Our BIM & Digital Transformation Journey

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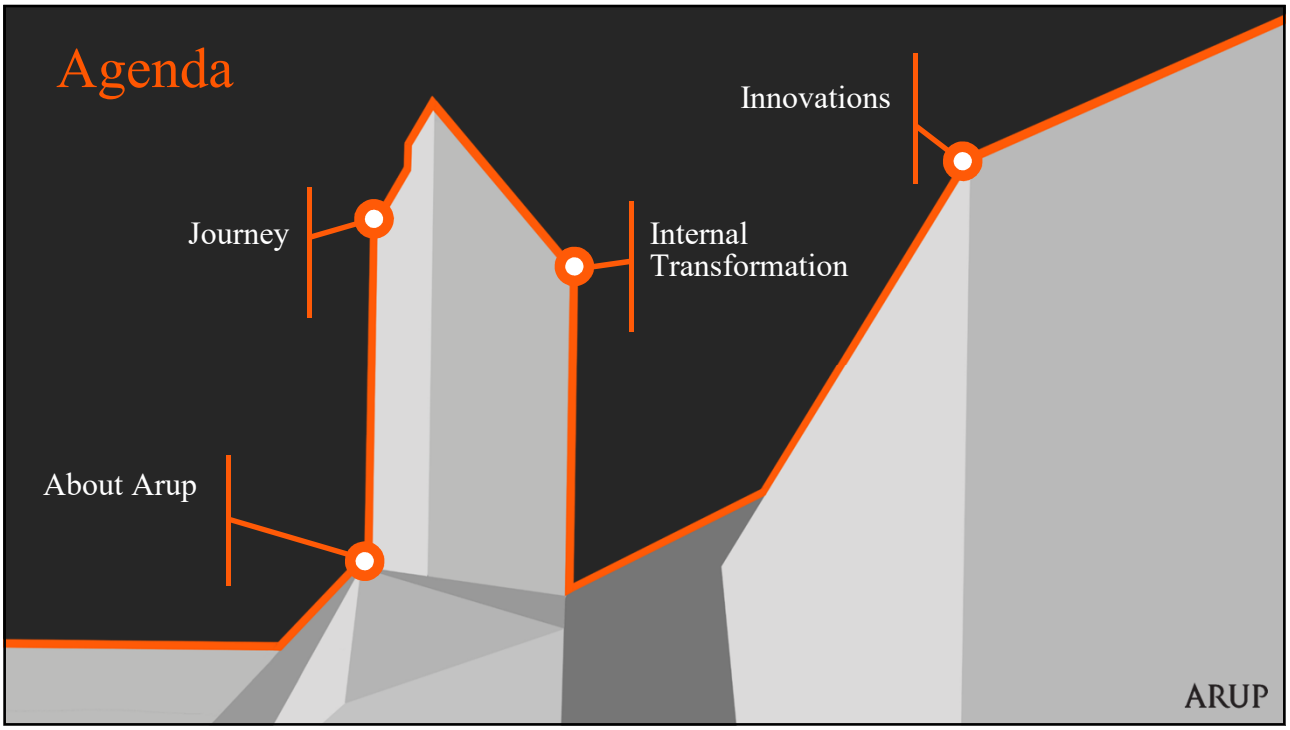
Agenda



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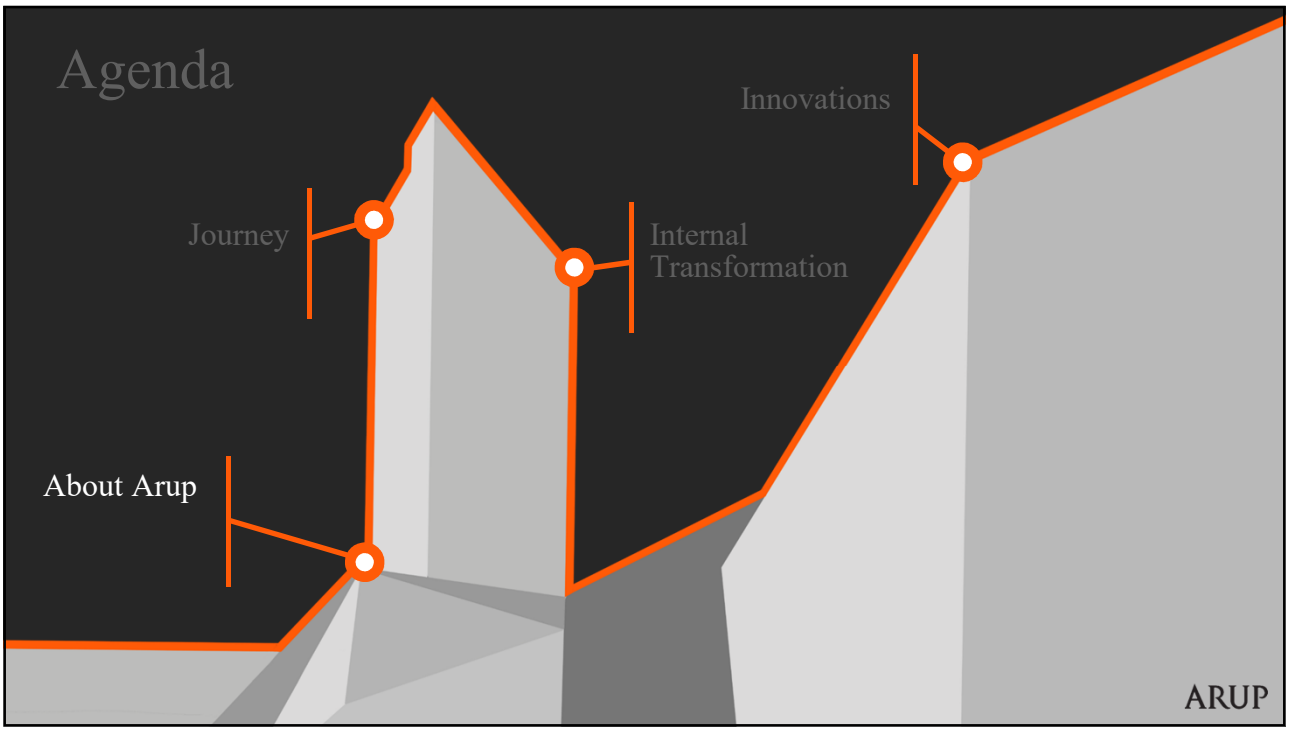
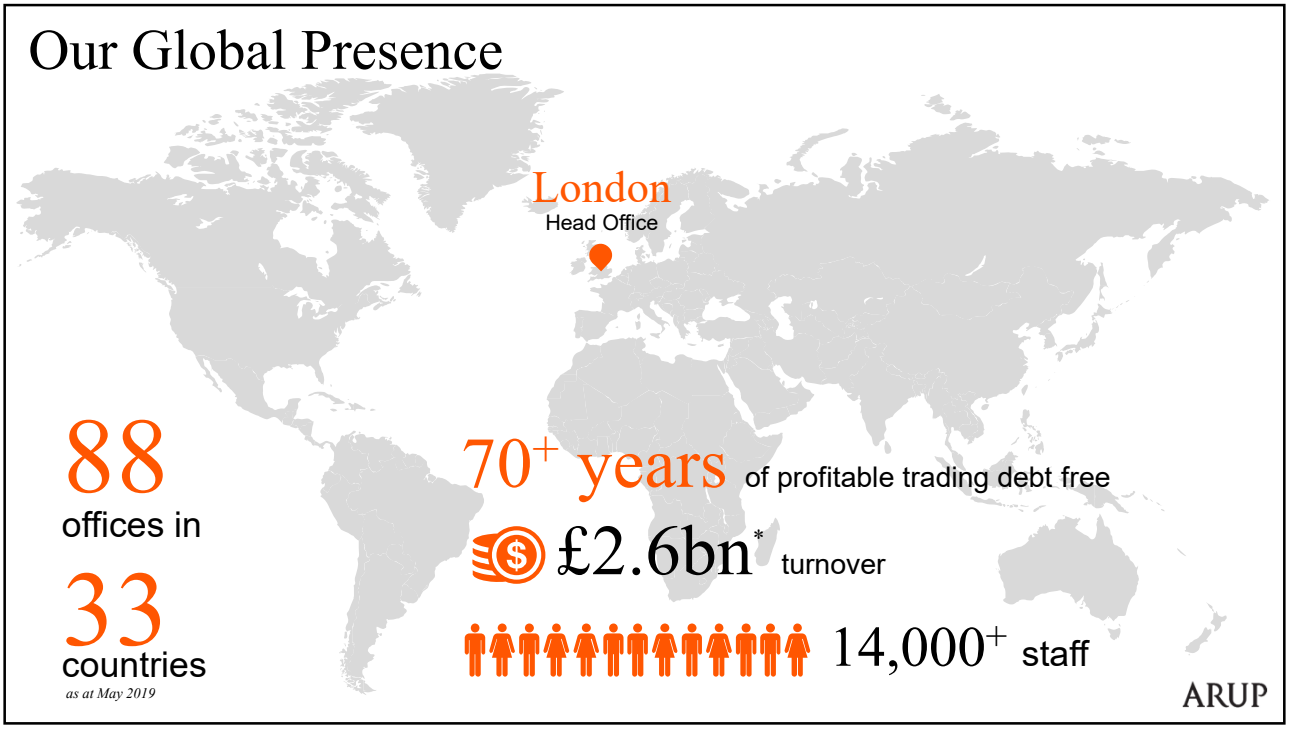

Agenda
Innovations
Journey
Internal
Transformation
About Arup
ARUP


Our Global Presence
London
Head Office
88
offices in
33
countries
as at May 2019
70+ years of profitable trading debt free
£2.6bn* turnover
14,000+ staff
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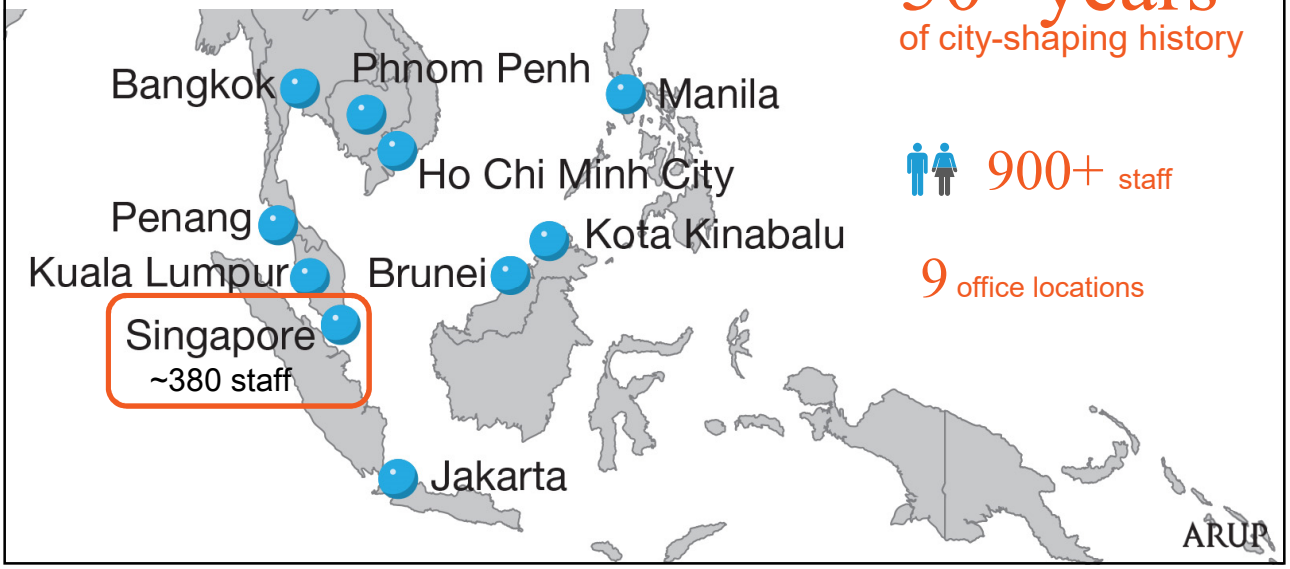
Southeast Asian Footprint



50+ years
of city-shaping history

900+ staff

9 office locations

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Truly Multi-disciplinary

visual \ Theatre Consulting \ Building Services \ Civil \ Environmentally Sustainable Design \ Facade \ Fire \ Geotechnics \ G
d Communications \ Maritime \ Program and Project Management \ Risk and Security \ Specialist Lighting \ Structural \ Tra
tical Transportation Design \ Vertical Transportation \ Acoustics \ Audiovisual \ Theatre Consulting \ Building Services \ Civi
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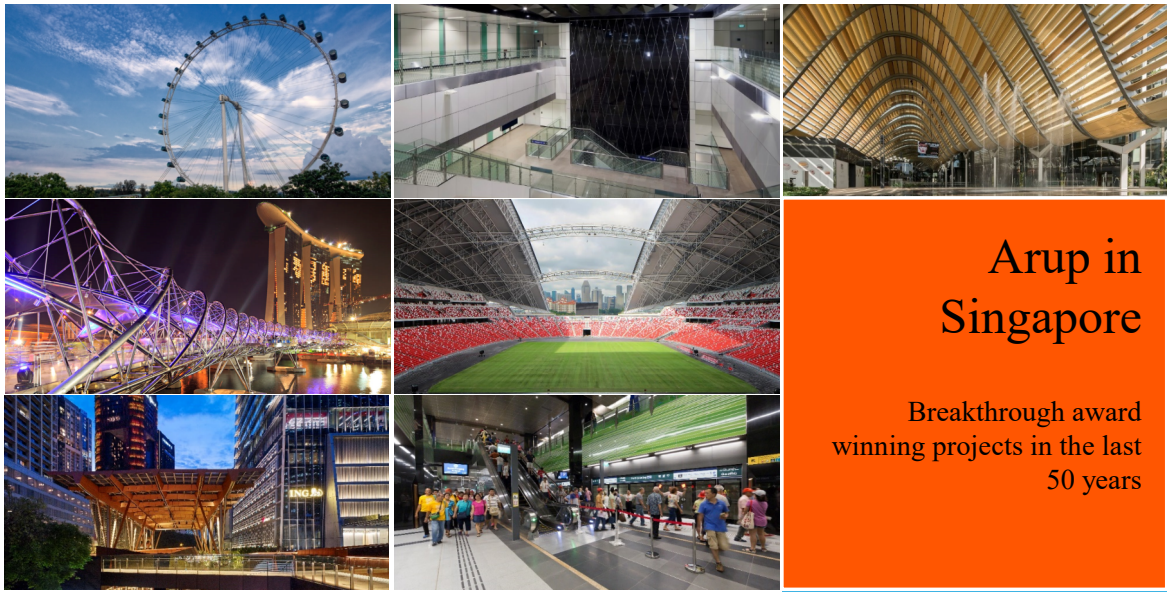

Arup in Singapore

Breakthrough award winning projects in the last 50 years

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Arup Singapore | BIM Awards

- ✓ Tekla Global BIM Award 2014 | Singapore Sports Hub
- ✓ BCA BIM Award 2015 | CapitaGreen [Platinum]
- ✓ BCA BIM Award 2015 | Tanjong Pagar Centre [Gold]
- ✓ BCA BIM Award 2015 | Yishun Community Hospital [Platinum]
- ✓ BCA BIM Award 2017 | Australian International School [GoldPlus]
- ✓ BCA BIM Award 2017 | JTC Furniture Hub [GoldPlus]
- ✓ ….

BCA AWARDS 2015
Recognising Excellence in the Built Environment

BCA AWARDS 2017
Recognising Excellence in the Built Environment

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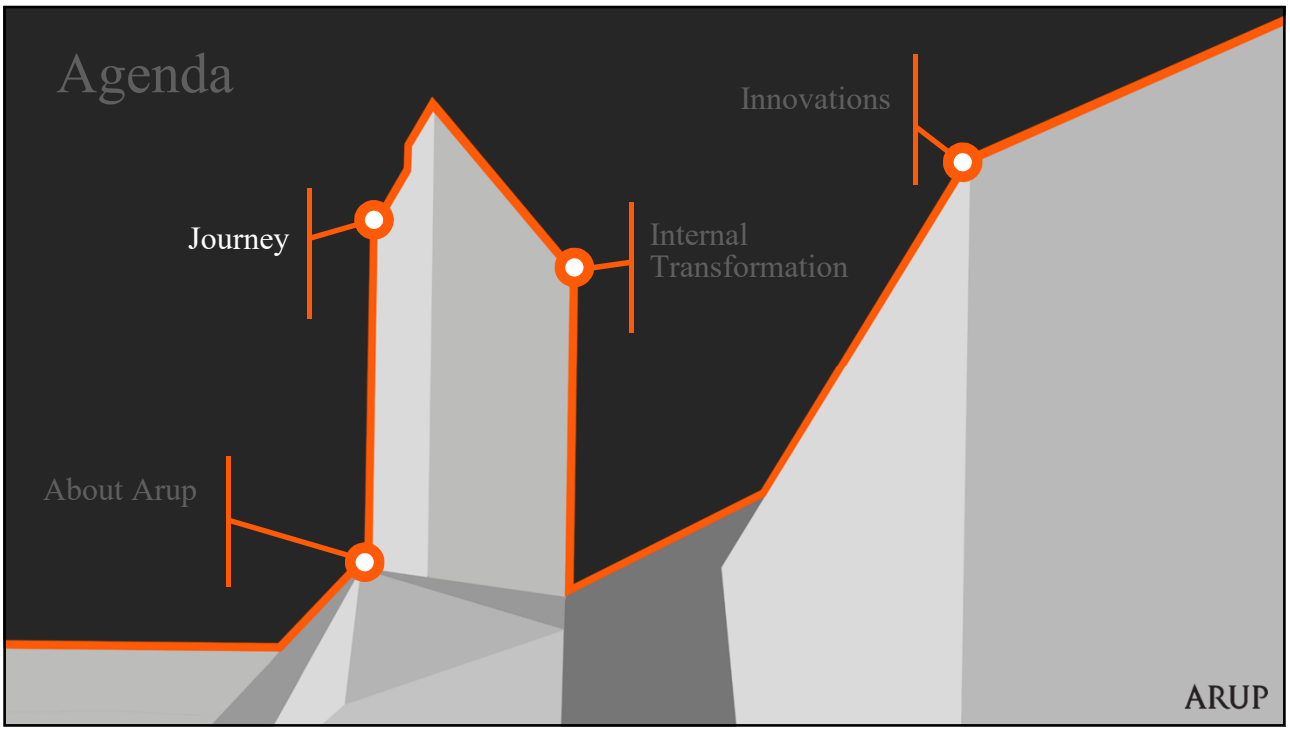
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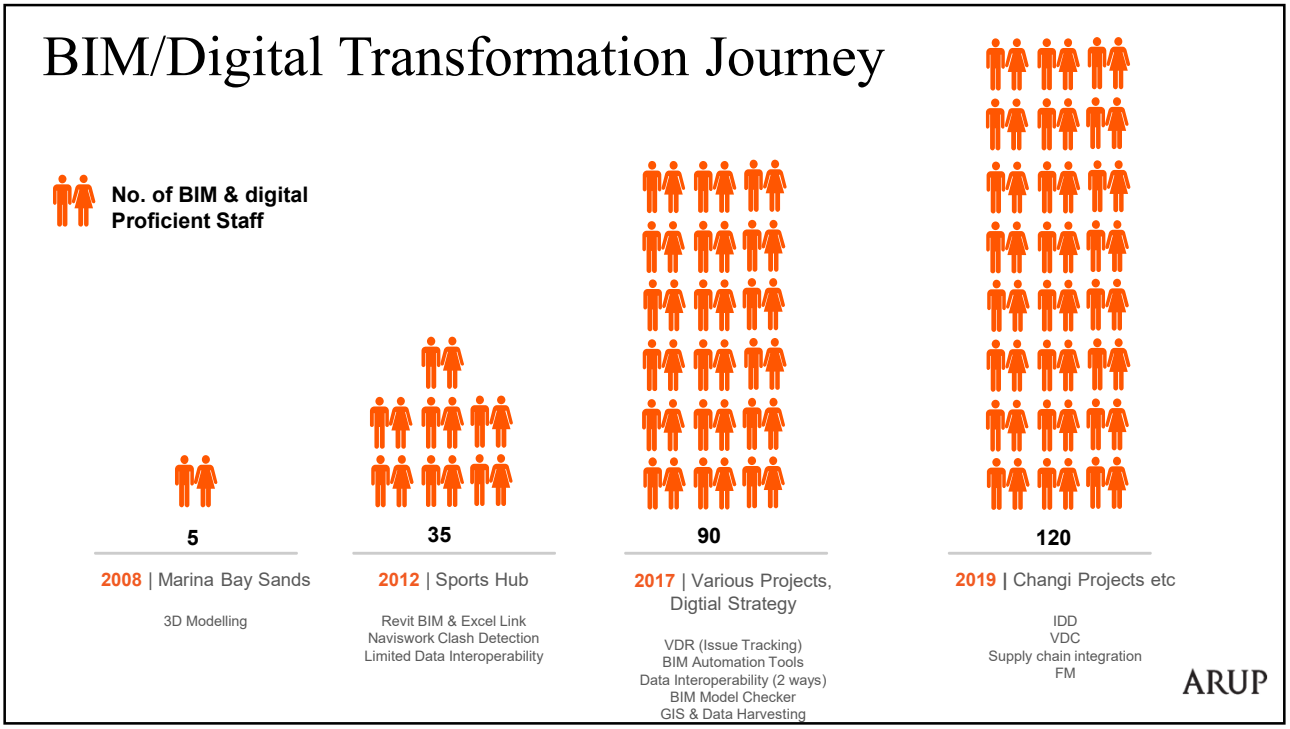
BIM/Digital Transformation Journey
No. of BIM & digital Proficient Staff
5
2008 | Marina Bay Sands
3D Modelling
35
2012 | Sports Hub
Revit BIM & Excel Link
Naviswork Clash Detection
Limited Data Interoperability
90
2017 | Various Projects, Digtial Strategy
VDR (Issue Tracking)
BIM Automation Tools
Data Interoperability (2 ways)
BIM Model Checker
GIS & Data Harvesting
120
2019 | Changi Projects etc
IDD
VDC
Supply chain integration
FM
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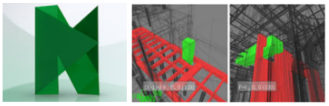
Digital Delivery Trends

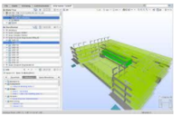
BIM Modelling Packages

Bentley
AECOsim
Building Designer

Tekla
Structures

BIM Review Packages





SOLIBRI

revizto

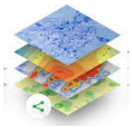
BIM Issue Tracking / GIS / Interopt

Jira Server

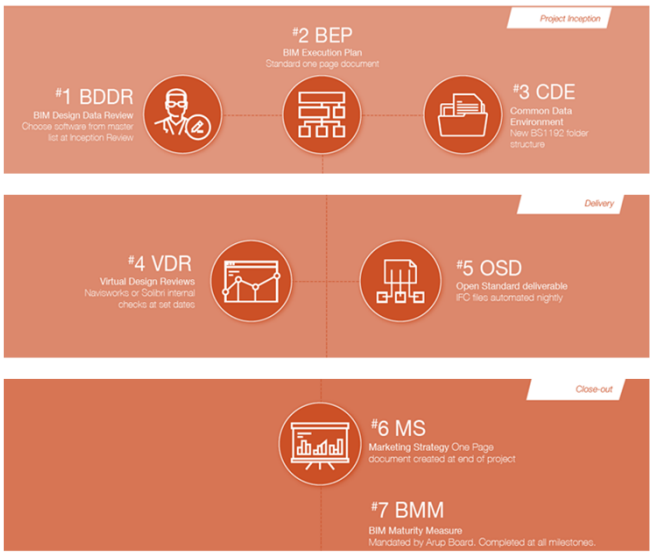
CASE Issue Tracker
Desktop application

FLUX.IO
SEAMLESS DATA EXCHANGE
WITH FLUX PLUGINS

ESRI ArcGIS



Digital Delivery Steps – "BAU" 7 Key Steps



Business As Usual

1. BDDR — BIM Design Data Review
2. BEP — BIM Execution Plan
3. CDE — Common Data Environment
4. VDR — Virtual Design Review
5. OSD — Open Standard Deliverable
6. MS — Marketing Strategy
7. BMM — BIM Maturity Measure

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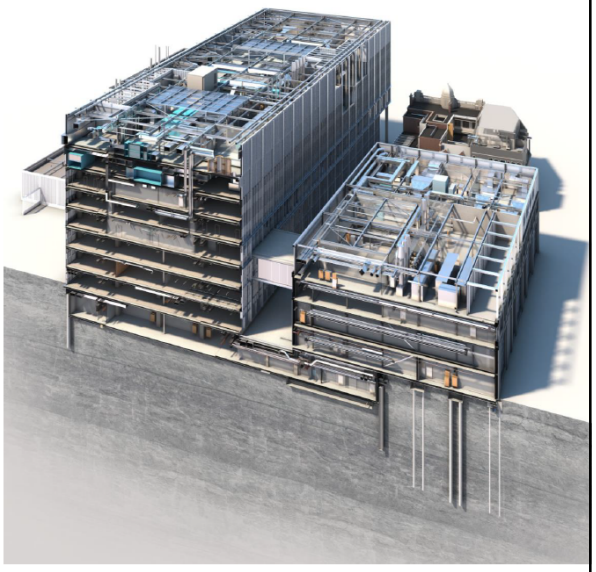
Digital Delivery | BIM Maturity Measures

Why Measure BIM?

- To promote common understanding
- To identify strengths and weaknesses
- To compare regions, groups and disciplines
- To set targets and assess progress towards meeting them
- To communicate goals and strategies across different levels within the firm

TO DELIVER BETTER PROJECTS
TO BETTER DELIVER PROJECTS



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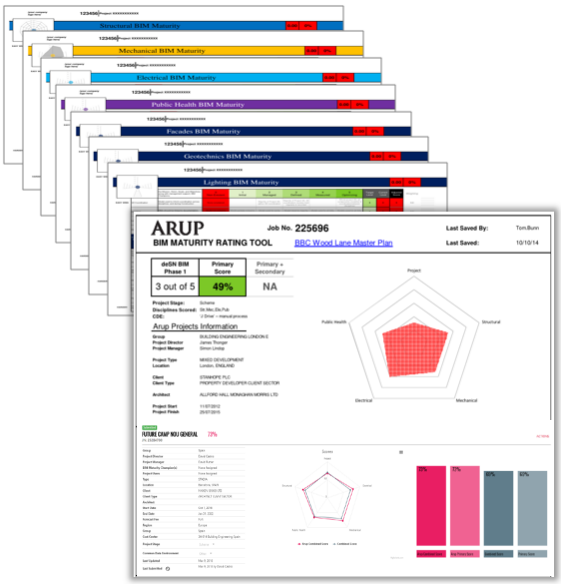
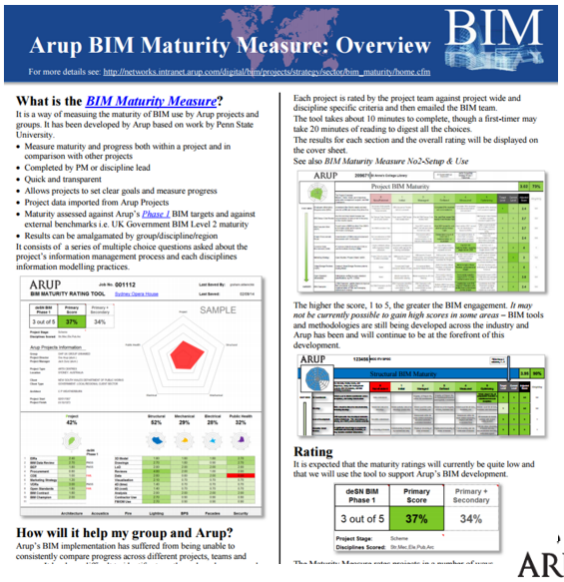
Digital Delivery | BIM Maturity Measures





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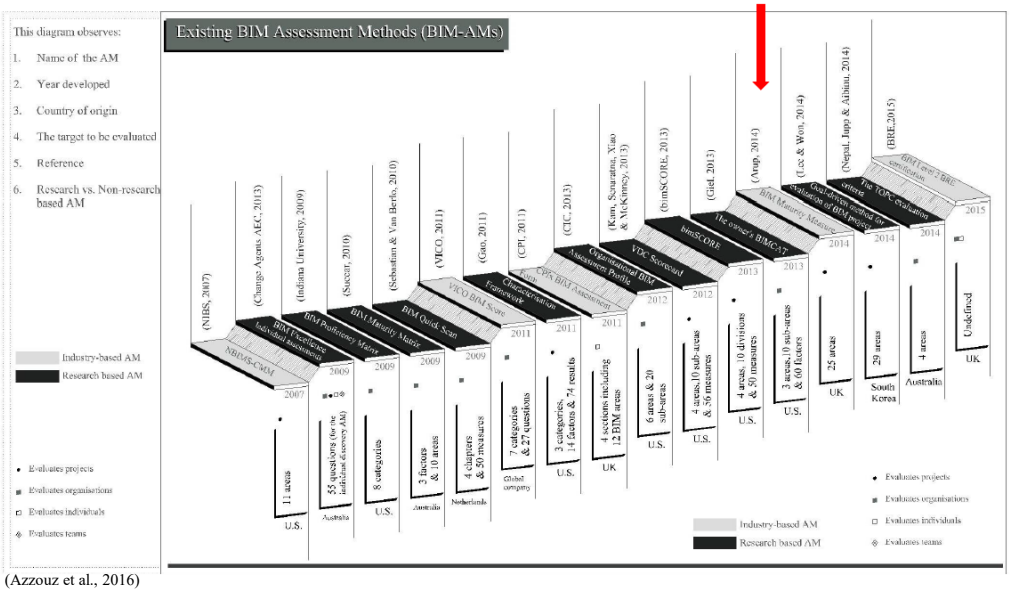
Digital Delivery | BIM Maturity Measures

Arup's Maturity Measure



(Azzouz et al., 2016)

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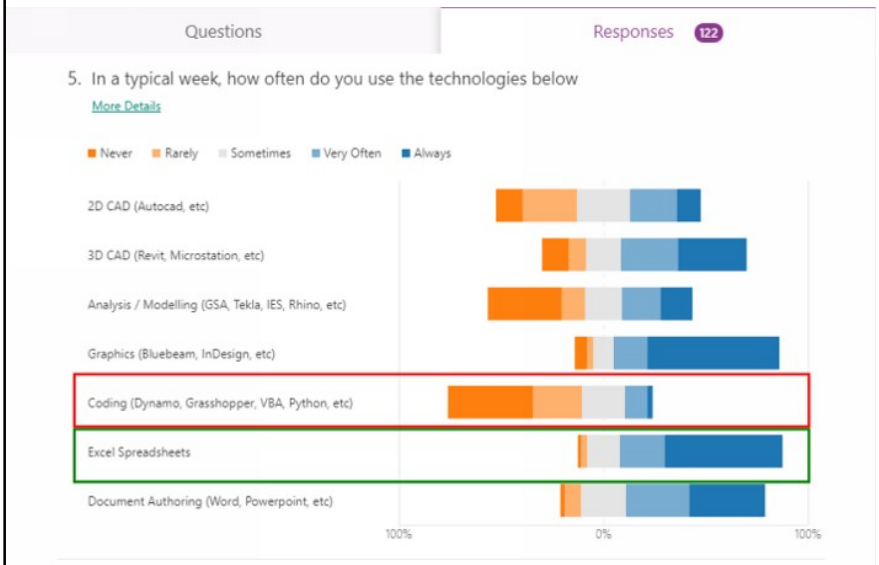
Digital Transformation | Systematic Steps



20% Ready

50% Ready

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Digital Transformation | Challenges

What are issues preventing wider adoption?

- Lack Confidence and guidance
- Lack of practical examples
- Big change in working practice
- From the niche to the everyday
- Lack of workflow planning
- Lack of project-leader awareness, direction and buy-in

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Digital Transformation | Solutions

What have we done?

- Lack Confidence and guidance: Training, sharing sessions
- Lack of practical examples: Pilot project to develop Work flow
- Big change in working practice: Make it step change or Disrupt with change management
- From the niche to the everyday: Make it a norm or "Bau"
- Lack of workflow planning: Establish detail work flow
- Lack of project-leader awareness, direction and buy in: Leadership influence and top down change management

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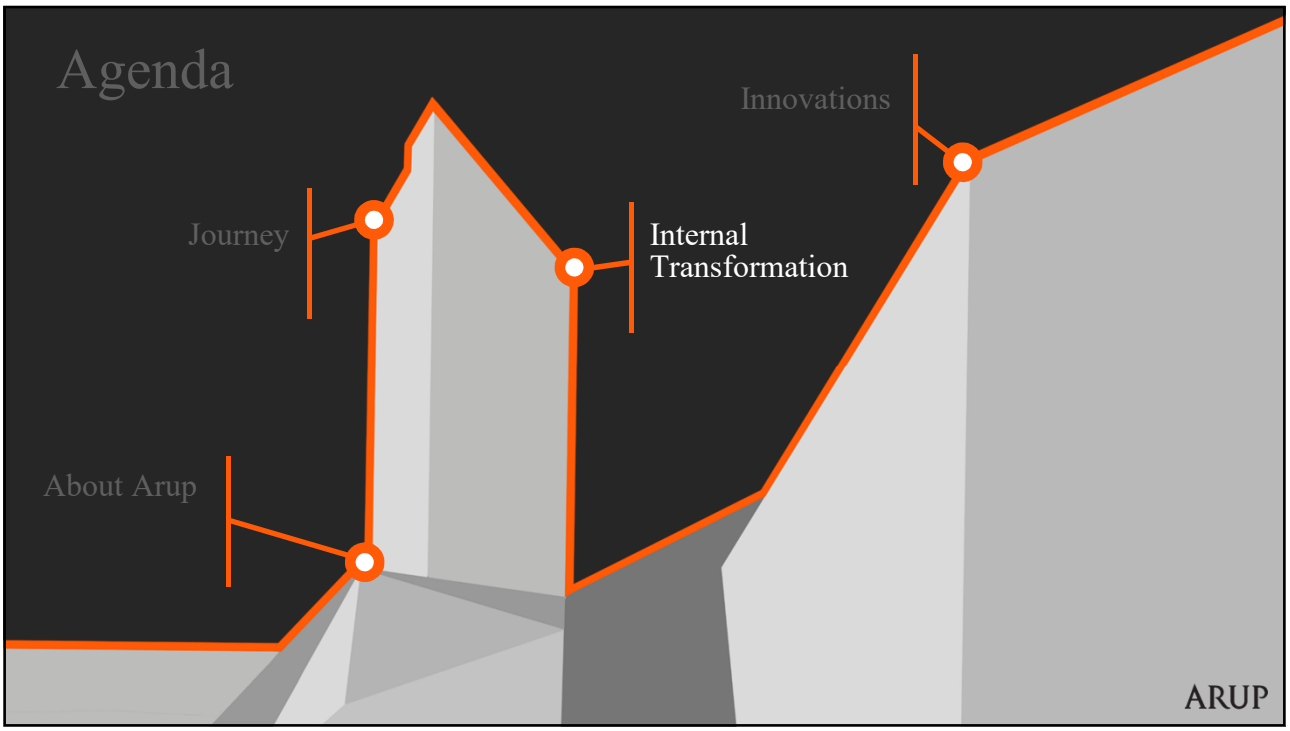

Internal Transformation | 5 Key Approaches

- Setting Digital Mindset
- Setting Digital Implementation Strategy
- Investing in Digital Technology
- Investing in Digital Skills and Talent
- Organization Change

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Internal Transformation | 5 Key Approaches

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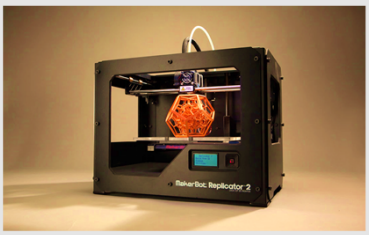
Digital Mindset

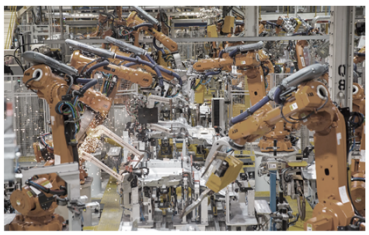
Hand crafted

Engineering the products one at a time



Mass bespoke

The model for how we need to be consistently working



Mass production

Engineering the process that creates the products

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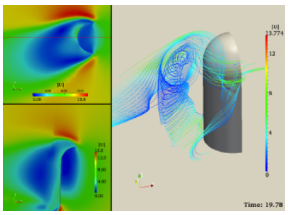
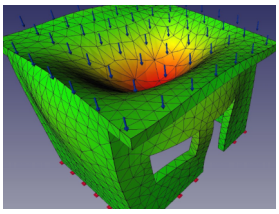
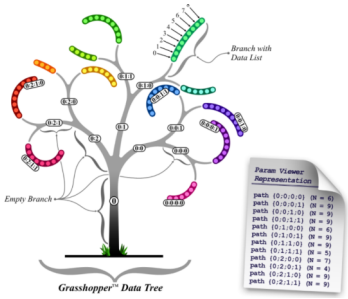
Digital Mindset

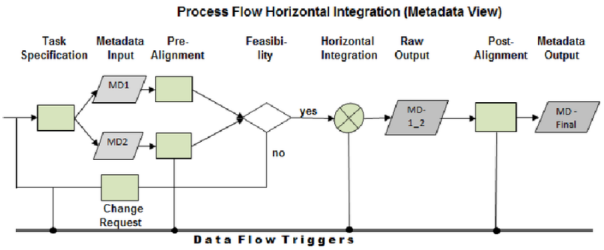
IDD = Flow of Data

A supply chain, as opposed to supply chain management, is a set of organizations directly linked by one or more upstream and downstream flows of products, services, finances, or information from a source to a customer. Supply chain management is the management of such a chain









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Digital Mindset

BIM is not a Software

BIM = Meta Data

Metadata is "data [information] that provides information about other data".[1] Many distinct types of metadata exist, among these **descriptive metadata**, **structural metadata**, **administrative metadata**[2], **reference metadata** and **statistical metadata**[3]

Purpose of the data

Time and date of creation
Creator or author of the data
Location on a computer network where the data was created
Standards used
File size
Data quality
Source of the data
Process used to create the data

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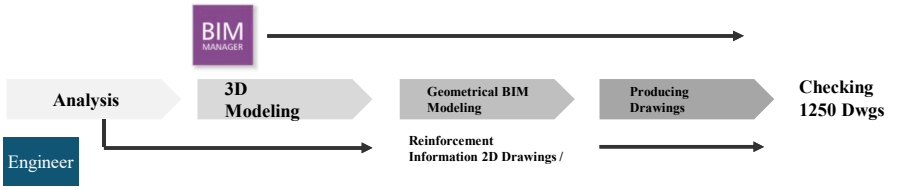
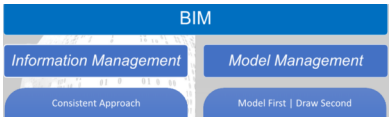
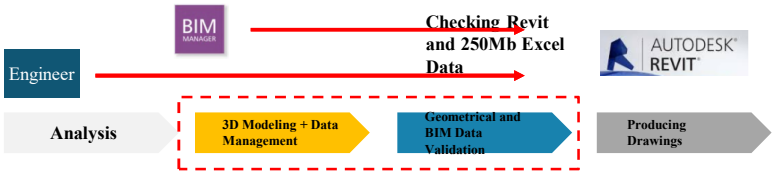
Digital Mindset

Traditional Structural Bim Workflow



Arup Structural Bim Workflow





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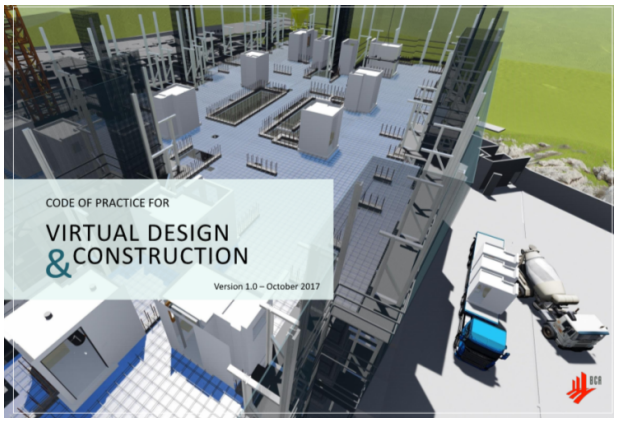
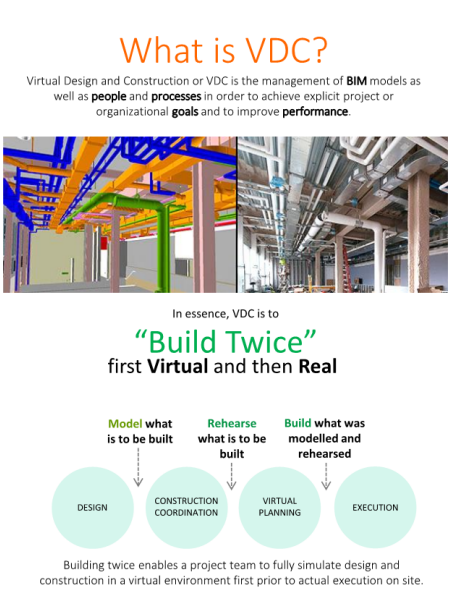
Digital Mindset





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Digital Mindset | Our Journey of VDC

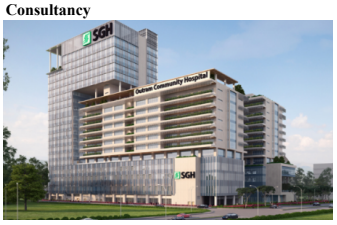
VDC in Design and Build (D&B) and Design Bid Build (DBB) Projects are difference

Singapore Sports HUB (D&B)
(Construction Completed)
Arup: Structure + Consultancy

Furniture Hub (DBB)
(Construction On-Going)
Arup: Structure + MEP + Consultancy

National Cancer Center (DBB)
(Construction On-Going)
Arup: Structure

Paya Lebar Quarters (D&B)
(Construction On-Going)
Arup: Structure + Consultancy



Outram Community Hospital (DBB)
(Construction On-Going)
Arup: Structure

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Internal Transformation | 5 Key Approaches

- Setting Digital Mindset
- Setting Digital Implementation Strategy
- Investing in Digital Technology
- Investing in Digital Skills and Talent
- Organization Change

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IDD - Managing Data Flow

Computation

What skills should we have?

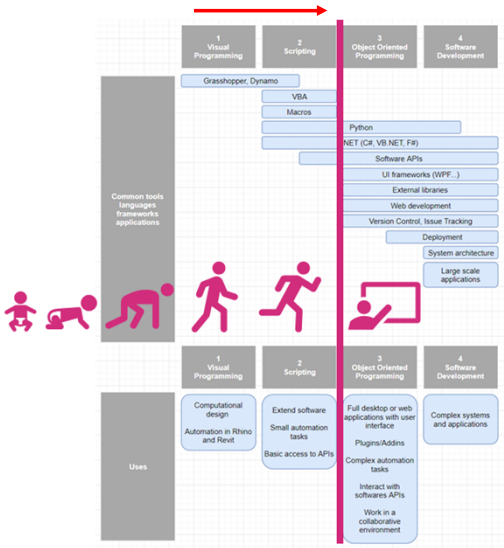
- Read/ write data
- Write functions & sub-routines
- Use of loops & Arrays
- Use API/ Com Interfaces

Why have these skills?

- Manipulate data between software packages
- Understand shared tools
- Adapt and extend existing tools
- Write new tools

Who should have these skills?

- Core skill for Engineers and technicians
- Aim for 40/40/20 split: coders/ learners/ non-coders



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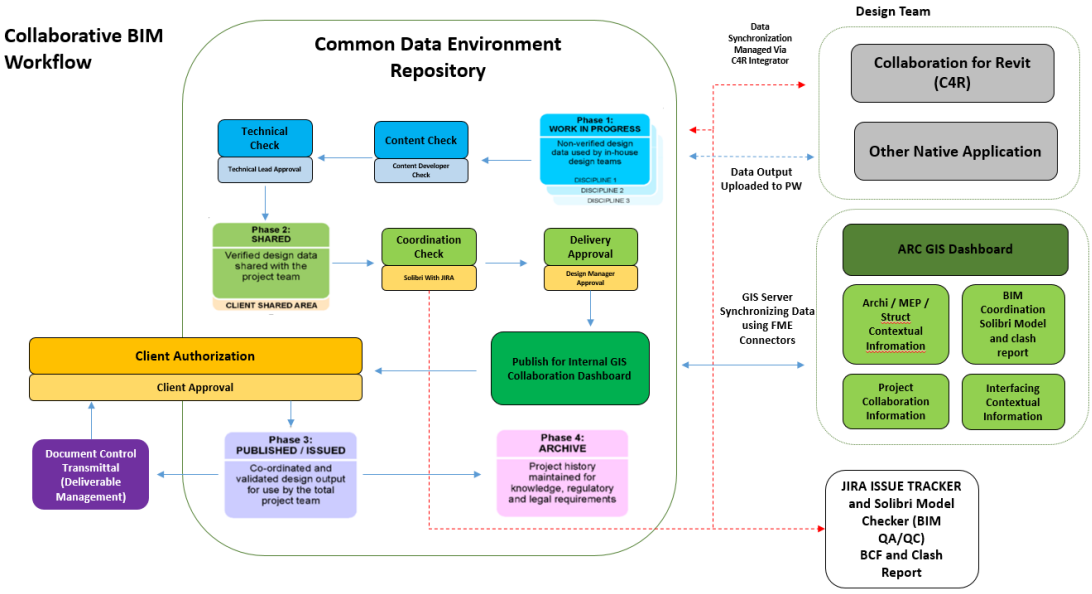
How to Work in a Common Environment



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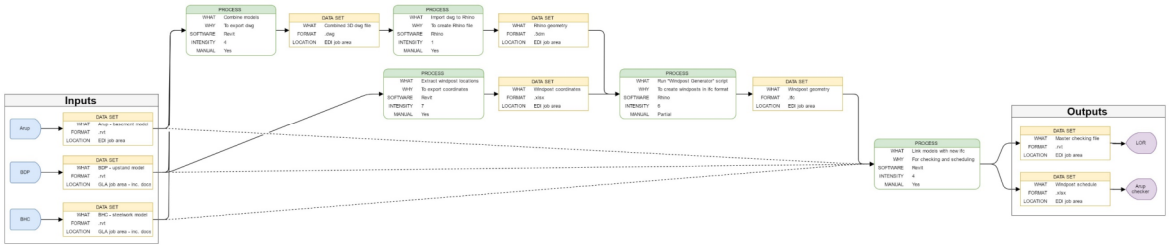
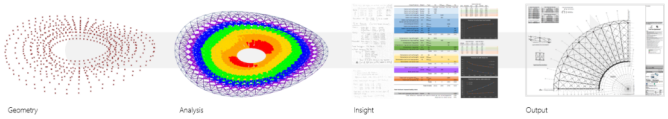
Digital Strategy | Workflows



A common set of digitally-enabled engineering workflows is the key to connecting development across a broad range of project types and tool sets.



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Digital Technology

> *"Digital technology is redefining the property sector as we speak, bringing the potential to radically improve our working lives, increase asset value and create more sustainable buildings. However, investors, developers and owners of corporate real estate must be careful – this isn't about gadgets and equipment, it is about strategic thinking that avoids wasting money on the wrong innovations and inefficient capital and operational expenditure. With the right strategy in place, we can align the property sector with the demands of our digitally enabled society and truly deliver buildings for the future."*

Volker Buscher
Global Leader, Data

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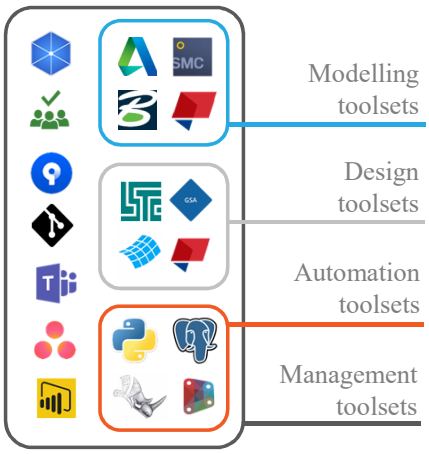
Digital Technology | Tools

Tool sets must serve the way we want to work and we must become expert users and adaptors of our tools.

The digital process drives everything else so we must own and manage our processes, and do so in a visible way that includes and empowers our teams to do new things.

Mastery of our current tool sets creates a basis for spotting new tools that will help us improve.



Creating

Designing

Connecting

Delivering

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Digital Technology | Arup University

Ask
A regional Library team – research to support winning work, project work and keeping current.

Share
Sharing our knowledge and skills to develop our staff and our business.

Learn
Enabling high quality technical learning across the region.

Explore
Exploring new possibilities through research, foresight and innovation.

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Digital Technology | Have Fun

hackathon AMSTERDAM

March 6th, 2018

Arup University

Internal Transformation | 5 Key Approaches

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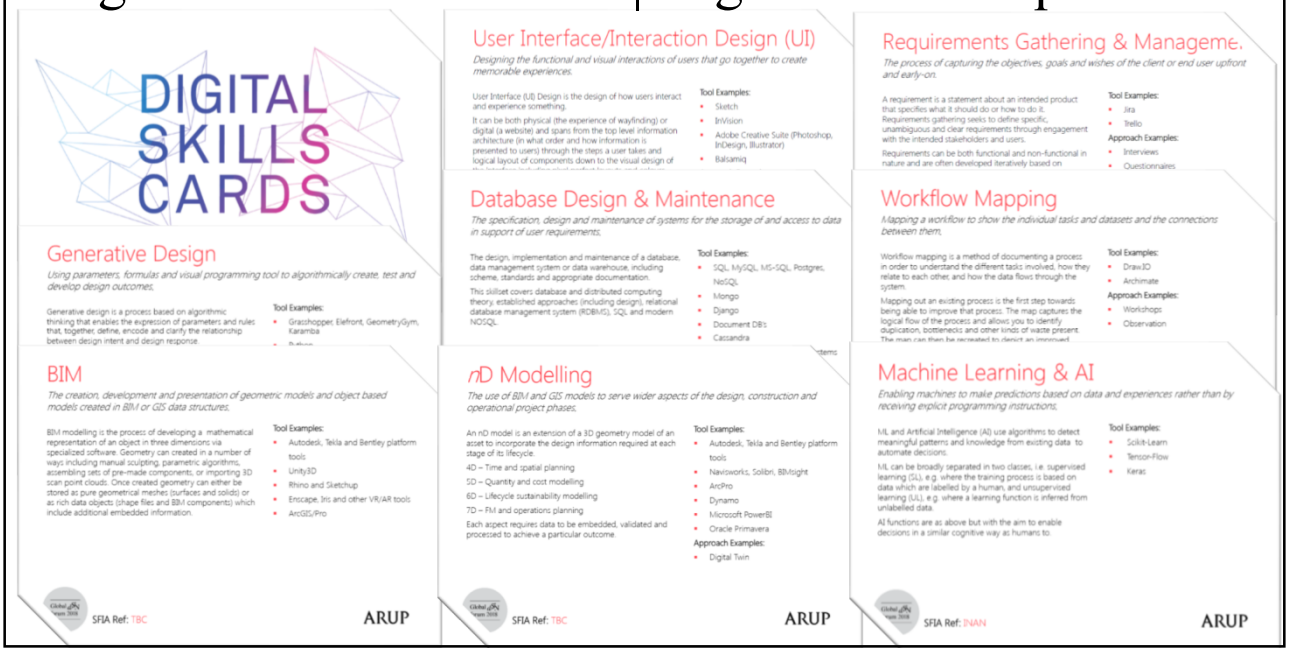
Digital Skills and Talents | Digital Skills required



Digital Skills and Talents | Skill Gaps

Structural engineering
Management skills
Communication skills

Process engineering
Data engineering
Software engineering

Technical & operational skillsets

The structural engineer (and team)

Digitally enabled skillsets

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Digital Skills and Talents | Filling the gaps

Information managers
Technical services engineers
IT and Cloud specialists
Visualisation specialists
Gaming designers
Analysts
Programmers
Data Specialists – Big Data
DB administrators
Neural networks, machine learning
IoT
Web developers

Needed during project delivery

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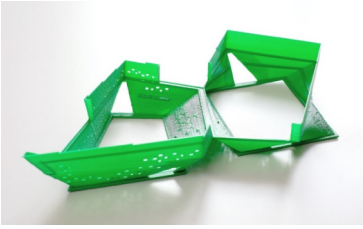
Digital Skills & Talents | Progressive Mindset

Portability
Take your design with you wherever you go

Interaction
More intuitive ways to work, interact and share



Prototyping
Let's become makers and explore design though objects

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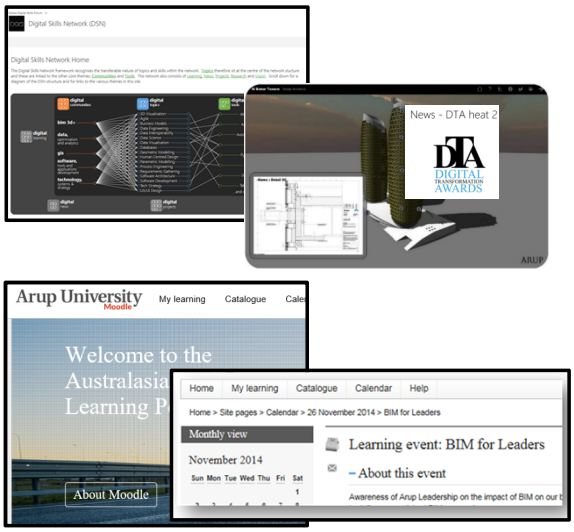
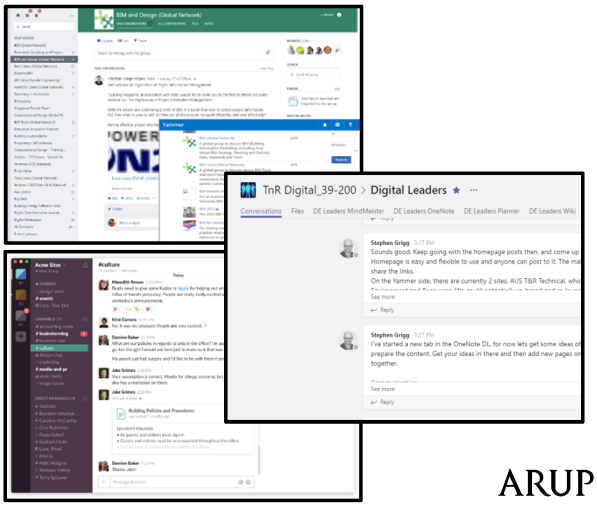
Digital Skills & Talents | Success Factors

Learning



Communication



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Digital Skills & Talents | Learning

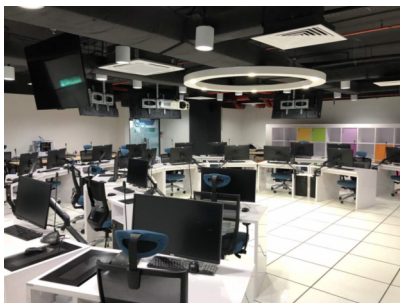
Basic BIM

Bespoke, large scale, business driven

NUS | iss

STACKUP
EMPOWER YOUR IMAGINATION

Year 2017
(Pioneer training)



Year 2018
(Revit bespoke and basic progamme)

Advanced BIM

Specialist development, partners

A2K technologies

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Arup Professional Services v1.04

Training Courses – Breakdown

Below are brief breakdowns of what content will be covered for the proposed bespoke training courses.

Revit MEP Advanced – 3 day course

Ideas for advanced (master) Revit training:

1. Coordinates
   - a. Shared
   - b. Project base point
   - c. Survey point
   - d. Revit internal origin
2. MEP family creation
   - a. Connector settings
   - b. Family categories
   - c. Family sub categories
   - d. Part types (breaks into, etc)
   - e. Controlling reference planes/lines to allow families that not just stretch in size but are articulated, eg rotate connector from front face to top face
   - f. Nested families
   - g. Type catalogues
   - h. Lookup tables
   - i. Formulas
   - j. Parameters
   - k. Detail levels

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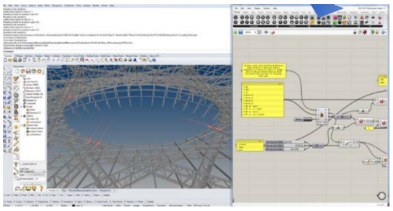
Digital Skills & Talents | Learning

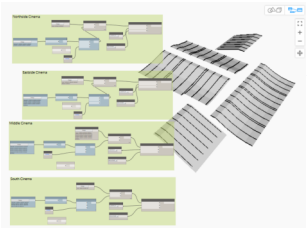
Parametric Skill Upgrade

Visual Programming



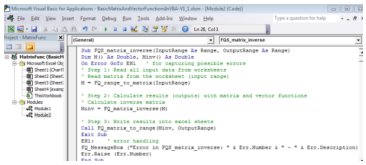
Rhinoceros
NURBS Modeling for Windows

Creating Complex Geometry Using Rhino-Grasshopper

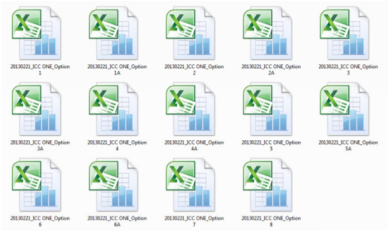


Creating Sloping Beam along Surfaces Using Revit-Dynamo

Coding



Database



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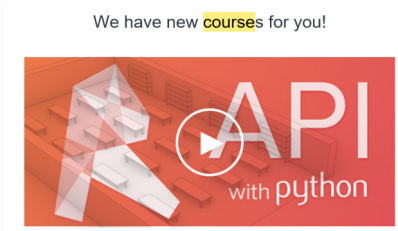
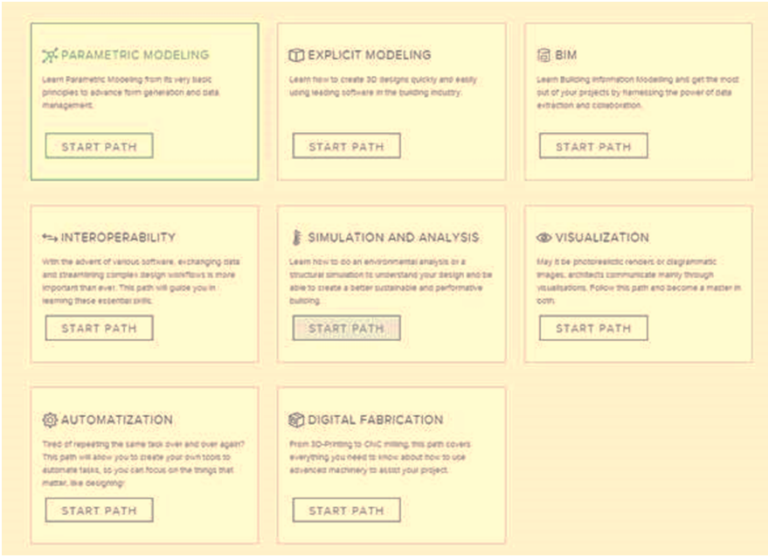
Digital Skills & Talents | Learning

Interoperable Skill Upgrade



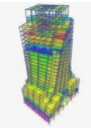
Basic Interoperability Rhino & Revit



Digital Skills & Talents | Learning

Visualisation Skill Upgrade

COMPUTERS & STRUCTURES, INC
STRUCTURAL AND EARTHQUAKE ENGINEERING SOFTWARE
APPLICATION PROGRAMMING INTERFACE



AUTODESK FORGE APIs

Microsoft Excel API
Office 365

Microsoft

amazon web services

Coding

MySQL

Figure 2: A Central Database Server Optimized for Data Storage and Retrieval

mongoDB

Figure 7: NoSQL Store for Version Control

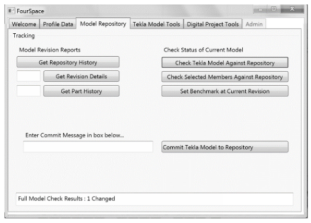


Figure 8: Structural Analysis + TEKLA Model Version Control

Database

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Internal Transformation | 5 Key Approaches

- Setting Digital Mindset
- Setting Digital Strategy
- Investing in Digital Technology
- Investing in Digital Skills and Talent
- ▶ Organization Change

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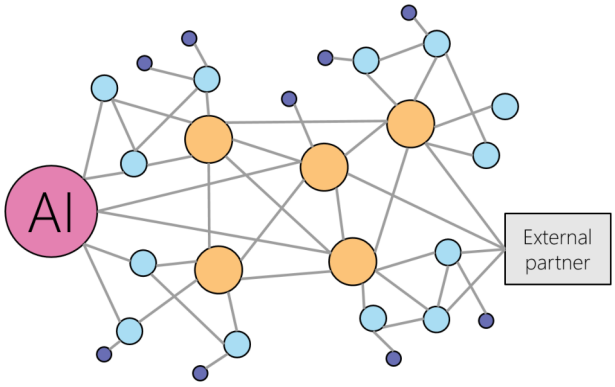
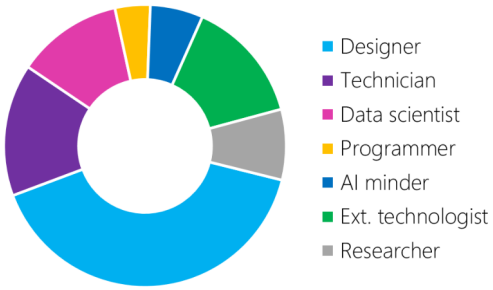
Teams

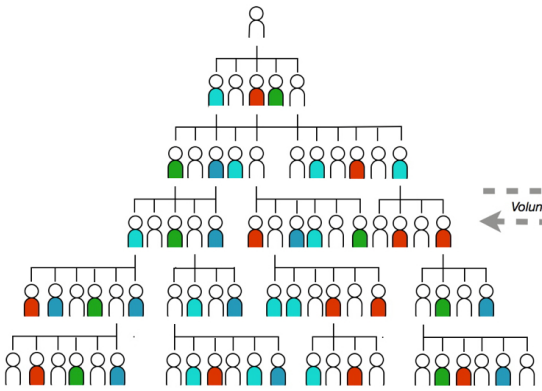


The composition of the team should be driven by the outcomes we are seeking.

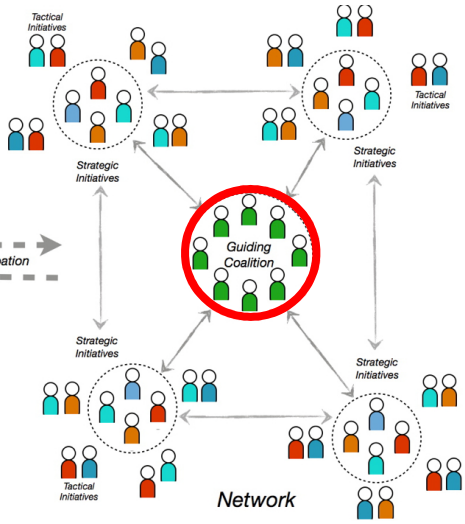
Roles, skills and tasks are products of the processes we build.



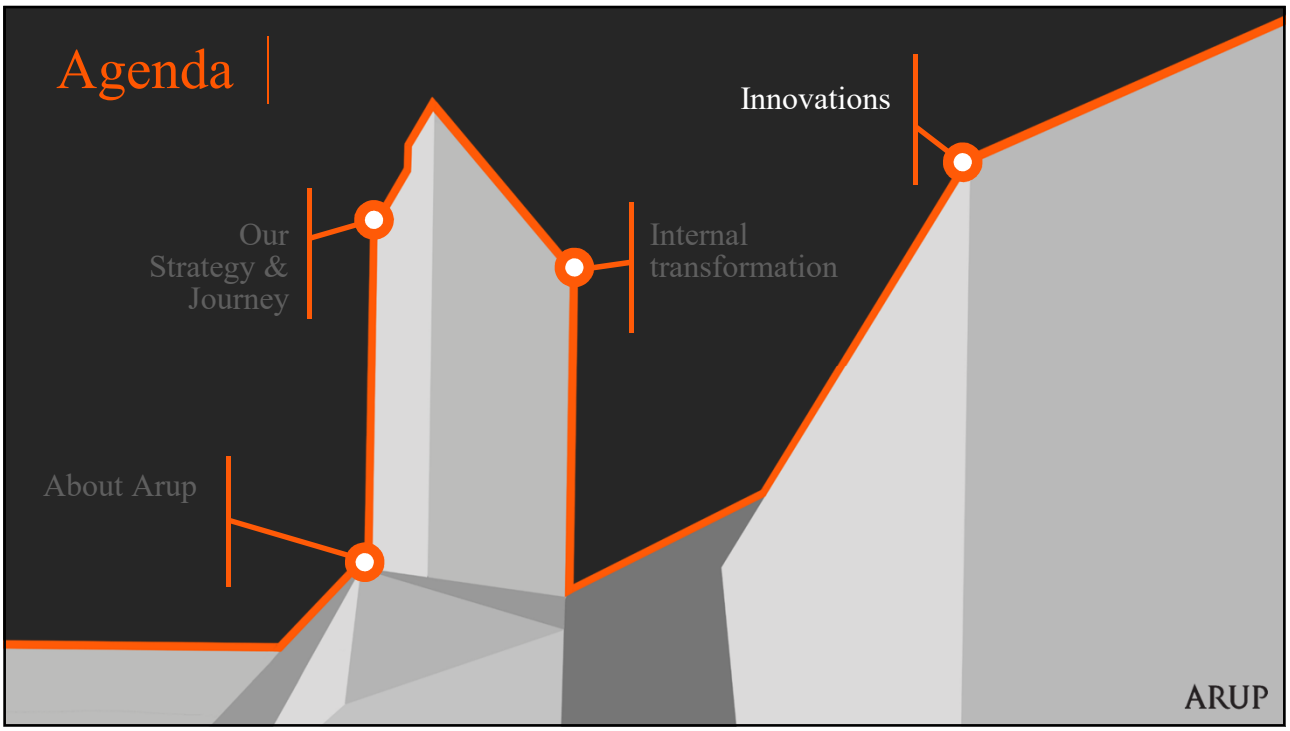
Teams



Hierarchy



Network



Innovations | Industry Sharing and Collaboration

Agencies and Industry

ASSOCIATION OF CONSULTING ENGINEERS SINGAPORE
PUB
SIA
SCDF
BCA
HOUSING & DEVELOPMENT BOARD
URBAN REDEVELOPMENT AUTHORITY

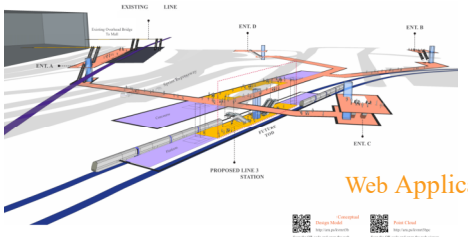
Varsities & Organization

SUTD SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN
speckle. works
STACKUP
Flux.io
NANYANG TECHNOLOGICAL UNIVERSITY
NUS National University of Singapore
buildingSMART International Alliance for Interoperability

Technology

Microsoft
AUTODESK
Avetics
Bentley Advancing Infrastructure

AR | Metro Project

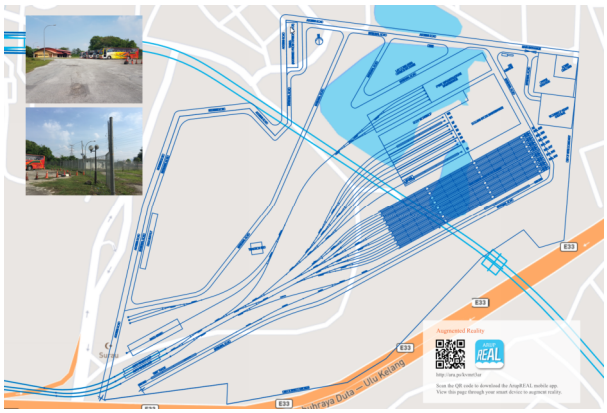


Web Applications

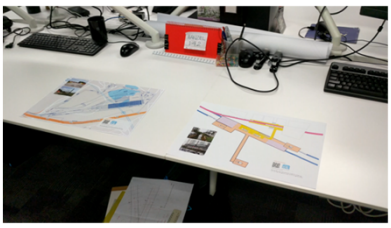
3D VIEW

1 3D Model Viewer

2 Point Cloud Viewer



3 ArupREAL AR



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AR | Metro Project

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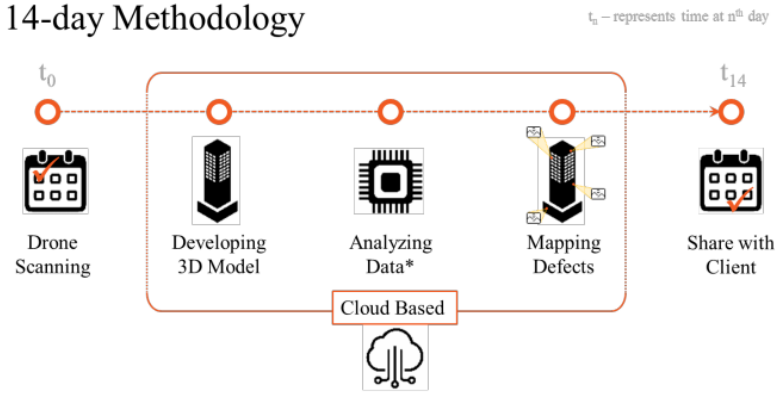
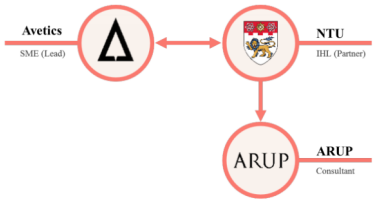
Drone Façade Inspection (Research)

14-day Methodology



*Phase 01 – includes image processing algorithms and codes to identify defects like cracks and spalling concrete in concrete, plaster, tile surfaces
Phase 02 – involves defect identification using artificial intelligence including corrosion, efflorescence and discoloration to metal supports and along with the materials in phase 01

Team



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Arup DriveSim | Simulator

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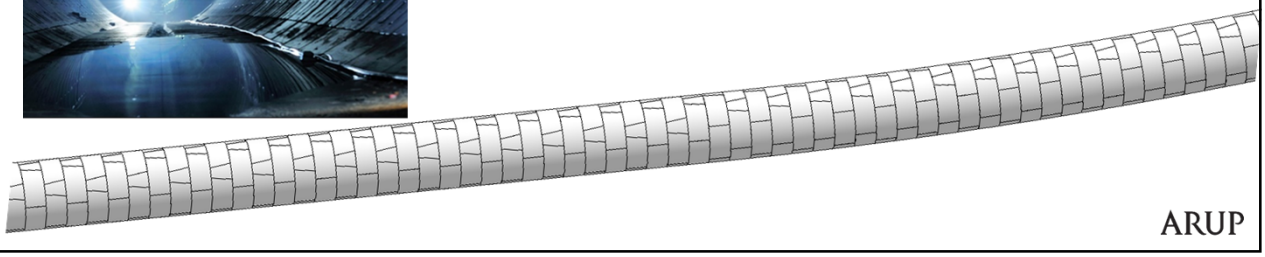
Arup Parametrics for Segmental Tunnel Lining Configuration



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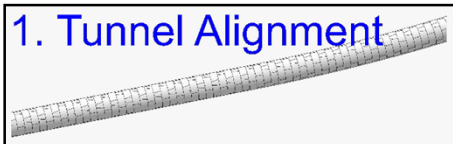
1. Tunnel Alignment

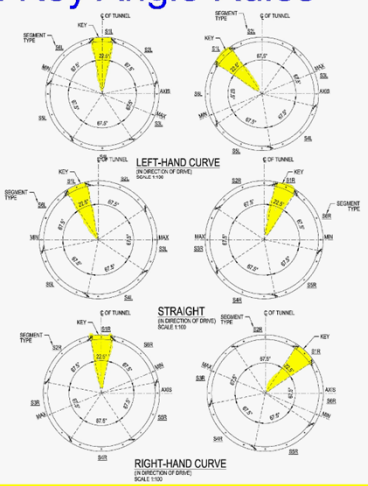


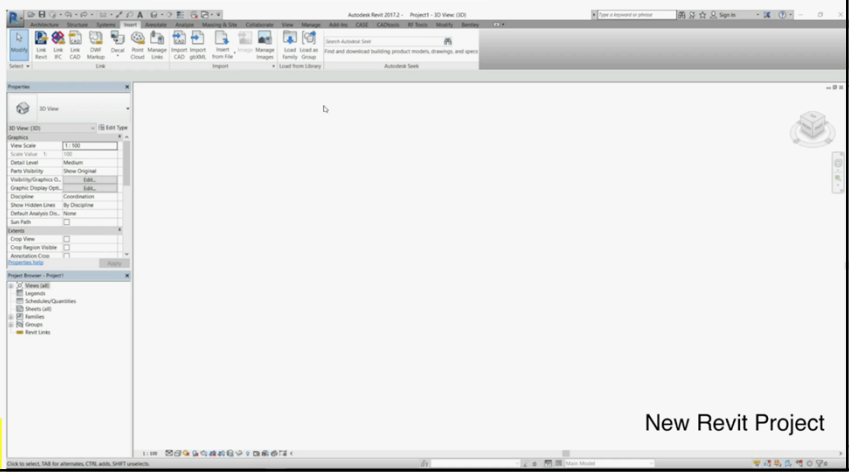
2. Segment Min/Max Width Rules

4m Internal Diameter		
Case:	Segment Max width	Segment Min width
Straight	1400	1400
Radius 40 (Right)	1487	1313
Radius 150 (Left and Right)	1422	1378
Radius 250 (Right)	1414	1386
Radius 300 (Left)	1412	1388

6m Internal Diameter		
Case:	Segment Max width	Segment Min width
Straight	1600	1600
Radius 150 (Left and Right)	1638	1562
Radius 200 (Left)	1628	1572
Radius 300 (Right)	1620	1580
Radius 500 (Left)	1609	1591
Radius 1200 (Left and Right)	1604	1596

3. Key Angle Rules





Key Considerations

CoT with NTU / BCAA (Research) | Code Complying Machine

Cities of Tomorrow (CoT) R&D

The CoT R&D Programme is a multi-agency effort, led by Ministry of National Development, to identify challenges that cities face and develop R&D solutions to address the challenges.

A total of $150 million has been set aside for CoT, which is part of the $900 million allocated to the Urban Solutions and Sustainability (USS) domain under the Research, Innovation and Enterprise 2020

Proposed Teaming

Principal Investigator — NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Co-Principal Investigator — BCA ACADEMY

Engineering Consultant — ARUP

Consultant (E-Corenet) — NOVA GROUP

Collaborators

Trimble, GRAPHISOFT (A NEMETSCHEK COMPANY), THE UNIVERSITY OF NEWCASTLE AUSTRALIA, ARUP

CoT with NTU / BCAA (Research)

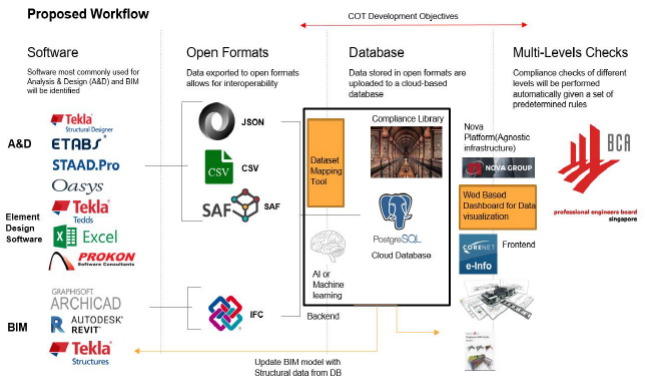


Figure 2 The proposed workflow for Structural A&D submission and processing

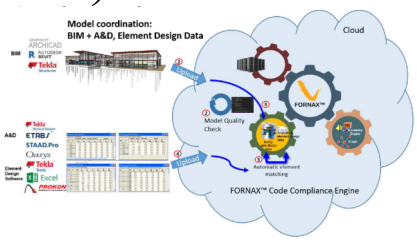


Figure 5 The workflow for developing Code Compliance Engine

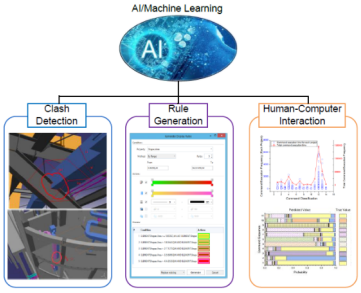


Figure 8 Role of AI/Machine Learning in the developed Code Compliance Engine

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We shape a better world