



How *MATLAB* & *MV* are transforming Shell

James Martin & Amjad Chaudry
Advanced Analytics CoE



Cautionary Note

The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal entities. In this presentation “Shell”, “Shell group” and “Royal Dutch Shell” are sometimes used for convenience where references are made to Royal Dutch Shell plc and its subsidiaries in general. Likewise, the words “we”, “us” and “our” are also used to refer to Royal Dutch Shell plc and subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. “Subsidiaries”, “Shell subsidiaries” and “Shell companies” as used in this presentation refer to entities over which Royal Dutch Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as “joint ventures” and “joint operations”, respectively. Entities over which Shell has significant influence but neither control nor joint control are referred to as “associates”. The term “Shell interest” is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

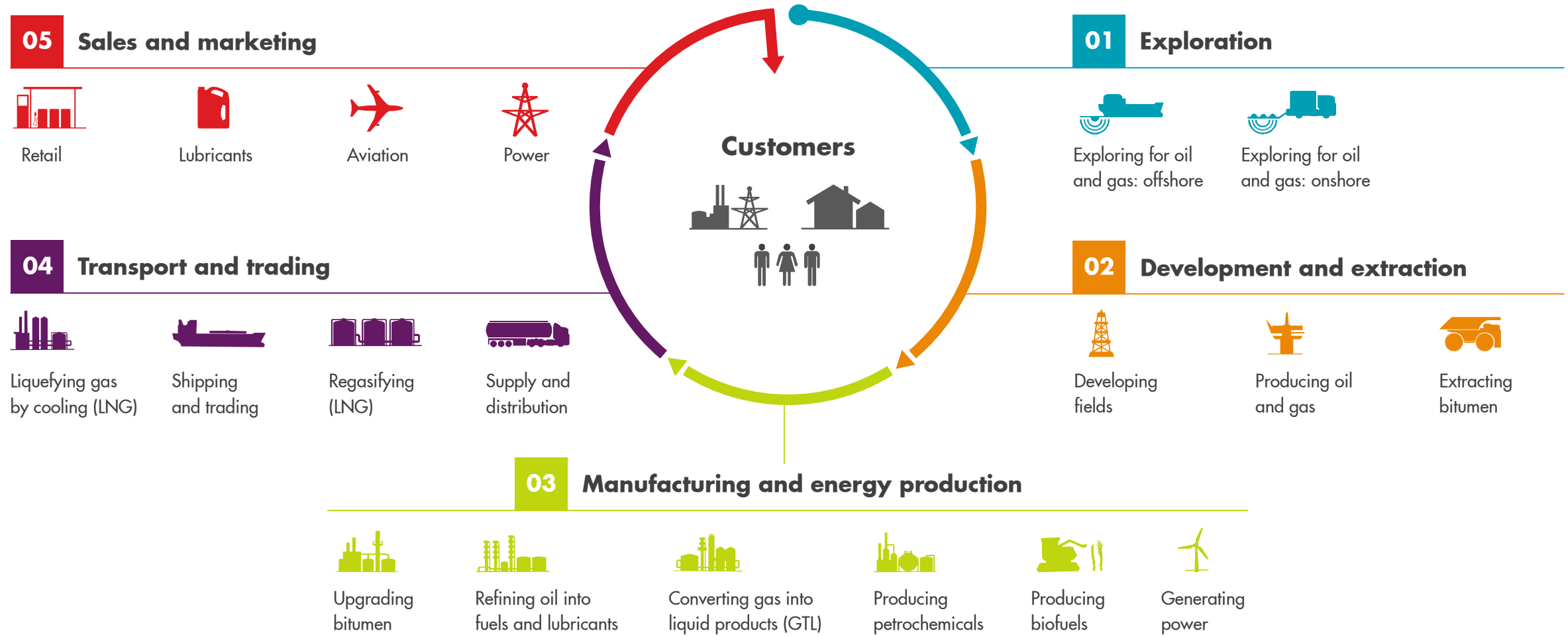
This presentation contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management’s current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management’s expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as “aim”, “ambition”, “anticipate”, “believe”, “could”, “estimate”, “expect”, “goals”, “intend”, “may”, “objectives”, “outlook”, “plan”, “probably”, “project”, “risks”, “schedule”, “seek”, “should”, “target”, “will” and similar terms and phrases. There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this [report], including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell’s products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; and (m) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this [report] are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Royal Dutch Shell’s 20-F for the year ended December 31, 2017 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward looking statements contained in this presentation and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, 3rd October 2018. Neither Royal Dutch Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

We may have used certain terms, such as resources, in this presentation that United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. U.S. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov.

Agenda

- About Shell
- Innovation and delivery pipeline
- MATLAB to accelerate innovation
- Example use case: Tag recognition in 'street-view' imagery
- Example use case: Terrain recognition in hyper-spectral satellite imagery
- Planned Next Steps

Shell business overview



We serve Shell's value chain, focused on value delivery via analytics

EXPLORATION & DEVELOPMENT

- Inspection, Monitoring & Surveillance
- Imaging & Interpretation
- Visualisation
- Drilling optimisation
- Training
- Prospect Analysis

PRODUCTION & MANUFACTURING

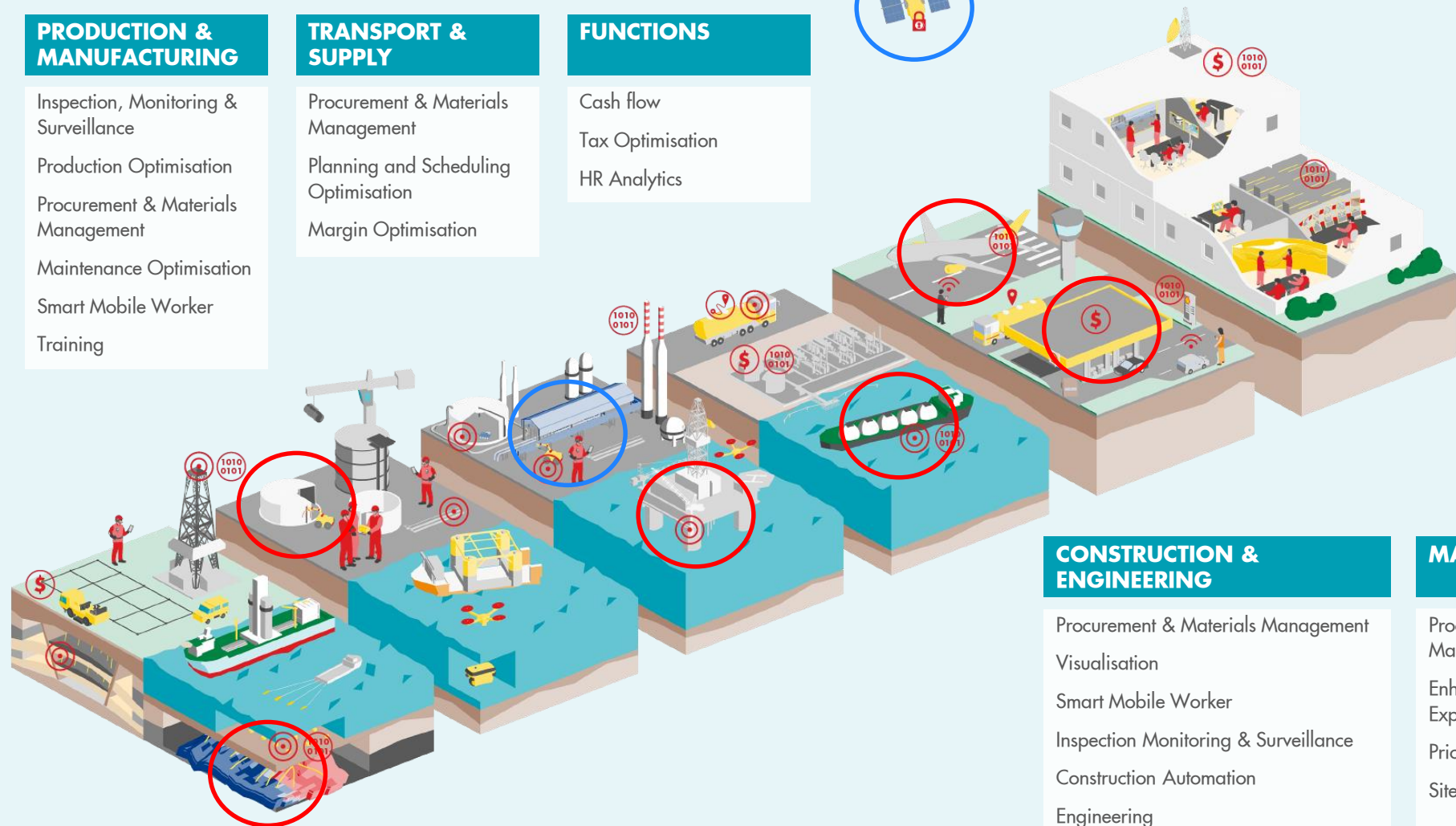
- Inspection, Monitoring & Surveillance
- Production Optimisation
- Procurement & Materials Management
- Maintenance Optimisation
- Smart Mobile Worker
- Training

TRANSPORT & SUPPLY

- Procurement & Materials Management
- Planning and Scheduling Optimisation
- Margin Optimisation

FUNCTIONS

- Cash flow
- Tax Optimisation
- HR Analytics



CONSTRUCTION & ENGINEERING

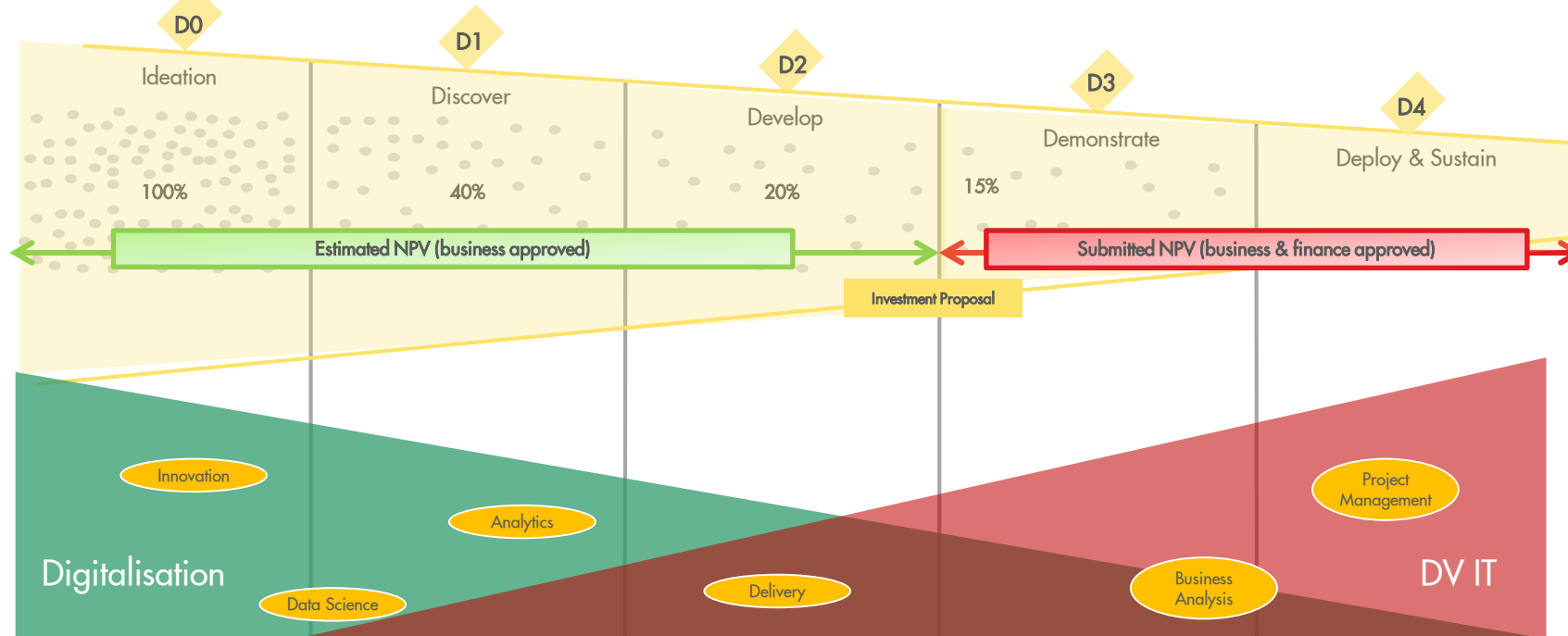
- Procurement & Materials Management
- Visualisation
- Smart Mobile Worker
- Inspection Monitoring & Surveillance
- Construction Automation
- Engineering

MARKETING

- Procurement & Materials Management
- Enhanced Customer Experience
- Pricing
- Site Management

How We Work – Data Science CoE Use Case

Our delivery pipeline transitions from Value Identification to Value Delivery and finally Value Enablement. Initial ideas can come from Conferences, universities, external visits, business problems, and innovation within the Data Science CoE. Using our breadth of data science & analytics skills, we deliver POCs and pilot projects which prove the value potential. Once investment is obtained, the delivery verticals take a lead role in managing the delivery of the pilot into 'Run and Maintain' mode.

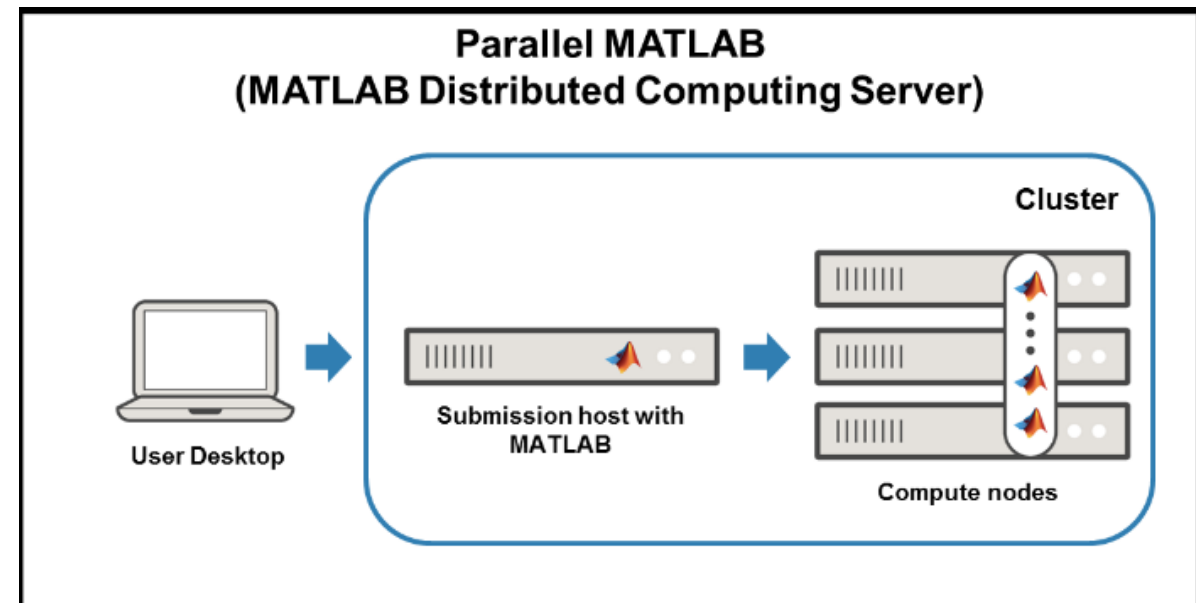
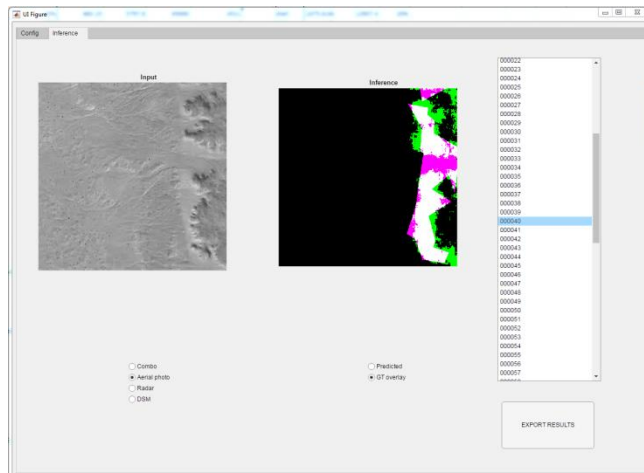
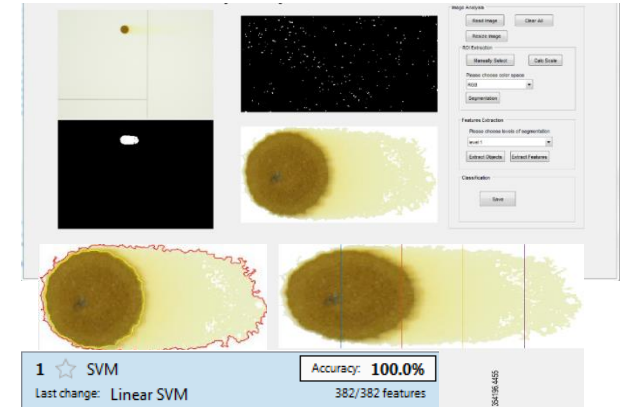


Key Responsibilities

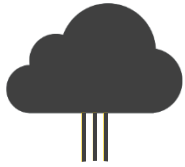
Accelerate Incubation and Integrate Delivery	Build New Capabilities
<ul style="list-style-type: none"> Integrate and deliver Shell's strategic technologies. Move quickly to get value proven tech scaled up Deliver tech in a focused, fast and cost effective way 	Maintain specialist core capabilities of hybrid technical discipline and IT staff across hubs Develop new capabilities which are required to be competitive in the new emerging tech world of digital

Where does MATLAB add value?

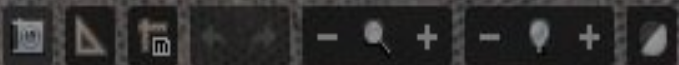
- Fast prototyping.
- Specialist support if needed.
- Growing deep learning toolkit to integrate with existing modules
- Huge set of examples and documentation for rapid experimentation
- WebApp delivery to clients
- Scalable cloud compute via MDCS



Shell & MATLAB milestones

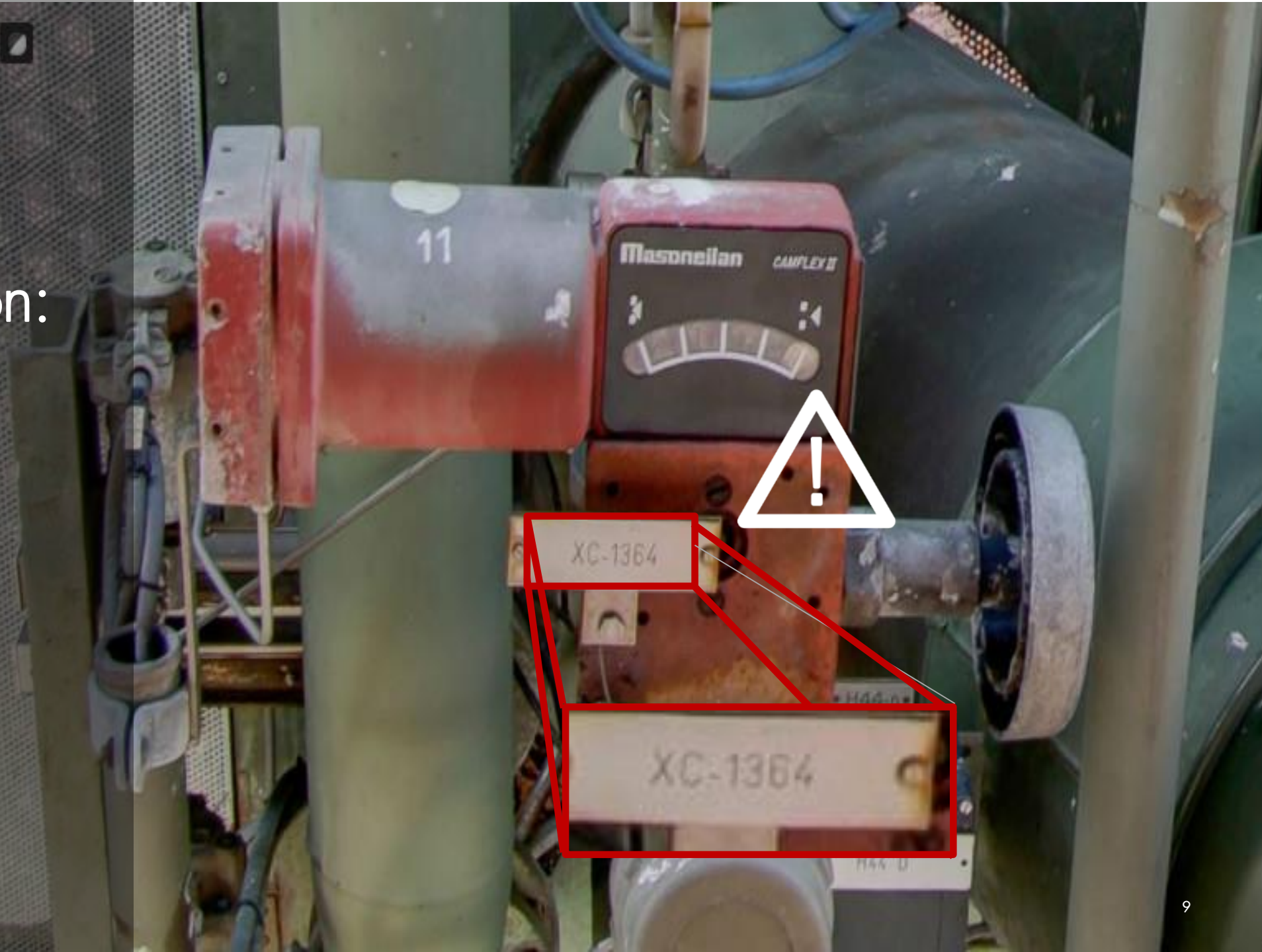


- Enterprise-wise deal with MATLAB
- Achieved 2nd MPS license
- Currently onboarding MDCS service (ongoing)
- Improving productivity with Mathworks consulting
- Expanding use of India-hubs



Tag recognition:

Identifying
Machinery at
Location



Regional Convolutional Neural Networks

R-CNN: *Regions with CNN features*

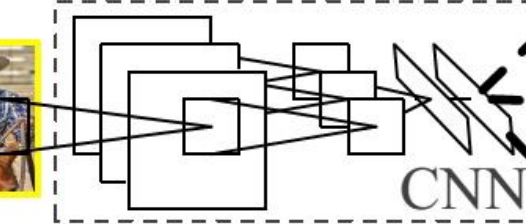


1. Input image



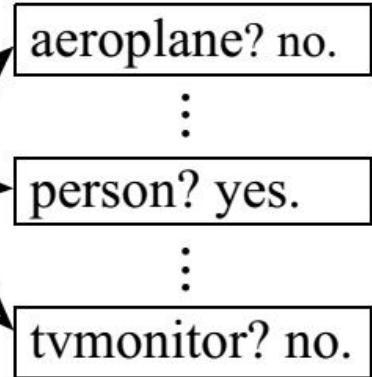
2. Extract region proposals (~2k)

warped region



CNN

3. Compute CNN features



4. Classify regions

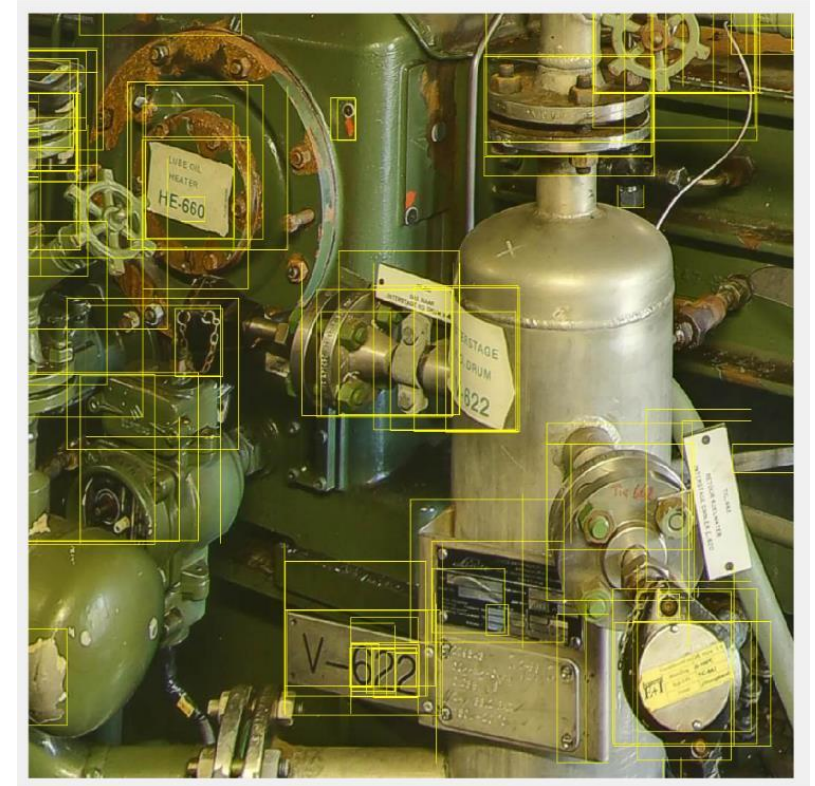
Region proposal:
Use a standard method

Use pre-trained Neural Network, and adapt to our specific task using "transfer learning"

Region proposals

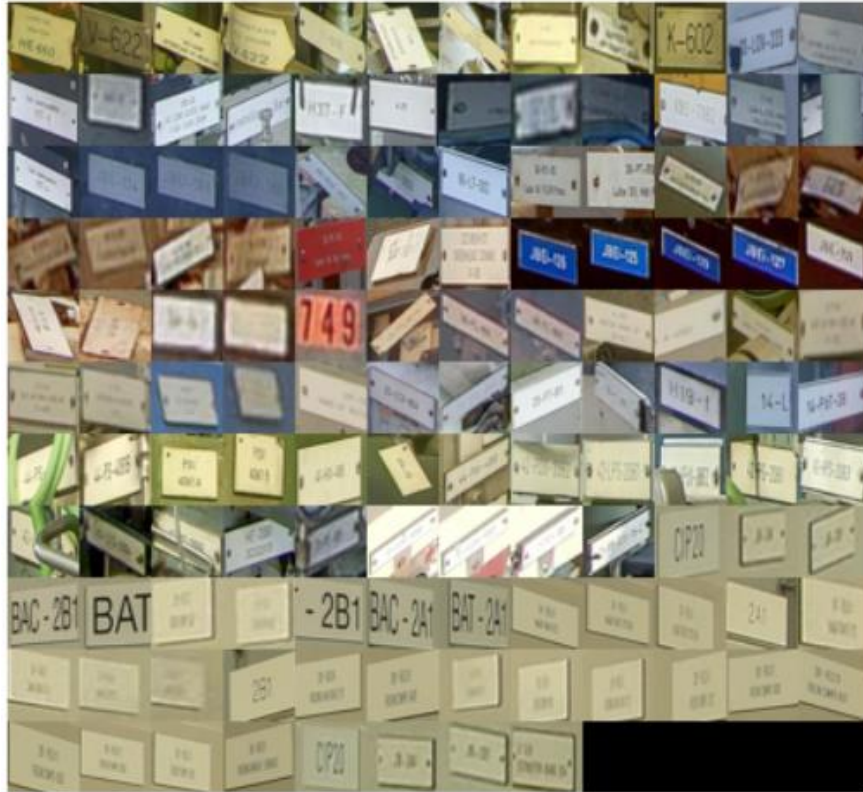


Fish-eye correction



Pdollar's EdgeBoxes

Training labels and 'attention' areas



Training dataset

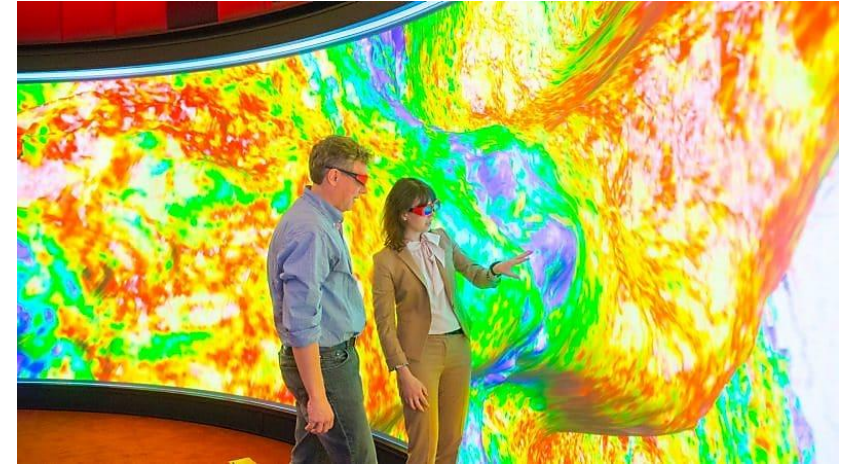


Identified tags ready for OCR and integration into SAP



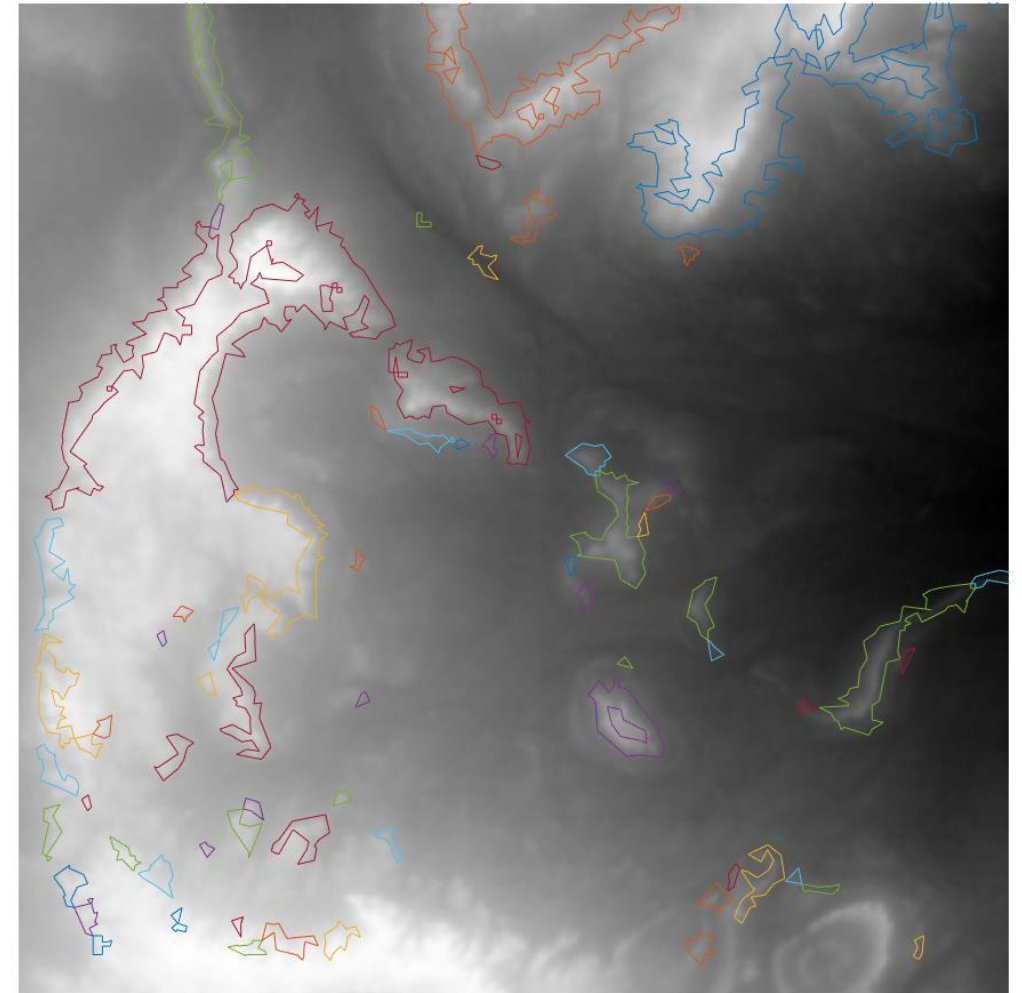
Tag recognition – next steps

- Transfer learning used to identify tags in industrial images.
- OCR to extract SAP codes.
- Currently 3-4 minutes detection, considering Fast RCNN for 100x improvement.
- Use larger GPU to increase image size of network (VGG16).
- Ready to experiment with augmented reality overlay of information.
- Further interest from European and Asian business units.



Terrain recognition in hyper-spectral satellite data

- \$10m's spent on land seismic acquisition each year.
- Terrain type very important to daily shot target.
- Currently manually drawn polygons on satellite/drone images + direct site visits - weeks.
- We replace whole workflow with DL semantic segmentation approach (segnet).



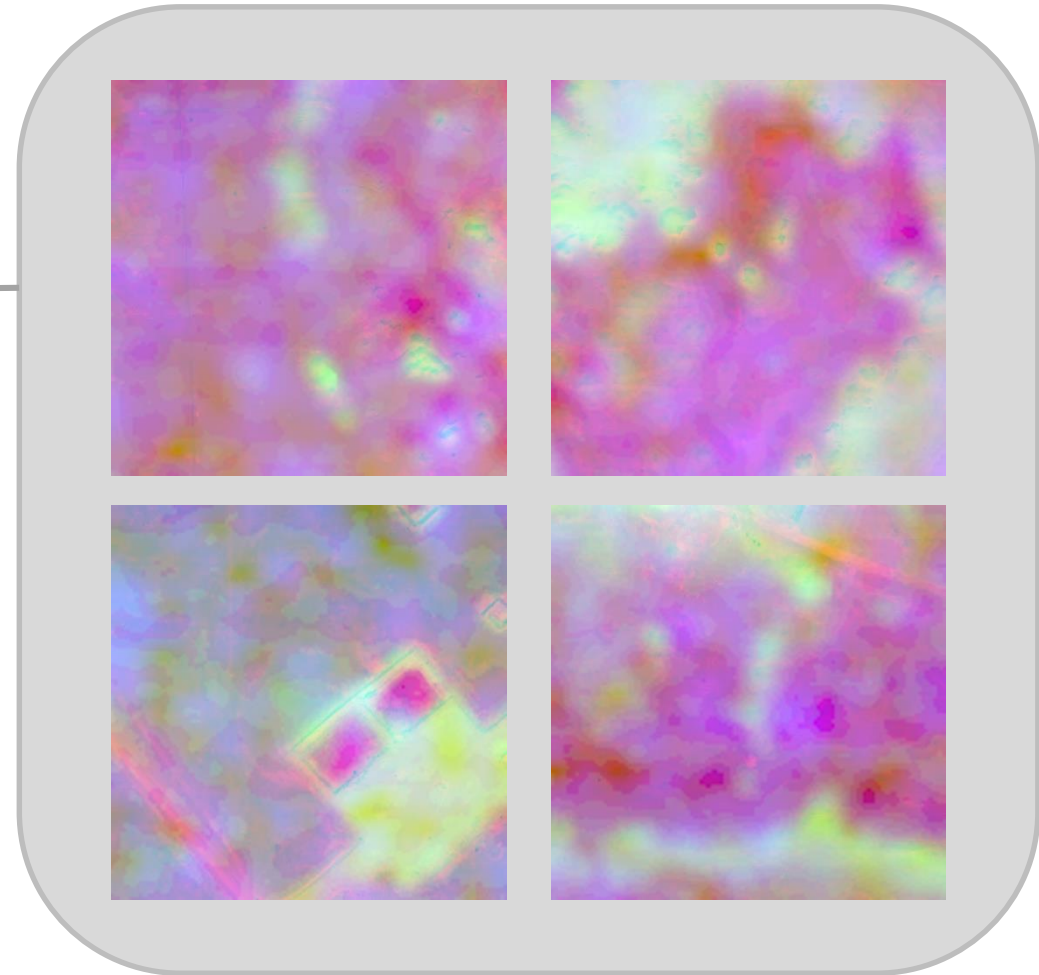
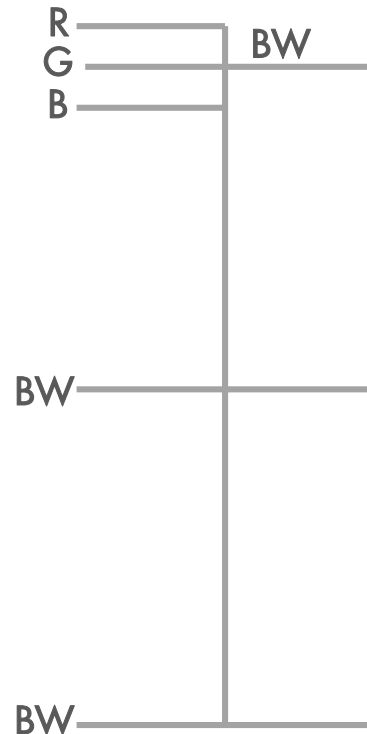
Radar image with rough polygons overlaid

Data prep – colour composite images

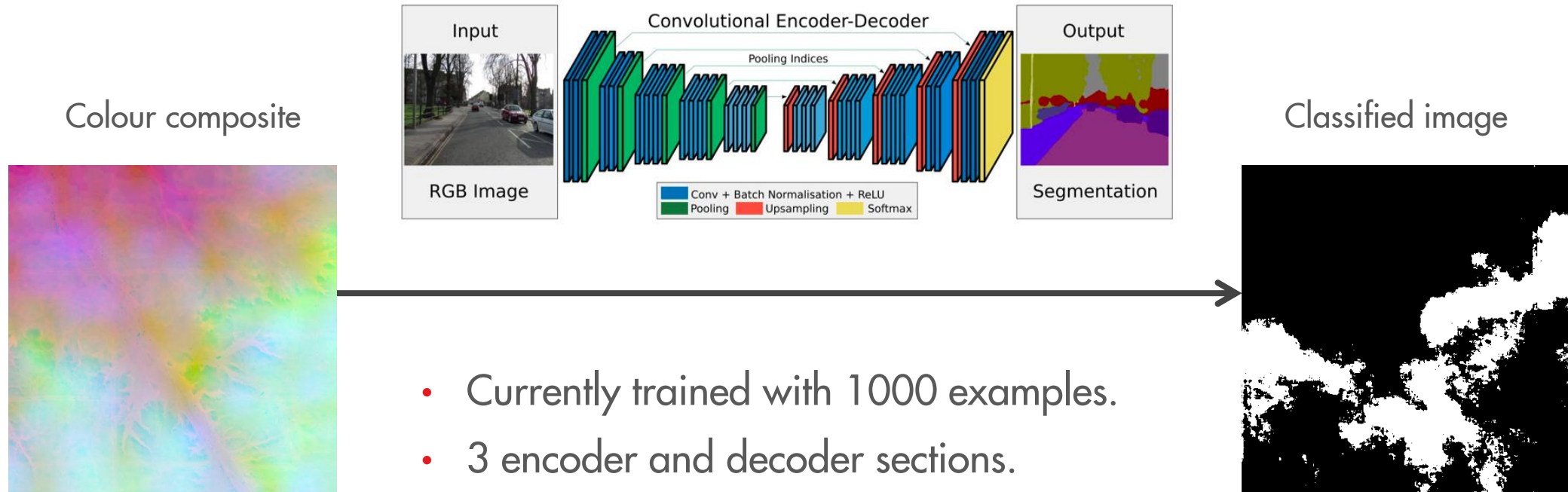
■ Aerial photo (RGB)

■ Radar

■ DSM



Network (SegNet)



Prediction (Semantic segmentation)

Input imagery



Actual



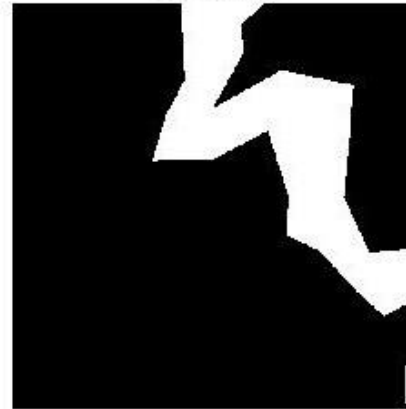
Predicted



Input imagery



Actual

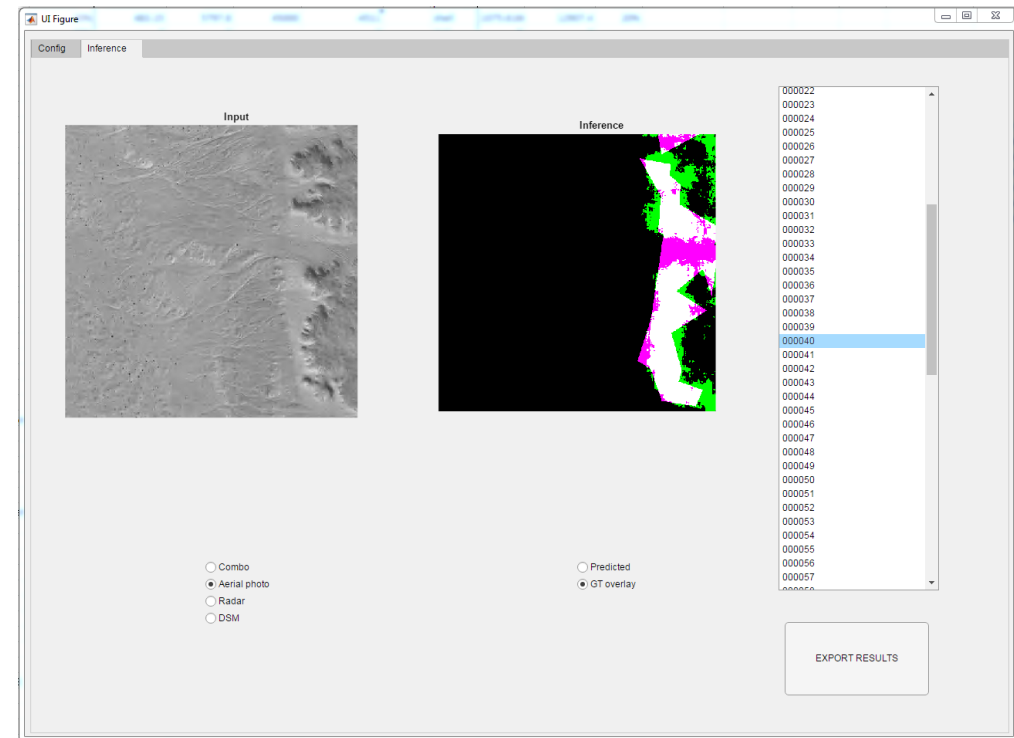
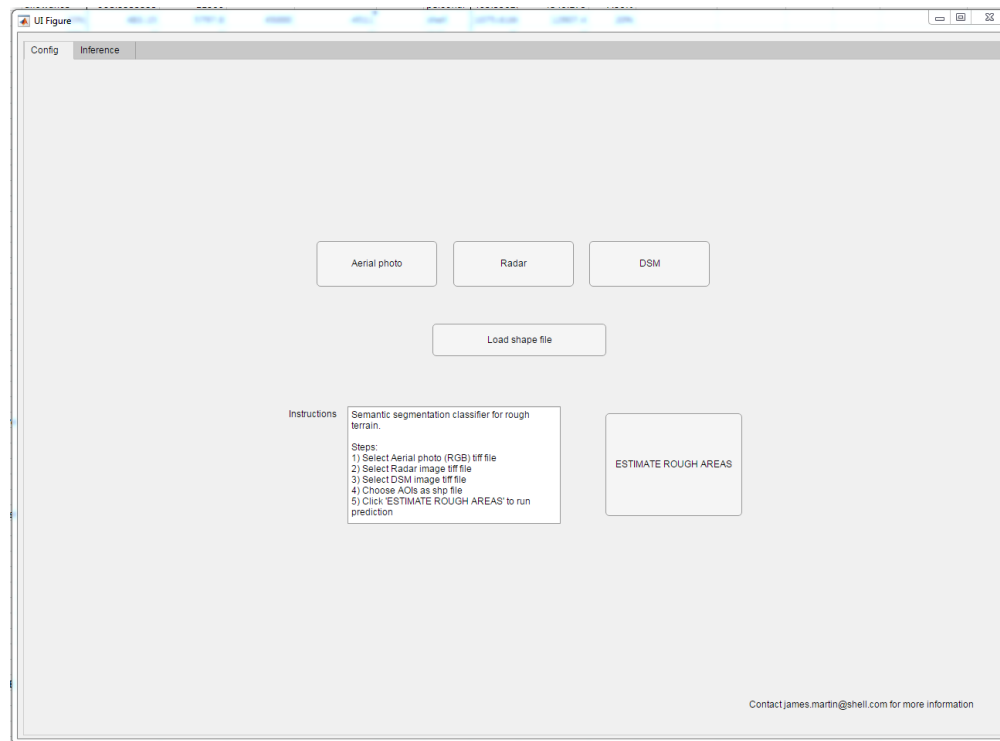


Predicted



Delivery via WebApp

- Customers interaction via WebApp tool.
- Can upload new data and regions of interest.



Terrain recognition – next steps

- Optimise network and training parameters.
- Increase training data.
- Add more modalities and classes.
- Tailor app to business demands.
- Business wants technology integration + upskilling staff.
- Potential for further work with Middle East and Asian business units.



Facilities class



Additional drone data

Shell & MATLAB, the Future?

More explicit linkage to other Digital Themes:

- **Everything to the cloud** - Edge computing
- **High Performance Computing** - Distributive computation and scalable GPU for training.
- **Advanced Analytics** - Smart apps development/management

■ Immediate Priorities for 2018

- Continued deployment through MPS and MDCS
- Prove the business value of current Mathworks projects in innovation pipeline:
 - Expand on terrain recognition work and tailored solutions.
 - Ultrafast hydrocarbon attribute calculation from seismic with DL.
 - Augmented overlay of SAP information during warehouse inspections.

