

# **HE CAP Workshop 18.07.2019 (Embley)**

15 - 18 Jul 2019

Poll results

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- RQ: In one word (join with hyphen) which organisation and networks are you representing?
- RQ: Which segment of the industry do you represent?
- How many employees in your organisation based in the UK?
- RQ: Where in the UK is your main HQ office based?
- RQ: Is your main company UK registered?
- RQ: Are you an i3P member?
- RQ: Have you heard of i3P before today's event?
- RQ: In one word, list what does 'Connect Autonomous Plant' mean to you? (One word multiple entries - in the next two minutes... go)
- RQ?: What are the external trends / factors driving CAP? (multiple answers please - we will leave running during the presentations)
- Survey
- 2. Challenges: What's stopping you from implementing CAP? (Select your top 3)

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- 2: Challenge - List challenge and thoughts on the potential mitigation and enter onto slido (you can have more than one)
- 3: Mark Lawton - Who thinks that HE has mandated 3DMC usage?
- 3: Mark Lawton - What are the next sensible areas to mandate?
- Survey
- Survey
- Survey
- TRIALS: Outline your trial focus on slido
- 7: NS Have you enjoyed today?
- 7: NS what would you like to see happen as the next step?
- 7 NS Do you want I3P to organise another event in autumn to share best practice?
- 7 NS My main focus for the demonstration would be at the following stages
- Final thoughts and feedback

**RQ: In one word (join with hyphen) which organisation and networks are you representing?**

0 4 5

highways england

costain

bentley systems

marubeni komatsu limited infrastructure  
m o'brien plant sitech uk surrey university network  
hire smt mtc  
highways england komatsu  
construction rail speedy plant  
james fisher university a plant hire  
taxpayers rssb cdbb school telematics  
survey4bim trimble vodafone ices  
innovation leadership leads supply i3p skanska wmg sitech nokia telefonica  
jacobs railway irse  
hexagon(leica rail alliance sustainability heathrow  
highway maintenance

# RQ: Which segment of the industry do you represent?

(1/3)

046

Government / Regulator



Client (Asset Owner)



Standards / Institution



University / research / training



Contractor



# RQ: Which segment of the industry do you represent?

(2/3)

0 4 6

Sub Contractor / supplier



Design consultancy



Technology (Software / hardware)



Machines manufactures OEM



Telecommunications



**RQ: Which segment of the industry do you represent?**

(3/3)

0 4 6

Other



## How many employees in your organisation based in the UK?

043

Less than 50



5 %

Less than 250



14 %

Less than 500



7 %

Less than 1000



9 %

Greater than 1000



65 %

**RQ: Where in the UK is your main HQ office based?**

0 4 4

(1/2)

Scotland



Ireland



Wales



North East



North West



**RQ: Where in the UK is your main HQ office based?**

044

(2/2)

Midlands



South East



South West



**RQ: Is your main company UK registered?**

0 4 5

Yes



No



Not sure



## RQ: Are you an i3P member?

047

Yes



No

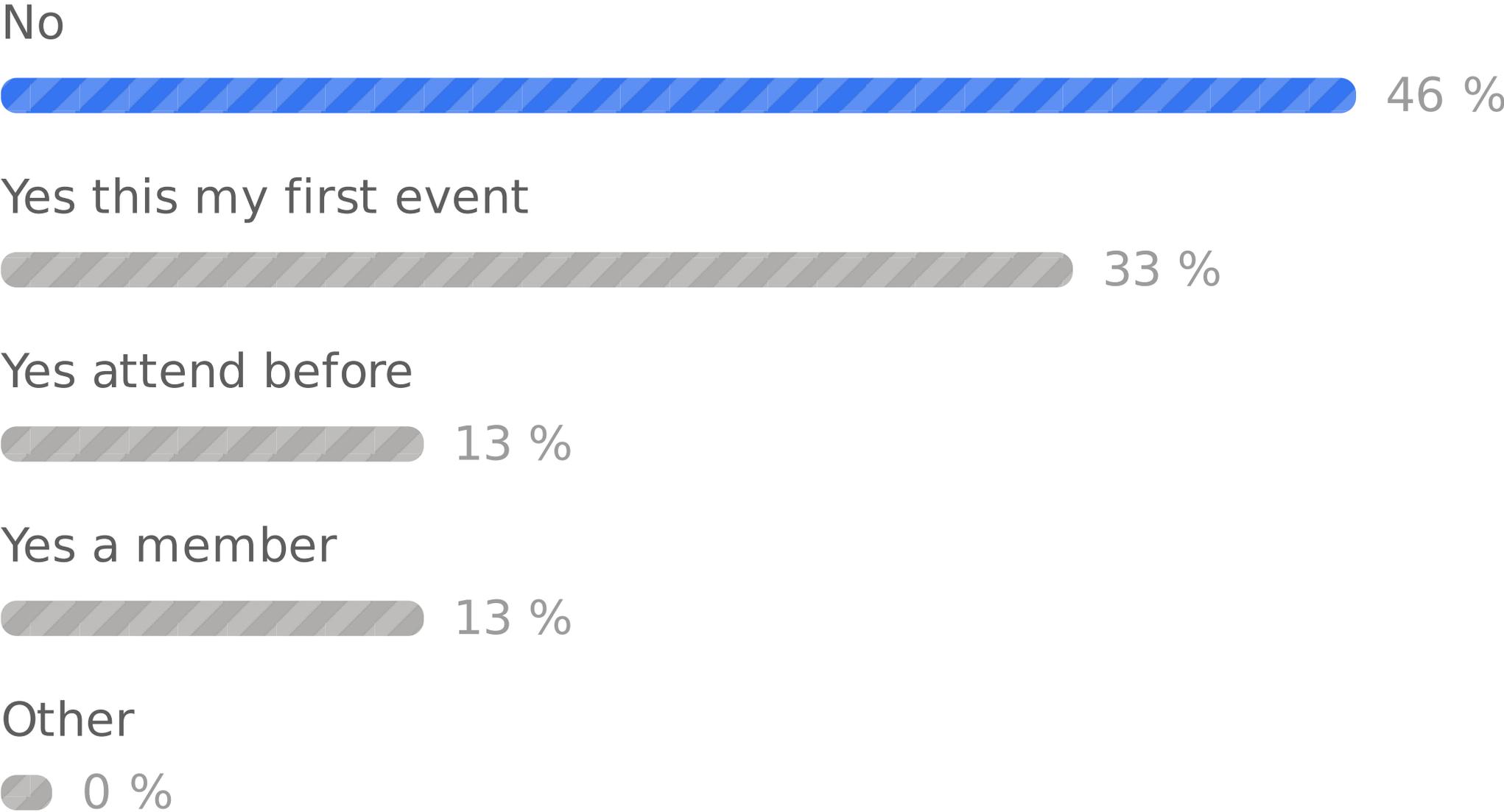


Not sure



# RQ: Have you heard of i3P before todays event?

0 4 6





**RQ?: What are the external trends / factors driving CAP? (multiple answers please - we will leave running during the presentations)**

0 4 6

(1/6)

- AI
- External
- skills shortage
- Utilising technology to improve safety, wellbeing and productivity
- school children today are digitally connected, they are the workforce of tomorrow
- Productivity and cost improvements
- Technology advancement
- Maintaining improvement in technology
- Current technological trend - driverless cars, automated warehouses, machine learning, internet of things.
- Enhanced delivery with autonomous design models, as built models and assurance data
- Large infrastructure projects
- Costs to deliver efficient solution
- Economic drivers for efficiency
- Industry leaders
- Improving technology

**RQ?: What are the external trends / factors driving CAP? (multiple answers please - we will leave running during the presentations)**

(2/6)

- Advancements
- Intelligence at the Edge
- competitive business advantages Resilience Safety Productivity
- Data Collection Explosion
- Advancements
- Changing attitude towards safety
- Gov
- wellbeing
- Skill shortage
- Advancement
- Digital Transformation
- Belief- that-its-possible
- technology approval
- Brexit
- IoT
- World labour supply
- Cost
- Digitisation, Digitisation, Digitisation, Digitisation, Digitisation, Digitisation
- future proofing
- Futureproofing
- job-costs

**RQ?: What are the external trends / factors driving CAP? (multiple answers please - we will leave running during the presentations)**

(3/6)

- Cost Efficiency, Time Efficiency, Safety
- Safety
- Limited number of operators  
Efficiency needs to be driven on our scheme and this is one way
- Labour shortages
- Adoption by other Industries - Quarries
- Connected business processes
- Productivity and cost improvements
- gameing
- Efficiency
- Safety
- Efficiency
- Ethical-acceptance
- behaviour-change
- Digitalisation
- Data sharing
- Efficiency
- Culture-change
- Requirements
- Business relationships
- Capitalism
- Communication technology

**RQ?: What are the external trends / factors driving CAP? (multiple answers please - we will leave running during the presentations)**

0 4 6

(4/6)

- Market
- Factory type production
- Technology advancement
- power-issues
- Informative
- Digitisation
- Low latency communication
- Operator availability
- speed of connectivity
- Understanding
- Acceptance
- Client
- Technology
- Digitisation
- Technology advancement
- Material costs
- sensors & fusion data aggregation
- SITE CONNECTIVITY
- AI
- Semiautonomous before automation
- data
- Design
- Safety Cost
- Forward thinking

**RQ?: What are the external trends / factors driving CAP? (multiple answers please - we will leave running during the presentations)**

0 4 6

(5/6)

- Available-technology
- Client
- Labour shortage
- Digitisation
- Access Restriction to Asset
- Cost savings
- designersdata
- Safety
- Available
- Client-pull
- efficiency
- Cost-saving
- Competitiveness
- Safety
- cost
- Lack of operator availability
- safety
- skills shortage
- speed of connectivity
- Efficiency
- Skills
- R&D-funding
- Innovation
- Safety
- Technology
- safety

**RQ?: What are the external trends / factors driving CAP? (multiple answers please - we will leave running during the presentations)**

0 4 6

(6/6)

- Client-requirements
- Internet
- Productivity
- efficiency
- labourshortage
- 5g

Survey (1/2)

0 1 4

## **T1.1 List the key parts of the vision (multiple answers)** (1/7)

- Fast data, safer sites, site to site connectivity, sharing knowledge and innovation education on risk commercial viable, need right case study sites, (vr1)
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- Fast data, safer sites, site to site connectivity, sharing knowledge and innovation education on risk commercial viable, need right case study sites, (vr1)

## T1.1 List the key parts of the vision (multiple answers)

(2/7)

- site connectivity, sharing knowledge and innovation
- education on risk commercial viable, need right case study sites,
- Productivity PPI Upskilling New opportunities
- Efficiency/utilisation Up time
- Management Information Work
- Fast data, safer sites, site to site connectivity, sharing knowledge and innovation
- education on risk commercial viable, need right case study sites, (vr1)
- Management of intelligent data as an enabler to build and maintain our infrastructure of the future
- Table 5. -
- - Educate people on the systems; enable further uses by their application to other challenges
- Table 1 - Move from

Survey (1/2)

0 1 4

## **T1.1 List the key parts of the vision (multiple answers)** (3/7)

- human focused processes to machine focused processes - design, implementation, operation, maintenance - End to End life cycle. Connectivity Digital Twinning Creating/Enabling a collaborative environment through standards & cultural change Creating a shared data environment
- Common data environment - bring
  - in the construction data side as opposed to being a design management/client management only tool
  - Fast data, safer sites, site to site connectivity, sharing knowledge and innovation education on risk commercial viable, need right case study sites, (vr1)
  - - Change of specifications to enable plant eg. slipform kerbs
  - - education into the

Survey (1/2)

0 1 4

## T1.1 List the key parts of the vision (multiple answers)

(4/7)

workforce; people need to understand their input and their responsibilities

- Collaboration between different contractors on worksites.
- Fast data, safer sites, site to site connectivity, sharing knowledge and innovation education on risk commercial viable, need right case study sites, (vr1)
- table 4: Efficiency,

Safety, quality, cost, productivity and attracting new talent

- Table 5.
- Table 5: Highways England will own a fleet of connected and autonomous plant, repairing our network, safely and efficiently, keeping our asset at optimum capacity and our customers happy.
- Improved customer experience through efficient construction

Survey (1/2)

0 1 4

## **T1.1 List the key parts of the vision (multiple answers)** (5/7)

- projects. 1. Reliable connection throughout the the project lifecycle. 2. Site governance - improved management. 3. CAP will enable further known unknown improvements in efficiency & site governance. 4. Improved safety. 5. Improved quality. 6. Improved output.
- - Plant data lead assurance - Automated cut/fill management - Automated design
- model assurance - Automated compaction assurance - Automated works approval - Automated V&V creation - No disparity between records - everyone has the same records - Mandated by other contracts and strategic projects - Part of the contracts - Enhanced

Survey (1/2)

0 1 4

## T1.1 List the key parts of the vision (multiple answers)

(6/7)

- speed of payment based off records - 6D BIM - Project progress based off models - Enhanced safety rates - connected site - people also connected for enhanced safety - Industry wide Data specification (input to plant and output from plant)
- Table 5: Highways England will own a fleet of connected and autonomous plant, repairing our network, safely and efficiently, keeping our asset at optimum capacity and our customers happy.
- Supplier to site link -tarmac to paver
- Fast data, safer sites, site to site connectivity, sharing knowledge and innovation education on risk commercial viable, need right case study sites,
- Integrated data management

Survey (1/2)

0 1 4

## **T1.1 List the key parts of the vision (multiple answers)**

(7/7)

- Please put table answers in this box

Survey (2/2)

035

## **From your perspective what are the key objectives (Individual exercise)** (1/11)

- Require designers to provide USEABLE data
- One standard, industry lead
- Collaboration across industry design implementation operation
- Intelligent Edge Computing near the plant
- As a client I want a safety site that is efficient and effective  
We want to be able to act on real time data having the connectivity to make smart decisions. We need educate decision makers on risk and accuracy on these system. One standard for all, vanilla management systems. Whole life costing need to be considered when thinking about investment required. Not guilty proof so need back stop to convince policy makers
- As a client I want

Survey (2/2)

035

## From your perspective what are the key objectives (Individual exercise)

(2/11)

a safety site that is efficient and effective We want to be able to act on real time data having the connectivity to make smart decisions. We need educate decision makers on risk and accuracy on these system. One standard for all, vanilla management systems. Whole life costing need to be considered when thinking about investment required.

- As a client I want a safety

site that is efficient and effective We want to be able to act on real time data having the connectivity to make smart decisions. We need educate decision makers on risk and accuracy on these system. One standard for all, vanilla management systems.

- As a client I want a safety site that is efficient and effective We want to

## From your perspective what are the key objectives (Individual exercise)

(3/11)

- be able to act on real time data having the connectivity to make smart decisions. We need
- Develop a standard platform in order that equipment from different manufacturers will work & report together.
  - What are the ways to design and manage communication between equipment, people, other static and dynamic objects on the site?  
Centralized or Decentralized communication? The importance of human in the loop in the case of database distribution Reliable data backup and storage
  - To identify how we want our sites to look and operate. Is the goal for full automation driven by the need to remove people from the process at ground level?
  - Managing the flow of data across an

Survey (2/2)

035

## From your perspective what are the key objectives (Individual exercise)

(4/11)

integrated business process between stakeholders AND capturing records for long term management of the asset across its whole lifecycle

- - Single platform for information with permissions to access data. - utilisation - automatic stops if someone enter the possession zone - challenging supervision and control of site.
- Segregation of people

from autonomous plant (including the public) Live data to and from plant in a format that allows instant assessment by the end user Asset protection - utilities

Productivity of plant - efficiency evaluation to allow user to choose the right plant for the right activity

- - Educate the workforce - Change the

## From your perspective what are the key objectives (Individual exercise)

(5/11)

- specifications - enable data specifications - mandate across projects via supply chain using the contracts - Collaboration through design and worksite
- Safer faster better leaner ways of delivering managing maintains highways infrastructure to the benefit of the customer.
- As a client I want a safety site that is efficient and effective We want to
- be able to act on real time data having the connectivity to make smart decisions. We need educate decision makers on risk and accuracy on these system. One standard for all, vanilla management systems. Whole life costing need to be considered when thinking about investment required.
- Create a digital life cycle management culture in the industry Define

## From your perspective what are the key objectives (Individual exercise)

(6/11)

- and communicate clear standards for the industry to work and innovate against
- connected shared Data from original capture to maintenance of project/infrastructure
- Safety on Sites. Better communications between sites and all involved
- Addressing climate change throughout process Sustainability
- environment, economic, people, end of life Connectivity requirements - capability, reliability Technology agnostic implementations
- Fluidity of data flow to/from plant to manage process efficiency
- Total reliable connectivity, people, plant, site, supplier Needs to be commonality across all products and platforms to work effectively

Survey (2/2)

035

## From your perspective what are the key objectives (Individual exercise)

(7/11)

- Data interchange. Business environment to support investment. Acceptance of technology into a conservative business segment. Connectivity infrastructure Implementation of autonomous operations to offset lack of skilled operators - NOT a threat to jobs. Training of people coming into construction
  - "up skilling" by influencing the current teaching content in colleges & universities.
- Ensuring sufficient network coverage for CAP Connectivity for smart working Customer satisfaction through communication
- As a client I want a safety site that is efficient and effective We want to be able to act on real time data having the

Survey (2/2)

035

## From your perspective what are the key objectives (Individual exercise)

(8/11)

connectivity to make smart decisions. We need educate decision makers on risk and accuracy on these system. One standard for all, vanilla management systems.

- Efficiency, Connectivity, safety, uniform construction.
- Improving communication between Plant - Site - offices to create real-time results.
- As a client I want a safety site that

is efficient and effective We want to be able to act on real time data having the connectivity to make smart decisions. We need

- Total reliable connectivity, people, plant, site, supplier
- Table 4 Define site type (risk and size of opportunity)  
Process - think new not as it is  
Technology on man and machine

Survey (2/2)

035

## From your perspective what are the key objectives (Individual exercise)

(9/11)

Scan site (drone) real time and live Deploy telecoms array around site Deploy machine control on equipment (operator, semi or fully autonomous ) All equipment with telematics to assess output and performance of machines  
Also Leaning to semi autonomous being more realistic on most sites high risk =

Compare cars on small roads to construction sites Lower risk = mines compare to motorways

- Safety, Connectivity, Integration, Efficiency
- Ensure the workforce are informed and kept abreast of developing technology.
- Connectivity, design interoperability, minimal network occupancy
- connectivity. speed

## From your perspective what are the key objectives (Individual exercise)

(10/11)

- to resolution
- 1. To remove staff from danger. 2. To relieve stress on labour supply. 3. Save one life. 4. Reduced overheads. 5. Reduced business risk.
  - Connected site
  - - Single platform for information with permissions to access data. - utilisation - automatic stops if someone enter the possession zone
  - Consistent 2 way data
  - 1. To remove staff from danger. 2. To relieve stress on labour supply. 3. Save one life. 4. Reduced overheads. 5. Reduced business risk.
  - - Single platform for information with permissions to access data. - utilisation
  - Integration onto latest legislative and standard changes - BIM, Internet

Survey (2/2)

035

## **From your perspective what are the key objectives (Individual exercise)** (11/11)

of Things, Connectivity Networks (Cyber Security) and Data Management. Formation of recognised controlling mind for CAP. Design for CAP - changing how we design in order to optimise CAP.

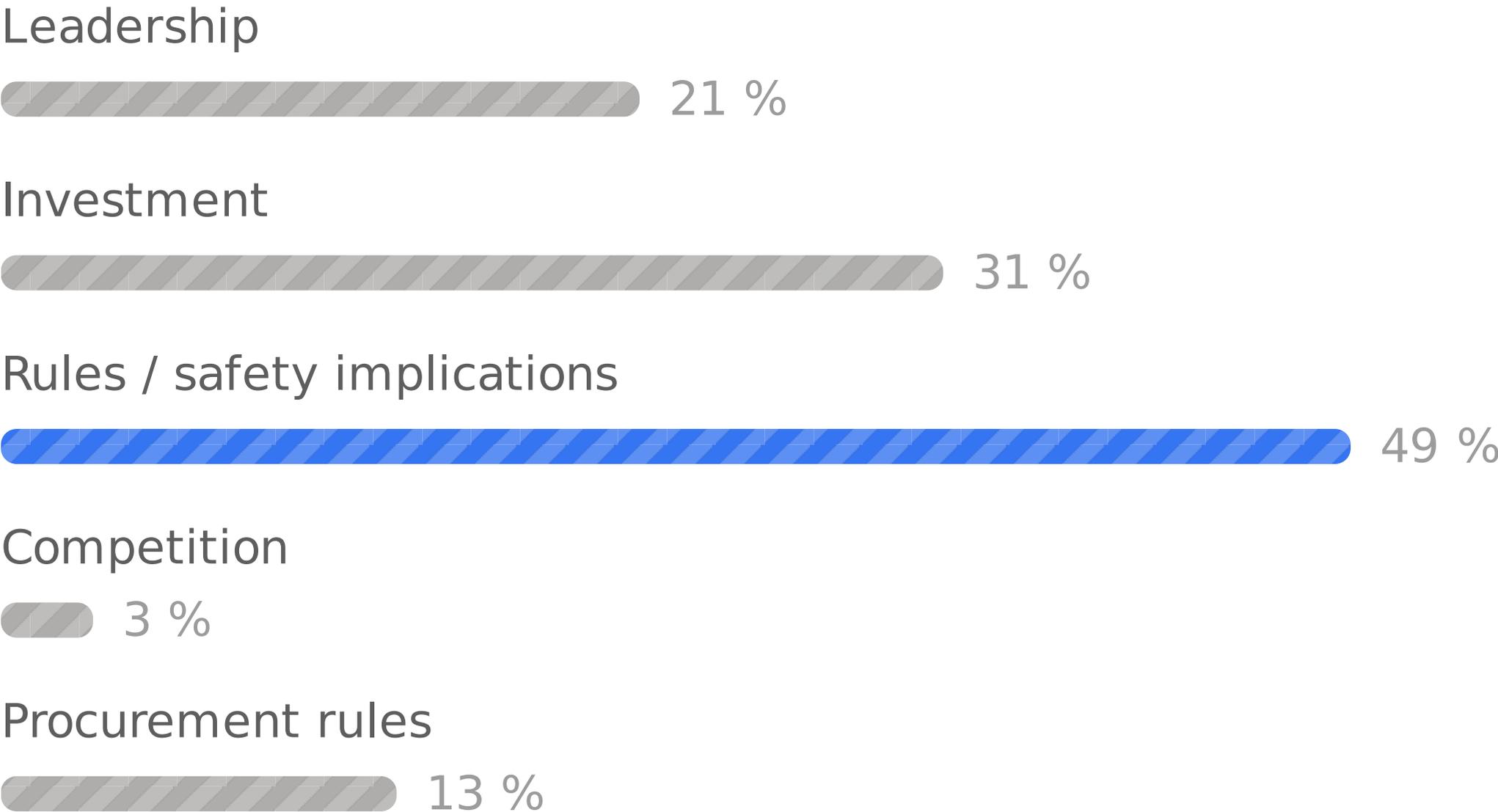
- Client funded communications or tender requirements
- Efficiency Productivity
- Efficiency
- The vision needs to include connectivity 5g

- The vision needs to include connectivity 5g

## 2. Challenges: What's stopping you from implementing CAP? (Select your top 3)

(1/4)

039



## 2. Challenges: What's stopping you from implementing CAP? (Select your top 3) (2/4)

039

Commercial



Technology



Skills



Research knowledge



Joined-up industries



## 2. Challenges: What's stopping you from implementing CAP? (Select your top 3)

(3/4)

039

Standards



Patents



Data availability



Availability of the tech



Connectivity between equipment



## 2. Challenges: What's stopping you from implementing CAP? (Select your top 3)

(4/4)

039

Cost of development



Other



## 2: Challenge - List challenge and thoughts on the potential mitigation and enter onto slido (you can have more than one)

0 1 2

(1/7)

- Table 5 - Challenge: Correct use of systems Mitigate: Provide proper education and training on correct use of systems/technology. Not a tick box exercise.
- CHALLENGE: Where the burden of investment sits to develop the enabling infrastructure? MITIGATION: H.E CHALLENGE: Cyber security MITIGATION: Provide access control/ learn from high security sectors - military?
- Clients won't pay for adoption of new technology Contactors don't make enough to pay for it Cost at the moment is high Technology is machine control only Investment model doesn't work in early adopter phase Innovation director excited but procurement and ops won't pay for it
- CHALLENGE - Lack of single controlling mind to determine

## 2: Challenge - List challenge and thoughts on the potential mitigation and enter onto slido (you can have more than one)

0 1 2

(2/7)

direction and classification of levels of automation.

MITIGATION - Formation of coalition to govern technical aspects, provide oversight and influence law, financing options & commercial risks.

- CHALLENGE - Lack of single controlling mind to determine direction and classification of levels of automation.

MITIGATION -

Formation of coalition to govern technical aspects, provide oversight and influence law, financing options & commercial risks.

- Data - Data formats - Data standards - Buy in by designers, supply chain and contractor - Data management and assurance (quantity and cleansing of data) - Edge computing and size of datasets
- Ethics, cost of tech lead plant -

## 2: Challenge - List challenge and thoughts on the potential mitigation and enter onto slido (you can have more than one)

0 1 2

(3/7)

Contractors with standard plant are removed from the procurement process -

Procurement is not clear in rail, contractors are put out by lack of clarity of spending - Cost of having the data; picked up by client - asset owners support and commitment needed

- Legality and indemnity - Legal framework for guidance on a live site

- indemnity for H&S risk -

Couple onto current government policies,

emissions, power, 5G and connectivity, carbon etc. -

ethics, removal of people from site and re-training to cover other areas of low staff cover

- Challenges: Public procurement processes stop adoption of new technology  
Mitigation: Legislation needs to support

## 2: Challenge - List challenge and thoughts on the potential mitigation and enter onto slido (you can have more than one)

0 1 2

(4/7)

innovation + uptake  
Challenge: Connectivity Who decides what level is required, who pays for it, and who supports it.

Mitigation: Support alternative methods of connectivity, take input from CAV using multiple communications sources to supplement each other.

- Challenges: Public procurement processes stop adoption of

new technology  
Mitigation: Legislation needs to support innovation + uptake  
Challenge: Connectivity Who decides what level is required, who pays for it, and who supports it.

Mitigation: Support alternative methods of connectivity, take input from CAV using multiple communications sources to supplement each other.

- Data - Data formats - Data standards - Buy

## 2: Challenge - List challenge and thoughts on the potential mitigation and enter onto slido (you can have more than one)

0 1 2

(5/7)

- in by designers, supply chain and contractor - Data management and assurance (quantity and cleansing of data) - Edge computing and size of datasets
- Operative Training - No requirements (CSCS Card) for an operative to have specific training in the use of 3DMC or Proximity systems.
- VR 1 Commonality of system, same platform. Mitigate by legislation.
- Ethics If automation is deployed and there is going to be an accident what AI decides the outcome .
- Ethics, cost of tech lead plant - Contractors with standard plant are removed from the procurement process - Procurement is not clear in rail, contractors are

## 2: Challenge - List challenge and thoughts on the potential mitigation and enter onto slido (you can have more than one)

0 1 2

(6/7)

- put out by lack of clarity of spending - Cost of having the data; picked up by client - asset owners support and commitment needed
- VR 1 Liability and ownership of CAP equipment in the event of an incident who does it sit with.
  - Challenge: physical security, intruders taking control of plant. Mitigation, Automatic machine disablement.
  - Challenge: physical security, intruders taking control of plant. Mitigation, Automatic machine disablement.
  - Legality and indemnity - Legal framework for guidance on a live site - indemnity for H&S risk - Couple onto current government policies, emissions, power, 5G and connectivity, carbon etc. - ethics, removal of people from site and re-training to cover other areas of low staff cover

## 2: Challenge - List challenge and thoughts on the potential mitigation and enter onto slido (you can have more than one)

0 1 2

(7/7)

- Safety - person avoidance - can the people and the plant be monitored rigorously around a worksite
- Validation check before use of CAP: Minimum standards, mandate standards through new CAP Regulations
- Leadership - when push comes to shove, someone needs to authorise the plant to be working near live traffic - trust needs to be earned
- Cyber security - how will you prove that you can prevent malicious use by a teenage hacker?

### 3: Mark Lawton - Who thinks that HE has mandated 3DMC usage?

0 4 6

No



Yes



Not sure



No idea what you are talking about...!



### 3: Mark Lawton - What are the next sensible areas to mandate?

007

- Set up a controlled area within a new project and demo and test as much as possible
- Requirement for connectivity prior to project launch
- Design data format
- Design data
- Underlying digital transformation to enable this
- M/C operator training.
- Proof of final layer compaction, firstly on the earthworks then the asphalt
- connected setup
- connected setup
- Assurance requirements - linked to data
- Site collected data standards

## Task 3: key areas on the roadmap for free

- Define specific Technology Readiness Levels for 3DMC/CAP. Develop a clear procurement specification for 3DMC Define a set of productivity KPIs for site productivity Develop a design guide for 3DMC Commission an ethical review into the use of CAP
- HE to mandate imodel.js as the industry format. Clear solid leadership.
- feedback from all manufacturers and tech suppliers what is available now
- 1 Feasibility review 2 Consultancy services for changes in contract, safety and legislations 3 Plan for on field reviews for at least 100/200 operating hours 4. Simulated working model
- Share information of current technology.
- Define specific Technology Readiness Levels for CAP

## **Task 3: key areas on the roadmap in the short term**

- Develop a utilisation metric & methodology for plant Develop a design guide for CAP
- 1. Service and technical support 2. Trainings
- Adopt available technology on major projects.

## **Task 3: key areas on the roadmap in the medium**

- Specify and require data on the utilisation of plant Specify site/construction quality assurance as a quantitative measure, instrumentation based data set.
- Periodic checks
- Champion successful projects. |

## **Task 3: key areas on the roadmap in the long-term**

- CAP plant used for maintenance CAP used for at night in place of road workers CAP is at nano-level in building material repairing as and when (2100)
- Engineering support innovation upgrade options Warranty support
- All mobile construction plant on the job site to be fully automated.

## Task 5: Recommendations for free (1/6)

- Collaboration
- Demonstrate the technology and articulate a shared vision.
- Government project mandate.
- Knowledge sharing
- Industry collaboration
- Standards and specifications
- Form a 'competitive list' of what capabilities are 1) used by contractors, 2) available from vehicle/software suppliers, 3) Currently under research/development/demonstrator
- Work with design community to develop the designs needed for cap - Principal designer community meeting next Thursday, this item has been notified for that meeting Run a trial on sites that are using manual systems to capture what the

## Task 5: Recommendations for free (2/6)

connectivity issues are across the country. Use the data to help construct a predictability/probability map of how often transmissions are lost. This can then help understand when fully autonomous plant doesn't need a cab for a person.

- Information & awareness of available technology
- speak with networks team to understand current infrastructure and

see if it can be optimised for the site

- Knowledge
- Client to review tender process to allow space for investment from contractors
- Create the right climate for change, get all industry's on board. Engage with the HE supply chain to enable change. Review of Terms and Conditions of contracts
- Create the climate for change
- Knowledge

## Task 5: Recommendations for free (3/6)

- Feasibility Consultancy on legal, and safety changes
- Culture for change - create a business environment/relations that stimulates innovation investment.
- Feasibility Consultancy on legal, and safety changes
- Standards & specifications
- Document state of play (industry) - What has been done, develop retro-fitment specification if requirements are readily available.
- More use of simulators to train operators to get them used to remote semi autonomous vehicle
- 1. Technology agnostic Connectivity (e.g. 5G, 4G, Satellite, DSRC, LoRA etc.). Each tech brings its own benefits

## Task 5: Recommendations for free (4/6)

and limitations 2. End to end demo for earthworks from planning, design, implementation, operations & maintenance

- If Government/local govt/authorities mandate or legislate requirements this will drive uptake for machine control/CAP What can Leica, Topcon and Trimble have available now and use this capability as they can do lots Will off site manufacture alter

CAP requirements Will legislation allow autonomous operations on site Get clients to mandate and pay for this technology Share case studies through industry portal Set up research fund for trialling of technology

- Guidelines for implementation
- Accommodating under ground utility detection during excavation Integrated

## Task 5: Recommendations for free (5/6)

- connectivity to static and dynamic objects, people, equipment, structure, infrastructure
- Client to review tender process to allow space for investment from contractors
- Supply chain / commercial buy in
- Raise awareness at project procurement level Identify needs with best and easiest wins
- Share knowledge and
- raise awareness
- Engage with government. Have a Community Leader/ spokesperson
- Engage with government. Have a Community Leader/ spokesperson
- Intelligent compaction specification document (standard reporting values and minimum specification) Specify end value compaction rather than method standards
- Educate the industry to

## **Task 5: Recommendations for free** (6/6)

- the long term benefits and why we are aiming for autonomy
- Do it now designers create buildable models and be held accountable for MC models
  - Think digital
  - Mandated use of CAP
  - Culture change
  - One vision
  - Standard specifications
  - Design guide for modelling for Machine control

## Task 5: Recommendations for short term (1/4)

- Identify the tech we can use now
- Set up collaborative open data & APIs. Wireless connectivity. Standard quantified safety cases for emerging use cases.
- Dedicated communication network.
- Feasibility studies
- Open source + data platforms
- Identify clients needs and funding
- Automate 'small tasks' e.g. pre-heating the cab and engine, smart engine management.
- Short term is 1-2 years: Training - specifically training in cap and detailed plant driving systems from a semi autonomous perspective and data analytics, both from productivity and cost management.
- Temp solutions for immediate network coverage
- Demo of remote control machine

## Task 5: Recommendations for short term (2/4)

- Robust cyber security to be prioritised
- Create the new skills, jobs, roles etc to deliver what is required. Be clear about what is achievable put a framework, scope deliverables and measure against these. Establish a deliverable process.
- Legislative weight - government mandate a preference for the path to adoption
- Document success stories, build the story of innovation successes.
- Government mandates
- Cross-industry nominate case studies to be identified, funded and commissioned targeting enabler and quick win parameters such as connectivity, education, data sharing platforms, cyber security etc
- Specific 3D machine control training
- Open Data Exchange (each

## Task 5: Recommendations for short term (3/4)

- supplier has their own cloud, data formats not necessarily consistent etc.) Need intermediate and independent system to aggregate, filter and unify data for end use cases
- Deployment of improved telecoms Common standards adopted across industry
  - Open communication between all sources
  - Government mandate adoption
  - Cross industry collaboration and led standardisation
  - Identify needs & government mandate for standard
  - Employ existing technology
  - Employ existing technology
  - Commitment from authorities to accept and specify (semi)autonomous plant, connected site standards Legal framework for any liabilities from malfunctions/accidents
  - Gather better data for the landscape and profile of the works.

## **Task 5: Recommendations for short term** (4/4)

Gain better and more accurate data for below ground services.

- Open source data platform
- Semi Automation
- Utilise existing technology already in place with suppliers, Leica, Trimble and Topcon etc
- Secure wireless comms
- Open data source platforms
- Material management
- Suitable cyber security to allow implementation on a public project

## Task 5: Recommendations medium term (1/4)

- Policy and governance framework
- Standards and specifications, including on cybersecurity.
- Industry standardization across manufacturers.
- Standards
- Adapt legislation
- Accurate below ground data
- Automate 'specific functions' e.g. automatic positioning of components using the arm, ie over ~1m distance.
- Medium term is 3 years: semi autonomous plant is being used on all phases of the work from construction to maintenance and operations, with moves to make fully autonomous in some aspects.
- Setting up specific mandatory rules for machines
- Agreed Specification for CAP and machinery
- Follow basic SWOT analysis rules, what other opportunities are

## Task 5: Recommendations medium term (2/4)

being created, ensure integrity feedback on where we are what has been achieved and what needs to be achieved and professionally manage all deliverables ,

- On the fly design assurance.
- Design standards - Design projects to suit MC, minimise the need for the rewriting of data.
- ISO standardisation for design to 3DMC
- Legislative change to

encourage industry wide adoption. Conduct deeper and larger case studies into most challenging parameters as identified by the short term goal.

- Building framework to develop functionality
- Off site manufacture will alter CAP priorities and equipment required
- Establishing industry standards for data, communication, operations, implementation

## Task 5: Recommendations medium term (3/4)

- Future performance measures
- Standardised data and uk wide data depository
- Shared platform
- Develop and build functionality of project
- Higher margins to be made on contracts
- Machine control automated, but with operator overseeing the operation from the safety of the cab. Much like a pilot in a plane, being flown autonomously however they are present for adverse or unexpected situation.
- Contractual ownership by main client to force tech take up
- Design guide
- Secure and reliable networks and data availability for all projects
- On-the-fly design assurance
- Investigate alternate types of energy
- Standards for communication

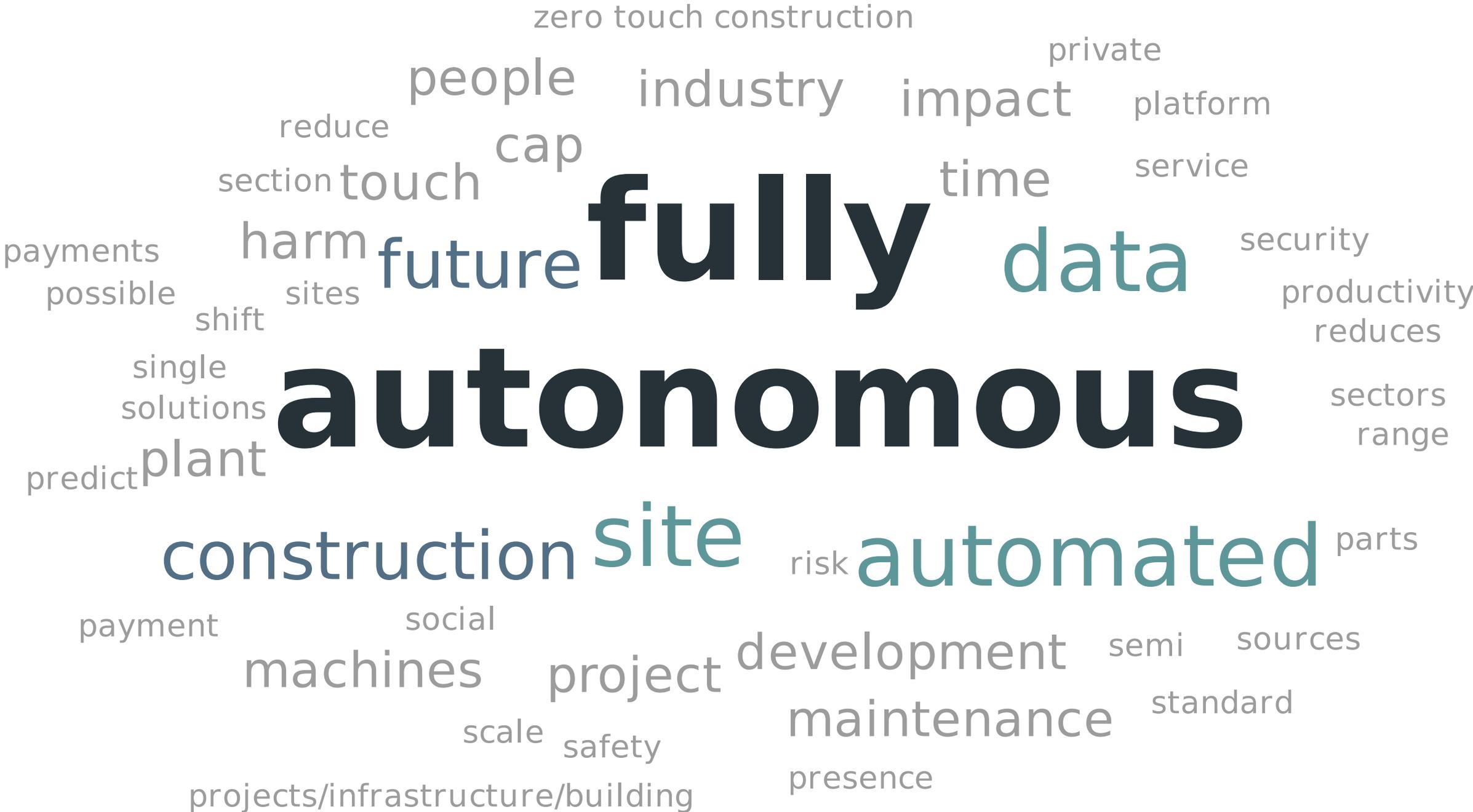
Survey (3/4)

031

## **Task 5: Recommendations medium term** (4/4)

- Accurate below ground data, utilities

# Task 5: Recommendations long term



## Stakeholder recommendations - now (1/8)

- Establish working rules for collaboration between all stakeholders
- The government needs legislate now to enable long term investment.
- Principal designers forum - next meeting Thursday 25th July CAP plant manufacturers These two need to meet to sort out what design models are needed to deliver efficient CAP models to site
- Government need to modify data standards and specifications to allow contractors to get on board with 3DMC
- Client and i3P should inform contractors that this is future requirement. Build relationships with universities
- Government needs to clearly define routes to funding for supply chain partners to finance CAP developments Institutions such as ICE

## Stakeholder recommendations - now (2/8)

needs to be endorsing current level and future developments of CAP to ensure that it is shared across the board

- Government need to embed new procurement framework for public agreements that reflect more collaborations and innovation in public purchases
- Mobile networks need to work together to provide better Communication solutions
- Contractors and their suppliers to work

together on common connectivity requirements for CAP operations to speed up the deployment of supporting networks.

- Hiring companies need to start the process of redefining JD's, building in the soft non-academic skills (including gaming) as of interest to the industry and in part a basis for job offer
- Clients and contractor need to collaborate to

## Stakeholder recommendations - now (3/8)

- raise awareness of CAP and united approach.
- Clients need to encourage the journey to CAP by funding, promoting, specifying by 2020, because without this innovators risk developing products that are not used due to cost, procurement rules or changed criteria.
  - Highways England as the entity requiring change must determine what that change needs to be and lead on it. Create a climate and framework to allow Change's to happen.
  - 1. I3P need to write a paper outlining CAP benefits and art of the possible for Clients - winter 2019. This need to state clear targets and these targets need to make the effort worth while. Eg if we had CAP deployed on the NOTTINGHAM tram project the benefits would have been

## Stakeholder recommendations - now (4/8)

2. Clients to write to and lobby government explaining benefits of CAP by summer 2020
3. Contractors and clients need to identify which type of projects will benefit from CAP. Maybe not all types of project will benefit
4. Constructors need to understand how off site manufacturing will impact CAP
- Client to explore the use of satellite connectivity and separately the use of Earth Observation data for planning and execution.
  - Clients and contractors need to collaborate agree minimum CAP standards and then lobby government collectively to legislate by end 2019
  - Connectivity providers (mobile network operators) provide communication links based on existing infrastructure

## Stakeholder recommendations - now (5/8)

to support low level of CAP operations, may be for individual machinery.

- Agree all component parts required to fulfil vision of CAP
- Community should engage with government at early stage to have a road map vision.
- Plant Suppliers & Designers -  
Data Specification  
Development Government -  
Mandate Requirement

across all infrastructure investments CITB - Training requirements and dissemination of change

- Clients, project leaders, project managers and technical managers accepting one clear vision.
- Main contractors.
- Get the various clients in one room to support the development of the framework that this type of technology must work in.

## Stakeholder recommendations - now (6/8)

- Client and i3P should inform contractors that this is future requirement. Build relationships with universities
- Government need to identify CAP as best practice and recognise potential to revolutionise infrastructure build, renewal and maintenance. Government need to adapt school curriculum to develop future innovators and inventors in the CAP area.
- OEM's need to develop standards & specifications for fully connected autonomous plant
- Engage the Health & Safety Executive, re ethics and safety requirements.
- Client and i3P should inform contractors that this is future requirement. Build relationships with universities
- Evaluation of requirements for initial planning and design
- Clients need to demonstrate

## Stakeholder recommendations - now (7/8)

- a need for continuous improvement on sites: Safety, Time and energy.
- Tier 1 contractors should take the approach of HS2 and specify a minimum of the EU CCC specification for Earthworks and like in the USA the IC standards for Asphalt compaction, as a minimum. This gives all a level playing field and a common minimum standard
  - Government need to introduce legislation on use of automated guidance systems on site to enhance site safety and reduce carbon footprint with more increased efficiency and fuel consumption
  - Clients need to offer clear, financial backing to connected site solutions
  - The Government needs to recognise the cost of implementing technology and reflect this in

## Stakeholder recommendations - now (8/8)

- contract values in a manner where the financial benefits of technology can be shared.
- Manufacturer, construction companies including consultancy, designer, contactor, government, Technology innovation centres, universities
  - Clients
  - Release funds to conduct a case study to prove the benefits of autonomy and machine control.
  - Industry needs collaborate and agree the vision
  - government need to engage network capacity and planning team

## Stakeholder recommendations - short (1/9)

- Open communication standards between contributors.
- The client needs to re-evaluate their position on acceptable costs for plant, labour and materials.
- UCL / RDP contractors / sub-contractors Training needed to implement CAP into both existing drivers but more into the new students coming into the market. Contractors - develop resource models that changes the plant drivers requirements over the time needed to take this plant and length of time the plant will be available for, unless the plant can adapt in which case shorter term resources will be needed.
- Technology developers need to develop robust cyber security systems

## Stakeholder recommendations - short (2/9)

- Government to create policy or guidance in this area.
- Highways England as an employer needs to secure insurances that allow the supply chain to explore, test and learn from the use of CAP on sites - share some of the risk Technology developers need to look at a defender level of security to protect from cyber threats. This also links to insurances.
- Clients need to agree an alignment of a common framework for implementation CAP
- Government need to legislate CAP
- Government and industry to assess CAP information security risks and propose a mitigation framework that will enable routine deployment.
- Government need to define data standards including collection,

## Stakeholder recommendations - short (3/9)

transmission, storage and retrieval. Standards need to be considered on a national international basis to provide a level of future-proof standardisation of hardware/software

- Clients, contractors, OEMs to carry out a gap analysis or more appropriate a study to confirm what is available, level of availability (is it just one has something, multitudes

have it or all have it). Identify any blockers or enablers to enable all to have it. Lobby government for legislation to mandate CAP using above knowledge as catalyst.

- Communications industry needs to improve coverage and reliability of connectivity by 2021 so that data transmission supports CAP
- Institutions and accrediting bodies are well placed to change their

## Stakeholder recommendations - short (4/9)

members way of doing things. They tie into academia, research, members, a huge stakeholder group of its own which is very useful when bringing about change to a while industry.

- Providing the business case stacks up: Government to approve and legislate for use of CAP by 2021. This will need to provide a reasonable investment timeframe - say 3/4 years to 2025 Contractors

need to mandate use of CAP on their projects by 2025  
Constructors need to identify the cost savings or benefits if using CAP to allow them to pay for the increased hire costs of CAP equipment

- Government to allocate frequency band for transport/construction. Tech can be adapted to bands for such use addressing issues around ownership and

## Stakeholder recommendations - short (5/9)

investment in networks.

Communications networks can be built per site for the life of the site yet interoperate with external networks.

- Government need to pass bills to include CAP standards within certain infrastructure construction disciplines. By end 2020
- 5G connectivity to support medium level of CAP on small scale plants (several machines).
- Understand all stakeholder enablers, share with stakeholders and costs, funding and target for case study
- Clearly defined levels of automation to be published with government
- Supply Chain / Principal Contractor - Contractual data sharing requirements Supply Chain / Designer -

## Stakeholder recommendations - short (6/9)

- Skill development for data management Supply Chain / Designer - Data security and hosting
- in depth project breakdown by different departments.
  - Mandate that all their machine operators have some kind of machine control knowledge and under go a formal operator competency test on a machine control enabled machine.
  - Work with DfT to understands the risk associate with machine control in the short term Work with CPA, CITB and NOCA to develop trading standards for 3D machine control
  - Government to create policy or guidance in this area.
  - Government need to fund targeted case studies and commit to fund enabler support systems such as legislation, internet connection etc

## Stakeholder recommendations - short (7/9)

- Government must mandate legislation for the operation of autonomous plant that must cover all scenarios.
- Series of roundtables specifically re CAP and safety, inc HSE, safety professionals etc
- Government to create policy or guidance in this area.
- Site based trials involving HE, OEM, tech providers, main contractor and sub contractor
- Customers need to accept new innovation may incur additional cost but reduction in downtime. This will demonstrate whole project costs.
- Government need to legislate the legal framework for the use of autonomous machinery to give OEMs the confidence to build and supply existing technology
- Standard specifications with industry coming together and agreeing the vision for

## Stakeholder recommendations - short (8/9)

- the future. Education at an early age through STEM
- OEMs need to offer a compelling, commercially available solution to semi autonomous plant (with relevant back up & SWOT analysis) within the next few years.
  - The "industry" needs to decide who is the key spokesperson/organisation and promote the implementation of technology. We
- need a national thought leader body who can cross segments and demonstrate the benefits to all construction organisations.
- Manufacturer, construction companies including consultancy, designer, contactor, government, Technology innovation centres, universities
  - Accept they have to pay for additional innovation, this can then be flowed down to the

## Stakeholder recommendations - short (9/9)

contractors - existing and new technology can then be brought in. Improving efficiency, and safety

- Mandate stage 1 - I.e machine control for the efficient management of materials on government funded projects.
- Engage with the regulators and describe the vision, take on board regulatory advice and enhance vision
- client needs to engage with

vodafone to understand what products are available for immediate connectivity in hard to reach spots

## Stakeholder recommendations - medium (1/7)

- Find a broad consensus on standards for data, communication, etc that everyone will adopt and implement it.
- Plant manufacturers need to harmonise communication systems across the market within 10 years.
- All tier contractors to be implementing raising the bar, Client and safety teams
  - to able to inspect and report on the technologies being adopted and used, but not penalising a company if they haven't used it yet as it will depend on costs profiles for the contracts and when they were let.
- Government need to mandate accurate collection of buried service data by the service owner
- Clients should provide gains for adopting this

## Stakeholder recommendations - medium

(2/7)

- and write CAP specifications into contracts
- Highways England need to ensure that the development of CAP is seen through until it becomes the norm, without allowing it to go off on a tangent. But also allowing continuous improvement and development of future technologies
- Geospatial commission need to implement underground mapping g
- None
- Tier 1 contractors and plant hire companies need to prepare operators and site personnel for changes to the way of operating, changes of job role
- Government to issue legislation for mandate of agreed CAP levels for all to achieve in a timeframe.
- Government needs to set standards for machine control by

## Stakeholder recommendations - medium (3/7)

2023 including implications on legal, behavioural and ethical issues

- Those entity's that can bring about change through financial gains. Insurance companies arrangements with service providers can massively influence change through financial rewards. Less risk.
- Hire companies need to invest in CAP related equipment

Equipment manufacturers need to agree common specifications and standards to allow mixed machines to be used on single sites and information seen and consolidated by 2025

- Government / clients contractors manufactures needs to create, maintain and subscribe to a data depository accessible by all by 2025
- 5G connectivity to support CAP high

## Stakeholder recommendations - medium (4/7)

- level of CAP (zero touch) for medium and large scale plants, medium level of Artificial Intelligence (AI) operations
- There needs to be legislation from a body to ensure OEM's and supply chain can see benefits through commitment of CAP, within next few months
  - Clients and contractors to share in vision of CAP Training bodies to be consulted.
  - Plant Supply Chain - Point of Sale ability of technology
- Government - Support supply chain toward technology based plant
- limiting project adjustment while in development and ensuring all teams are receiving the assistance they require.
  - All their machines to be fitted with 3D machine control and capable of working within a design model.
  - Work with CEA and manufactures to develop

## Stakeholder recommendations - medium (5/7)

vanilla standard for data collection and sharing.

- Clients should provide gains for adopting this and write CAP specifications into contracts
- Government need include percentage conversion to CAP as a specific target in policy and subsidise industry - similar to Solar Power and Electric Vehicles.
- The client must adopt & embrace the technology in

order that this is then mandated into contracts.

- Develop behavioural competence for site ops / engineers etc around CAP.
- Clients should provide gains for adopting this and write CAP specifications into contracts
- HE needs to specify requirements for CAP OEM need to mfr CAP that meets needs of client
- Contractors need to share site

## Stakeholder recommendations - medium (6/7)

- information as built projects which will
1. Reduce incidents on site
  2. Increase productivity.
- Industry needs to collaborate more as technology advances and create open portals on machines to allow data in and out directly
  - None
  - The education institutions need to be creating people who can implement this technology at all levels on the job sites.
  - Manufacturer, construction companies including consultancy, designer, contractor, government, Technology innovation centres, universities
  - Conduct case study into the use of fully autonomous machinery that can be overridden by the operator if required.
  - Embed policy and standards with a mandate from Government to drive adoption

Survey (3/4)

033

## **Stakeholder recommendations - medium** (7/7)

- government to understand road map for connectivity and work with networks to roll out on key sites and understand business case

## Stakeholder recommendations - long

(1/5)

- Establish autonomous community to maintain levels of involvement
- Clients need to have parallel standards across infrastructure: Rail & road.
- Operations and maintenance adopting the models out of CAP construction models, with full understanding of how a project has been constructed which then helps with future designers and maintainers / operators to have information to hand to manage those networks
- Contractors need to invest in CAP to ensure buy
- Standards - Create a body from exiting founding members that will monitor and further encourage CAP. Build

## Stakeholder recommendations - long

(2/5)

- relationships with others. New legislation required . Consider exploring human type machines for smaller jobs
- Highways England to set standard for BIM and how CAP feeds into that and the O&M manual
  - One platform for data analysis for total site control no matter which manufacturers are chosen for the project.
  - N/A
  - All stakeholders to introduce and comply with CAP mandated.
  - Industry needs to deliver Zero touch, zero harm, zero emission construction
  - The technology giants like Microsoft are working hard to support the construction sector to capitalise on technologies. They could potentially offer a great deal in this space with research and resources.
  - Review use and effectiveness

## Stakeholder recommendations - long (3/5)

- of CAP - has it been worth it ?
- Commitment to remove people from certain operations by and be emission free 2030
  - Connectivity provisioning (very high speed with very low delays) for highly configurable CAP and on large scale for distributed sites with full Artificial Intelligence (AI) operations.
  - Test concept, create case study, share benefits and look to widen CAP to other markets and sectors
  - EN specification and Machinery Directives for manufacturers may need changing
  - Government - set targets to achieve based on industrial strategy KPIs
  - Create a dynamic solution that is consistently updated.
  - Reduce out of cab personal on all job sites to bare minimum.
  - Identify with large programs where trail can happen.

## Stakeholder recommendations - long (4/5)

- Develop with Clients what the success measures are
- Standards - Create a body from exiting founding members that will monitor and further encourage CAP. Build relationships with others. New legislation required .
  - Government to base large infrastructure project decision on CAP readiness level.
  - Develop the reporting platform in order that this is then fed directly into the BIM models.
  - Site supervision is 100% remote, zero people plant interface.
  - Standards - Create a body from exiting founding members that will monitor and further encourage CAP. Build relationships with others
  - HE needs to mandate CAP
  - Government need to legislate cap use on site so all parties are on a level playing field.
  - Industry needs to show

## Stakeholder recommendations - long (5/5)

- that (semi)autonomous plant/sites are a benefit to quality and the environment
- The government needs to take the lead (as they did with BIM) in creating a standard for connected construction.
  - Manufacturer, construction companies including consultancy, designer, contactor, government, Technology innovation centres, universities
  - On the results of that case study implement the manadation of autonomy's technology to force the supply chain to gear up for this.
  - Engage with other industries to understand CAP can add value in the digital economy, how might linking of data from across sectors drive new insight for example

## TRIALS: Outline your trial focus on slido

029

(1/22)

- 1. GAP Group Ltd. 2. Customers job site 3. Introduction of Machine Control CAB Kits on hire fleet 4. Tier one customers 5. In partnership with manufacturers/dealers 6. Exposure of machine control technology to our customer base 7.Short Term.
- - Costain - A19, Testos - Highway construction - Road pavement; Stage 1, Stage 2 and Paving (non-kerbed) - Ensure design is provided to enable construction via 3DMC of all phases above formation - Demonstrates quality of plant deliverable on the most accurate layers of highway construction, use for design verification and quality assurance.
- Dynamic mapping of underground utility network, machine to machine communication
- James Fisher Prolec are currently demonstrating a technology called PMX. This

## TRIALS: Outline your trial focus on slido

0 2 9

(2/22)

technology combines the slew and height control of an excavator with GPS technology for the first time. The technology allows machines to work with the use of virtual barriers, virtual ceilings to prevent collision with onsite fixed hazards. This product is now available to the industry, however the ongoing future development will include creation of virtual floors to prevent

excavators striking buried (known) hazards as well as controlling volume of material being removed. In the mid-term the technology will utilise cameras to control machine movement and the creation of safe working zones, whilst preventing collision with dynamic hazards. More information at <http://www.prolec.co.uk/en/products/pmx/> James Fisher AIS currently have a technology, R2S, which is deployed in the Oil and Gas industry with 5 of the

## TRIALS: Outline your trial focus on slido

029

(3/22)

oil majors. R2S provides a photogrammetry solution to capture an asset or construction site with 360 degree photos. This The site or asset can have data tagged, documents attached to the appropriate section of site. Site personnel can use an app to access site drawings, build requirements etc. The technology is also available with an AR app. The technology has also been demonstrated with Transport for London, with a

view to setting virtual machine barriers for the above PMX machine technology. This technology is ready to be demonstrated as a 'Do Now' for the construction industry. In the mid-term, a collaboration with BP is developing a camera based system. This technology is being rapidly developed into a digital twin with live streams from site cameras, reporting of connected devices e.g. flow meters on an

## TRIALS: Outline your trial focus on slido

029

(4/22)

oil rig etc. More details at <http://www.r2s.co.uk/>. James Fisher AIS is developing an IOT platform (Insite) to capture information from connected machines across multiple sites, providing safety, productivity, environmental and cost data on a single machine brand agnostic platform. AI via IBM/Microsoft is being applied to provide deep insights into the activity of a site over different time parameters. This will

- ..extract from my project outline: The

first demonstration will show the ability to control the end effector in cartesian coordinates; instructing the vehicle to move the end effector in an (x,y,z) direction, which will be interpreted and converted into control actions, specifically through inputting electrical signals to the vehicle to actuate the appropriate hydraulic

## TRIALS: Outline your trial focus on slido

029

(5/22)

cylinders by the desired amount. The pre-requisites for this demonstration are to have the JCB Hydradig equipped with position sensors, to have calibrated these sensors, to have the load-extension-deflection characteristics recorded, to have determined the control inputs to give the required motions, and to have successfully demonstrated it in a simulation of the control software. A situation that could be used

to demonstrate the usefulness of this capability could include positioning a rebar cage in a hole or manually installing a façade panel on the end effector using control signal inputs in (x,y,z) coordinates by a driver using a simple remote control interface. The second demonstration will showcase the motion planning and execution system, where the system will calculate the required installation path and control inputs from 'known' start

## TRIALS: Outline your trial focus on slido

0 2 9

(6/22)

and end coordinates. The pre-requisites for this demonstration would be as before, but now also with trajectory planning and position error correction control loop codes. This could re-visit the previous demonstration examples as a powerful way of showing repeat audiences the massively increased potential of this system. It would perhaps be at this point that the

project could introduce compatibility with the MTC's pre-fabricated building component assembly system. The third demonstration would introduce the ability to identify a component and its associated information on how to install it, to identify the vehicle's position

## TRIALS: Outline your trial focus on slido

029

(7/22)

and pose, and then, as before, calculate the required installation path and control inputs, and then install the component correctly. The prerequisites for this demonstration would be the same as for demo 2 but also with the necessary positioning hardware and software, including data synergy and error correction code, and a means of retrieving the relevant component data from some sort of

database, or ideally, wirelessly accessing it from a cloud-based BIM model. This demonstration would ideally be performed outdoors using GPS signals for positioning, and this would also demonstrate the vehicle installing a component when the vehicle is not on flat and level ground as in the previous demonstrations.

- 1. Epitomical / Danish Alam 2. A14 Section 2 3. Project LEO (Network Agnostic & Automated Earthworks) 4. Site wide

## TRIALS: Outline your trial focus on slido

029

(8/22)

demonstration using data from satellite, drones and total stations to plan, execute and monitor earthworks). 5.

Epitomical, Academic Partners, Earthworks Partner, Design Partner, Satellite Partner, OEMs & Highways England 6.

Seamless Connectivity, Multi-sensor & Multi-sourced data aggregation, Data Exchange 7.

Automation of Earthworks, Reduced risk, reduced costs and increased safety. Broader scale planning data from satellite. 8. Now/Short-term

- 1. Network Rail 2. Track Infrastructure 3a. Autonomous Material Delivery to Work site within possession. 3b. CAP - Leaf Blower/Collector. 4a. Movement of people and equipment using CAP for transportation. 4b. Small Plant Capable of collecting leaf on the railway line before it can be compacted by the train (this lead

## TRIALS: Outline your trial focus on slido

029

(9/22)

to training sliding and causes delays). 5. ? Supplier Partner - Interest to be gathered in a fair manner. 6a. Flatbed type plant with capacity for storage and personnel area. Required to navigate track access paths, roads and Rail Road Access Points (RRAPs), identify areas to speed up and slow down depended on track features such as cant, gradient, points, guard rail, check rail etc. 6b. Retro-fitment of existing leaf blower/collector plant to operate in a connected and

autonomous manner on the railways infrastructure. Needs to be able to work in-between train traffic. 7a. Reduces the need for Machine Operator competence, connectivity with other CAP on site. 7b. Easier to deploy, ability to work in traffic, avoid compaction of leaf into mulch on the rail head. 8a. Medium Term (but need to start now - remits, scope etc take time) 8b. Short term (but need to start now - remits, scope etc take time)

## TRIALS: Outline your trial focus on slido

029

(10/22)

- 1. Costain - Gary Payne 2. Costain Worle Office 3. Connected Worksite 4. Demonstration of accurate personnel, plant and asset tagging system to allow onsite location and movement tracking 5. Connected worksite team + suppliers 6. Set up mock worksite to test location accuracy. 7. To provide assurance that accurate location tracking can be provided with small Tags which have 6-12 month battery life. 8. Short term
- 1. Aone+ 2. Yorkshire (Area 12) 3. M62 J30-J31 CSB Scheme - Resurfacing operations 4. In 2018 we undertook a resurfacing operation with our supply chain partners Tarmac. Tarmac have developed a system where they run a live construction site where all aspects were monitored

## TRIALS: Outline your trial focus on slido (11/22)

0 2 9

and recorded for efficiency review. The site was drawn onto a GIS map with all hazards ring-fenced. All the plant had intelligent monitoring equipment which loaded to a central database for live monitoring. Once the operation started we could monitor the lorries leaving the plant and log their journey. We could then record when they loaded onto the paver knowing where and where the load was layer. The temperature and density is all recorded. The

rollers are then tracked to record rolling and compaction; including density monitoring. This can then be illustrated to the client using heat mapping to show live compliance. 5.

Project team, Aone+ Tarmac & HE (Main people: Paul Swann Costain and James Beecham Tarmac GM) 6. Improved efficiency and details QA recording. 7. Efficiency and safety. 8. Now

- 1. GAP Group. 2. Customers job site. 3. Introduction of

## TRIALS: Outline your trial focus on slido

029

(12/22)

cab kits into our hire fleet.

4. Tier one customers. 5. In partnership with machine control manufacturer/dealer. 6. Exposure of machine control technology to our customer base. 7. Short term.

- Komatsu can demonstrate our Smart Construction solution currently, this consists of:  
intelligent Machine Control -  
integrated machine control on excavator (21t & 36t) and dozers. Everyday

Drone - UAV solution for measuring earthmoving progress without the need for GCP or cloud processing. A very simple workflow and on-site immediate processing allows the access to a point cloud within a very short time. 1Ha site, fly & process and see the point cloud

## TRIALS: Outline your trial focus on slido

029

(13/22)

in 30 mins. Smart Construction Application - our dashboard for bringing all the site information together, calculating cut/fill volumes, areas etc. Sharing the job site status with anyone who has access to the system. This enables off-site people to visualise the progress of the job. We have a number of customers running these technologies on a Proof of Concept basis and we have our demo ground in

the North East where we are able to fully demonstrate the solution including UAV flying and machine operations. People of all levels can get hands on with the hardware and software to fully understand the capabilities. As shown on the video, in Japan we have demonstrated the autonomous machines which we see as "Smart Construction 2.0". Although these are prototype units, they are running and can be demonstrated.

## TRIALS: Outline your trial focus on slido

029

(14/22)

- Morgan Sindall Highways, we have a Greenfield site in the Rugby area that we could explore using as a site for a physical trial of CAP. Top soil strip, earth moving, construction of working platforms (placing and compacting fills). Spring 2020, local authority scheme (Leicestershire County Council)
- 1 SMT-GB Martyn Brawn 2 location, any appropriate location in England, Scotland or Wales 3 Connected site trial 4 Carry out a full demonstration of the connected site tools that are available today. Look to pull together a full suite of reports for the various processes 5 SMT & client / contractor 6 ?? 7 demonstrate just what is available today but possibly not used. Client would get more comfort from knowing the actual data from the whole of site rather than from just a few localised test areas. 8 Do now.
- SITECH UK - demonstrate Trimble Earthworks

## TRIALS: Outline your trial focus on slido

029

(15/22)

semi-automatic excavators and the connected site from office to the machine. Location - TBC The Connected Site from Office to Machine Would require an excavator capable of utilising Trimble EW automatics - list of around 30 machines to date.

Road Map - Now Brian Core

- Proposed trials: Annual demonstrations showing development of a JCB that can perform automated 'last metre'

positioning. Dates: Annually for 3 years Location:

Manufacturing Technology Centre, Coventry Part of: CIH

- Raise media profile for innovation in construction. Use the B1M youtube channel to showcase CAP. Costain. David Owens
- Influence tier 1 to trial more use of simulators and talk to training bodies to identify is 3D machine control is in training packages.
- Flexible location - anytime Machine control

## TRIALS: Outline your trial focus on slido

029

(16/22)

- training, support and use Laser Scanning - training, support and use Hydrogen generator - 50kva Z-Lynk - it's a "hive" technology to reduce power demand on cabin set up Site Builder app - build your own accommodation set up Control Point - location data logging and guaranteed plastic weld technology
- My organisation: 5G research centre at University of Surrey, Guildford Location: 5G connectivity covered within University of Surrey, Guildford, Surrey
- Title: A combined demonstrator of CAV (cars) and CAP (Plant vehicles). benefits: maximise the shared knowledge between CAP and CAV, as CAVs have many existing demo sites. The trial will target industrial vehicles that move on the roads and within factories for industrial sites
- Topcon Location - Site tbc Title - Automatic Excavator Activity - Auto excavator with ability

## TRIALS: Outline your trial focus on slido

029

(17/22)

- to not allow operator to go below grade during operation. Machine will have remote access to allow upload of digital model and download of as built data. System is machine manufacturer agnostic. Who - tbc Benefits - auto excavator control to design or design offset Short Term Project
- Speedy could possibly support with site communication through GPS, WiFi, VOIP and satellite use. Scope of requirements to be realised to fully understand if our communications business could support with a trial.
  - Remote plate trials using capture of compaction data through compaction density indicator and GPS transfer of data to mobile app. Kevin Wacker Neuson
  - Jacobs - Martin - would like to develop the design models that will aid the

## TRIALS: Outline your trial focus on slido

029

(18/22)

efficient use of future CAP demonstrations, and under RDP North (Costain/Jacobs/HE) identify locations where CAP could be demonstrated - Birtley scheme may be possibility considering kumatsu are also in the team valley area of where the birtley scheme is being undertaken, and network rail.

- 1: Detect static and dynamic objects during operation, accident avoidance for safety of people, equipment, and

assets. 2: Utility network detection and protection All of the above mentioned issues can be achieved through utilizing of different sensor technologies, monitoring technologies. How you would integrate data from different sensors and transfer knowledge about the environment for a safe operation?

- Balfour Beatty would like to utilise CAP (or semiCAP) for elements of the construction of the

## TRIALS: Outline your trial focus on slido

029

(19/22)

- A63 Castle Street Improvement Scheme in Hull for Highways England. The short term activity would be to plan the site infrastructure to enable machine control Medium term aim to prove the technology that could be used. Long term to implement during construction phase in 2022
- - Connected Site - - Costain - Integration of 3DMC with Costain's GearBuddy - Demonstrate plant performance data as well as plant control data - Show correlation between performance of construction with performance of plant - Short Term
  - BOMAG Location TBC either on site in the UK or at our testing ground in Germany Autonomous Intelligent Roller trial Trial a semi autonomous earthworks roller with intelligent drum control that will work within a

## TRIALS: Outline your trial focus on slido

029

(20/22)

geofenced area and compact to a predefined target value  
The roller will show semi autonomous and autonomous controls as well as Intelligent Compaction Short term, in theory by September/October 2019 or 1st qtr 2020

- Design interoperability; Round trip alignment (ifc) trial with multiple software. Costain, David Owens
- CAP and CAV trail to explore which technologies may be

repeatable, importantly the safety solutions being developed to help accelerate. Trial could take place at Surrey 5GIC test bed. Invite a mix of client, tier 1 and suppliers to collaborate, via an open invitation and mini RFP, with companies selected based on best fit measured against client defined outcomes. Benefit would be an ongoing controlled environment to evolve technology and feed into best practice.

## TRIALS: Outline your trial focus on slido

029

(21/22)

- Would like it to be exciting and innovative - something that will spur discussion and vision
- We would like to trial machine control for earthmoving purposes. We would need 2 sections of works that could be replicated and mirror each other in order to get fair and accurate results. Things to measure would be, amount of earth excavated (cost of muck away), amount of fill material imported (cost of import) time taken and fuel used. Comparing the two methods with the same size machine and same operator would be interesting and could well help to prove the case for machine control and autonomous plant. M O'Brien Plant
- trial focus network capability. If you are wanting to do this over 5G one of the 15 cities. also use of other solutions. mini mast

## **TRIALS: Outline your trial focus on slido** (22/22)

0 2 9

- as used with JCB to give network in hard to reach quarry, or smart hubs to connect a anything immediately in remote areas where network s poorer
- Flannery would be willing to support any technology providers wishing to trial semi autonomous machine control using our machinery. It is likely we would also be able to support with the use of a safe/controlled environment

# 7: NS Have you enjoyed today?

0 3 1

No



Yes



Not sure



## 7: NS what would you like to see happen as the next step?

0 2 2

(1/4)

- Plant leads from all clients.
- Front line supervision engagement
- Who are we accountable to? DfT/IPA
- Work with Utility Companies to eliminate services strikes. CAP may be the vehicle to do this.
- Progress dashboard
- Follow on meeting in Autumn Demonstrations of leading technology that is available now Attend client meeting Map government lobbying route
- Some promotions from plant, software and technology companies about where they are at with being able to contribute to CAP
- Review of the day and feedback to all attendees.
- share names and contacts of attendees (unless specific people want to opt out)
- Show that we have taken steps to include other stakeholders
- Show that we have taken steps to include other
- Meet back together with smaller group split-out

## 7: NS what would you like to see happen as the next step?

0 2 2

(2/4)

sessions with a focus on different aspects of the roadmap, and/or to challenge hurdles and go deeper into solutions etc

- Can we tap into Innovate UK funding to make things happen.
- Further engagement with some agreement to discuss a tease out what organisations are key to delivery and which are not to ensure a focused group going forward.
- I would like to

see forums established around specific operations to get their thoughts and problems.

- Continue working together until next meeting, is there a portal where we can share information and receive updates other than wait for next meeting.
- Slack channel for CAP
- Condense today's ideas and focus on value adding areas
- secure budget allocation for demos
- Get back together but

## 7: NS what would you like to see happen as the next step?

0 2 2

(3/4)

- include more infrastructure clients
- Engage the data specialists with design teams to enable classification of data and data requirements.
- Proper presentations from manufactures and tech companies to explain the hardware available, how it works and if they're all going to talk to each other to make the data more uniform across their platforms so they can be used with each other
- What have we learned from today,. Out puts from today's event, project définition way forward
- Education of the cost around the technology, and commitments around paying for this.
- widen i3P membership to include people in the room.
- Demos.
- Define the scope of the proto activity you WANT to run, bring us

## 7: NS what would you like to see happen as the next step?

(4/4)

0 2 2

back together to determine what CAN be done in a short time.

- Actions from promised tasks and challenges.
- Imodel.js implemented

# 7 NS Do you want I3P to organise another event in autumn to share best practice?

0 1 1

No

0 %

Yes

91 %

I would like to present

9 %

I would like to work with I3P to trial and demonstrate

9 %

# 7 NS My main focus for the demonstration would be at the following stages (1/2)

030

Design



Construction



Asset maintenance



Safety

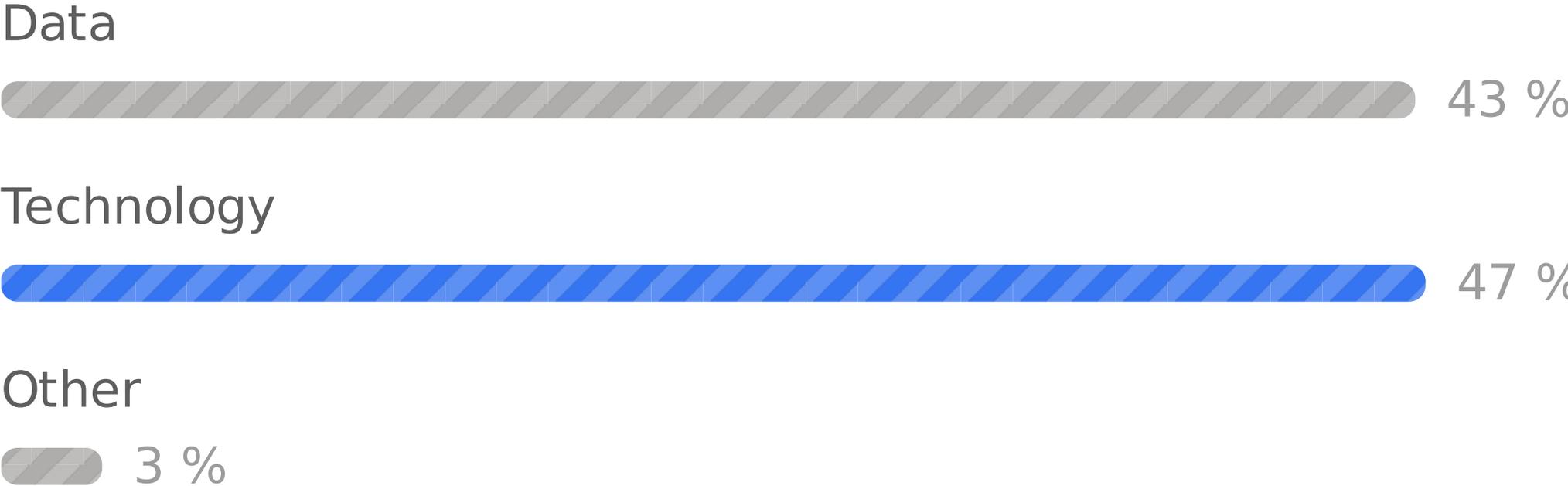


Machine



**7 NS My main focus for the demonstration would be at the following stages**  
(2/2)

030



## Final thoughts and feedback

015

(1/2)

- Awesome, more collaborative events like this are needed to transform industry. I wonder if having the regulator in the room might help?
- Great opportunity to get a good grasp of where the industry is in terms of machine control adoption.
- Good networking and input from all parties
- Very interesting session.
- The time is right to do this and the vacuum is there to be filled in terms of leading this activity. I3P has the opportunity to be the trail blazer for connected construction in the UK.
- Good start
- Good session & interaction
- Very good discussions
- BuildingSmart / Open Geospatial Consortium who lead/manage the data standards between design and site.
- Positive forward thinking team of individuals as a collaborative.

## Final thoughts and feedback (2/2)

015

- NOT Imodel.js
- Good session, like the use of Slido
- Great dynamic from across the industry, well done in pulling the attendees together.
- Excellent day. Thoroughly enjoyed the debate.
- Imodel.js