintenance and operational teams need ready access to very high quality, coordinated mapping and services information on which to base informed, cost effective decisions. For more information about Heathrow Map Live, click here.

Smart Cities

In the longer term, public owners are talking about the eventual merging of BIM data with infrastructure and GIS data to enable "smart" grids, cities, and infrastructure. These systems would enable public owners at every level of government to manage built assets in a safe, efficient, and responsible manner, improving the lives of citizens everywhere. Although there are challenges to overcome before achieving this vision—such as managing the huge amount of data, cybersecurity, and data exchange standards among different systems—some sample efforts are already underway.

Example: Singapore's National Research Foundation (NRF) has announced plans to develop 'Virtual Singapore'—a 3D city model platform for knowledge sharing and community collaboration by 2017. Potential uses of this 3D map include locating neighborhood facilities or amenities, sharing information and resource between the community, simulations of crowd and evacuation measures as well as enabling planning and decision-making when it comes to delivering municipal services and analyzing pedestrian flow.

Autodesk Company Overview

Autodesk is a world leading design software and services company, offering customers business solutions through powerful technology products and services. For 31 years, Autodesk has been the engine driving the design of nearly everything around us. With tens of millions of customers around the world, Autodesk makes tools for the people who are imagining, designing, and creating a better world. Our portfolio of software and apps empowers organisations of all sizes to help create the world's most compelling media and entertainment and solve the most complex global design, engineering and sustainability challenges.

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Headquartered in San Rafael (near Silicon Valley in California, USA), Autodesk has approximately 7,600 employees worldwide. Our professional software products are sold globally, both directly to customers and through a network of resellers and distributors.

Our longstanding flagship product, AutoCAD software is a customisable and extensible computer-aided design (CAD) application for professional design, drafting, detailing and visualisation. AutoCAD software provides digital tools that can be used independently and in conjunction with other applications in fields ranging from construction to manufacturing, civil engineering and process plant design. Autodesk has over 12 million professional customers, over 100 million consumer customers, and is used by employees at every Fortune 500.

Yours sincerely,

(signed)
Roger Somerville
Director, APAC Government Affairs.