Implementing Autonomous Vehicles in Commercial Operations
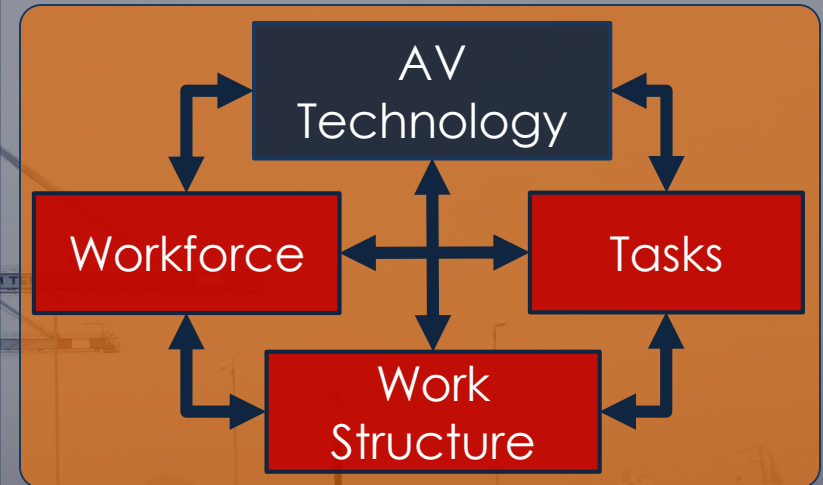
Strategic Planning & Considerations

Agenda

- **Overview**

- **Zylter**

- **Sociotechnical Systems Approach**
  - Operating Environment
  - Tasks
  - Work Structure
  - Workforce
  - Bringing it all together

- **Key Observations**

The Socio-Technical System for AV Technology Integration

Operating Environment

Autonomous Container Trucks at Port of Rotterdam

US companies are facing a steep learning curve to implement autonomous systems

- **The US is behind other countries in AV adoption, but can learn from their experience**

- **The biggest challenges for commercial AV use are <u>not</u> technical**

- **Successful AV use requires modernizing the entire socio-technical system**

Automated Systems per 10,000 Workers

	Auto Sector	Outside Auto Sector
Japan	**1562**	**219**
Germany	**1133**	**147**
United States	**1091**	**76**

Source: Executive Office of the President, "Artificial Intelligence, Automation, and the Economy", Report to Congress, 2016.

Zylter guides & supports AV implementation in engineering, logistics & energy

RESEARCH

- **Understand** current trends in AV technology

- **Assess** unmanned vehicle implications for industry verticals

- **Decide** on specific needs to address with automation

DEVELOPMENT

- **Design** a solution based on priority user needs

- **Apply** production & technical expertise to find solution providers

- **Build** the custom unmanned solution to address your needs

IMPLEMENTATION

- **Deploy** unmanned system(s) to increase efficiency, effectiveness or safety

- **Integrate** technology with existing processes & systems

- **Support** long-term use with in-house or external expertise

We are seeing four major trends in commercial AV development & use

1. The AV market is delivering many *technologies*, but few fully integrated *capabilities*

2. Successful AV use requires coordinated planning, exploration and adaptation

3. Organizational planning is not keeping up with AV technology advancement

4. Leading companies are starting early, but with a flexible and pragmatic strategy

Applying AVs in commercial operations requires addressing all sociotechnical system aspects

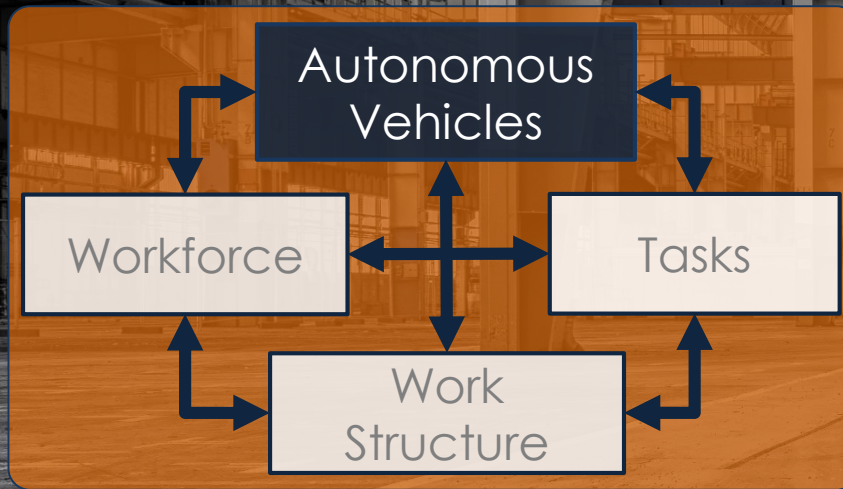## The Socio-Technical System for AV Technology Integration

Autonomous Vehicles

Workforce

Tasks

Work Structure
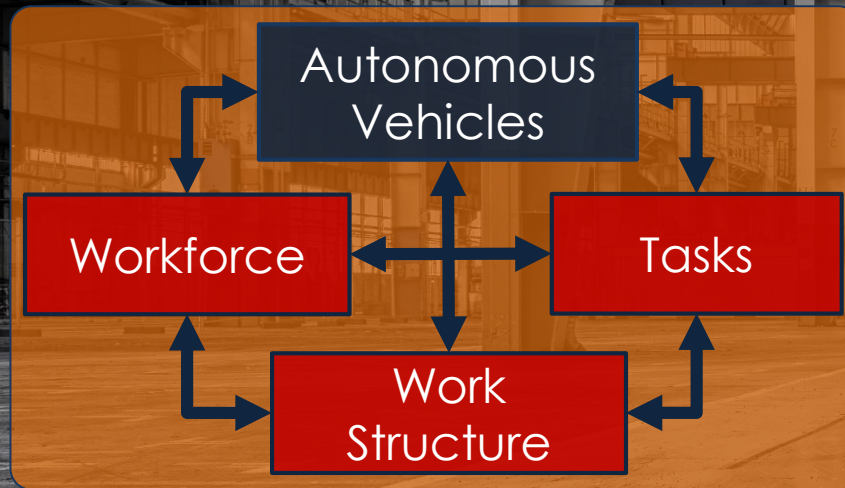
Operating Environment

- **The sociotechnical system approach address all the capability areas required to successfully employ AVs**

- **System-level analysis and planning is required to:**
  - Integrate individual AV technologies
  - Prioritize supporting investments
  - Address long-term organizational impacts

Billions of dollars of tech development is starting to deliver market-ready AV systems

Emerging Commercial AV Systems

ASI Autonomous Dozer

TNA Remote Aircraft Tug

Scania Track Platoon

CASE Autonomous Tractor

Autonomous Vehicles

Workforce

Tasks

Work Structure

Operating Environment

- **Almost all attention is focused on the AV technology**
- **Little consideration of implications for the "systems" that must use and support them**

Each commercial AV application must negotiate an often unique operating environment

- **Development and integration of effective AV technologies requires identifying the impact of the operating environment on the entire "system"**

- **Key aspects of the operating environment for AVs include:**

  - Terrain (natural & built)
  - Infrastructure
  - Legal/ Regulatory
  - Hazards
  - Threats
  - Electromagnetic Spectrum
  - Weather / Atmosphere
  - Other Factors

Example: This worksite illustrates operating environment aspects AVs must negotiate

Workers moving around job site

Access to power at control location
- Electrical grid or generator

Materials for distribution on jobsite

Consistently evolving worksite
- Requires consistent movement / adaptation of network components

Vertical aspects (as site / structure develops)

Vehicles moving around worksite
- Source of power and possibly geolocation info for node

Limited / no access to communications infrastructure (Wi-Fi, cell, fixed Bluetooth, etc.) to support IoT applications

Assessing likely impacts of AV use requires understanding the system "task profile"'

- **A task profile is a description of all tasks executed by a STS, to include:**
  - **Dependencies**
  - **Frequency**
  - **Timing**
  - **Complexity**
  - **Etc.**

- **Key factors impacting feasibility of task automation include:**

  - Task complexity

  - Frequency of task execution

  - Consistency of task iteration

  - Risks associated with task issues or failure

  - Certainty of task determinate factors

  - Predictability of task execution

Example: Organization of worksite tasks to deconflict AV ops with human-centric activities

24-hr Worksite Activity Profile

Normal worksite activity profile

Planned AV Operational Profile

24-Hour Work Day
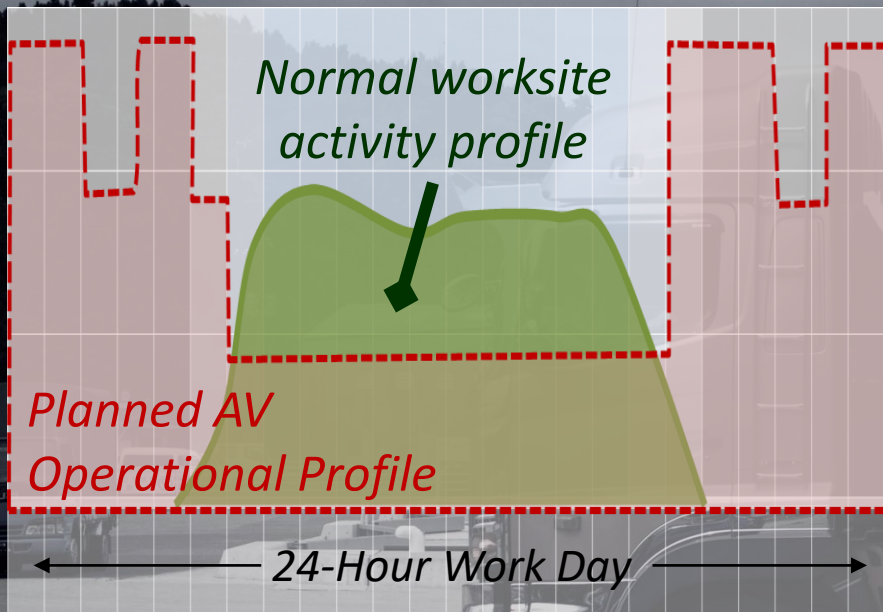
- **Key Question: How can tasks be distributed throughout the day to deconflict manned and AV operations?**

  - Minimize need for dynamic interaction with humans

  - Minimize adverse impacts to manned site operations that require illumination (e.g., daylight)

  - Replace low-skill human requirements (e.g. night watch)

AV-enable work structures offer efficiencies, but also pose operational challenges

- **Assessing work structure changes requires determining the new AV-enabled roles and responsibilities in the STS**

- **Key areas of concern for AV-enabled operations include:**
  - Span of control issues
  - Cognitive loads
  - Communications requirements/ limitations (connectivity, etc.)

- **HMI and AI technologies can help mitigate some challenges**

Work Structure Example: AV-enable mine ops

Mine Ops Supervisor

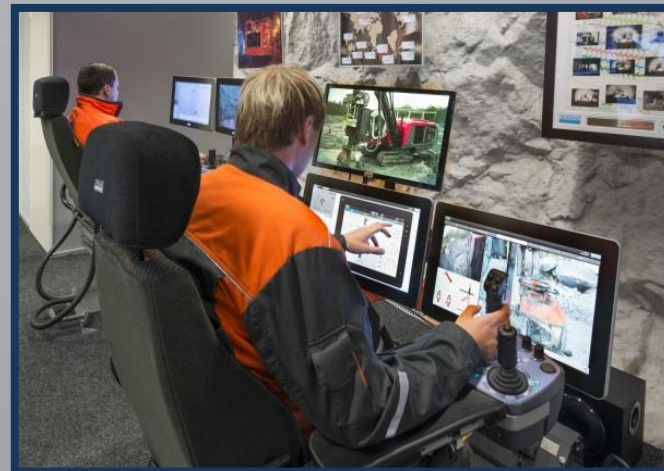**Mine Equipment Operators**

Manned Mining Equipment

Traditional Mine Ops

AV-Enabled Mine Ops

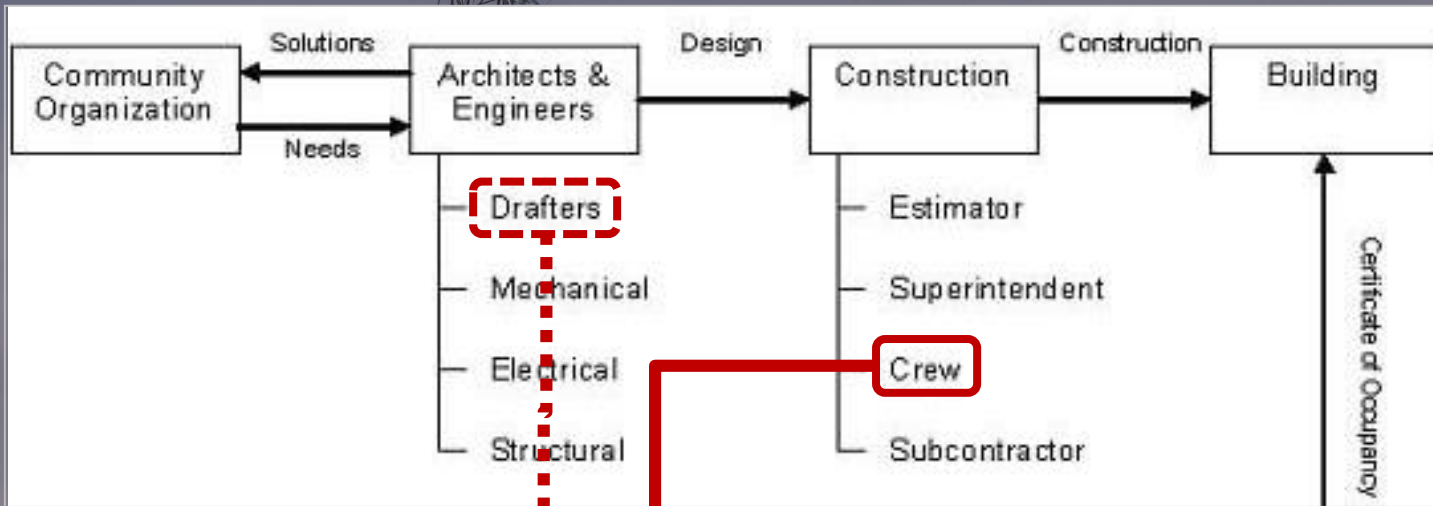Process Manager / Remote Vehicle Operator

Remotely-Operated / Autonomous Mine Vehicles

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Commercial AV use requires evolving the workforce required to employ & support them

- **New knowledge, skills, and abilities (KSAs) required for most roles and positions in the AV-enabled STS**

- **Identifying new workforce requirements for the AV-enabled STS requires:**

  - Determining KSAs required for each role / responsibility in new work structure

  - Identifying new KSAs required for roles

  - Identifying existing KSAs no longer need

  - Considering 2nd / 3rd order impacts of KSA changes (e.g., recruiting & promotions)

Work Force Example: Remote vehicle operator for multiple connected AVs

Design and Construction Team Breakdown

Community Organization — Architects & Engineers — Construction — Building

Solutions / Needs / Design / Construction

- Drafters
- Mechanical
- Electrical
- Structural

- Estimator
- Superintendent
- Crew
- Subcontractor

Certificate of Occupancy

Process Manager / Remote Vehicle Operator
(replaces one or more construction crew in AV-enabled STS)

Process Manager / Remote Vehicle Operator	
Knowledge	*Required KSAs for remote vehicle operator Role in AV-Enabled STS*
Skills	
Abilities	

Bringing it All Together: The AV-enabled STS

Operational Planning

Training / Talent Acquisition

Workforce Planning

Port Operations STS

Strategic Planning

Technology Investment

Market Strategy

Supporting Services

Terrain Mapping

Task Planning

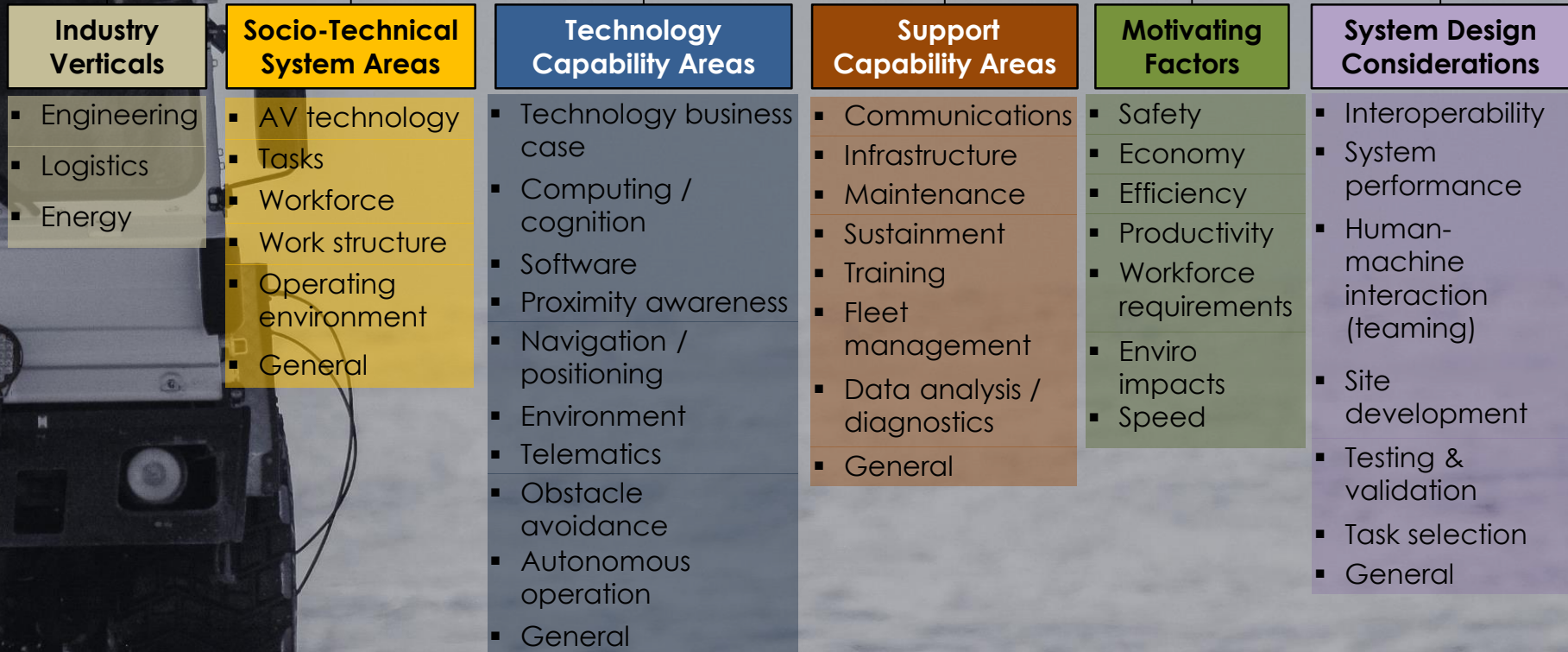**Communications Infrastructure**

Cyber /Info Security

Maintenance / Repair

We use a robust intelligence structure to assess AV trends & provide tech market visibility

Zylter AV Market Analysis Database

Industry Verticals
- Engineering
- Logistics
- Energy

Socio-Technical System Areas
- AV technology
- Tasks
- Workforce
- Work structure
- Operating environment
- General

Technology Capability Areas
- Technology business case
- Computing / cognition
- Software
- Proximity awareness
- Navigation / positioning
- Environment
- Telematics
- Obstacle avoidance
- Autonomous operation
- General

Support Capability Areas
- Communications
- Infrastructure
- Maintenance
- Sustainment
- Training
- Fleet management
- Data analysis / diagnostics
- General

Motivating Factors
- Safety
- Economy
- Efficiency
- Productivity
- Workforce requirements
- Enviro impacts
- Speed

System Design Considerations
- Interoperability
- System performance
- Human-machine interaction (teaming)
- Site development
- Testing & validation
- Task selection
- General

We use this database to identify key trends impacting AV development, use and support across industries

Final Observations

- **The AV hype is generally true, but can mislead**
  - It often highlights "best case" under controlled conditions
- **Context matters…allot**
  - Your AV solution design must account for user requirements, operational context and processes / work flows
- **The market is expanding from the "early movers" to "fast followers"**
  - Fast followers are characterized by hopeful practicality, innovative spirit and some comfort with uncertainty
- **Automation does not replace entire jobs, but does replace some key job functions (but not all)**
  - Companies must plan for long-term adaptation of roles and responsibilities as AVs are implemented
- **The biggest factors dictating the pace of commercial AV acceptance are regulation and risk management**

Integrate. Technology. Zylter.

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