



Technology Validation Report of



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TECHNOLOGY VALIDATION REPORT OF DETECT TECHNOLOGIES

The purpose of this Technology Validation report is to present the results of a high-level assessment of the potential commercial viability of the subject technology and solutions developed by Detect Technologies. This report presents an overview of the technologies used, results of their deployment in some key client projects, opportunities to commercialize the technology in these markets, potential market issues the technology may face in gaining market access and where possible, suggestions for facing or improvising these issues. As a high-level assessment, the report will substantiate what is determined by the research to be the most viable course for commercialization of the technology.

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EXECUTIVE SUMMARY

The subject of this Technology Validation report is Detect Technologies' products and solutions to manage the industrial risks for workforce, equipment, and process/productivity through intelligence at large process plants. The technology stack at Detect is primarily based on comprehensive AI algorithms which run on several visual data input sources, majority of which are existing infrastructure within industries. The data input sources comprise of visual devices such as cameras and UAVs, IoT enabled sensors and process data streams. Detect has developed a unique API and state of art AI algorithm that seamlessly collects data and performs complete analysis on risks for frontline workforce, equipment integrity, and steady state processes/productivity to provide real time actionable insights.

The core AI architecture at Detect Technologies uses computer vision and deep learning models for vision and numerical data. The platform by itself has various modules for end users at industries such as HSSE module to improve site safety, schedule control to monitor activity progress, productivity monitoring to know real time occupancy, inspection module for analyzing integrity of an equipment, security and surveillance monitoring for 24x7 monitoring of large and spread out assets, digital container terminal operations module for safety and productivity of container management at ports and turnaround module for effectively managing maintenance and turnaround cycles in any industry.

Predictive Risk Management is the process of analyzing collected data through analytics generated by Artificial Intelligence (AI) and data science to indicate potential issues in critical areas that require immediate interventions. Large process industries such as Oil and Gas, Construction, Chemicals, Petrochemicals, Fertilizers, Pharmaceuticals, Steel, Cement, Power, Renewables, Automotive, Manufacturing, Glass, and Metal that require regular monitoring and management to minimize the risks are the target customers of this technology.

Detect offers a wide range of products for various applications that fall under three risk categories

S.no	Product Name	Risk Category	Module Name	Description
1.	T-Pulse™	People Risk	Digital Workplace Safety	AI for automated HSE detection
2.			Digital Confined Space Monitoring	System for automating confined space monitoring
3.			Privacy Anonymization	High precision model to remove faces in data streams
4.		Process Risk	Digital Container Operations Module	Models for automating safety and improving productivity in ports
5.			STOs (Shutdown, Turnaround, Outages and Projects)	Several automated modules for optimizing short and long term project execution
6.	Noctua.AI™	Asset Risk	Digital Asset Inspection	Platform for analysis and visualization of asset data
7.			Digital Pipeline Patrol	Automated management of large spread pipelines and assets
8.			Distribution Automation Software	Software for predicting power outages through automated analysis
9.			Predictive Piping Leak Detection	Patented technology for predicting pipe leakages in process industries

T-Pulse™ is an end-to-end platform powered by high precision deep learning models, which was built to provide increased safety, automated compliance, and higher productivity to process industries. It seamlessly integrates with all types of visual data streams to draw accurate insights, leverages computer vision and deep learning technology, to enhance productivity and reduce project costs through actionable insights.

- Digital Workplace Safety identifies all safety non-compliances at any process industry site and categories it as per internationally accepted standards such as OSHA, IOGP577, COHS and other similar guidelines. Further, it also provides recommended actions along with an associated risk score to prioritize interventions. It also provides targeted actionable analytics regarding categories or location(zones) experiencing most growth, most frequently reviewed observations, high risk rated observations, etc.
- Digital Confined Space Monitoring is a system that provides an automated tool for safe working within any industrial confined space. Workers entering a confined space are automatically authorized using facial recognition and their skills are matched with a pre-existing data base. The system is also integrated with temperature and gas sensors to maintain a safe working environment within a confined space and provides centralized access to all such confined spaces. It also provides a smart tool to program and monitor occupancy within these high-risk areas to reduce and manage the relevant risks.
- Privacy Anonymization is a high precision computer vision model that is designed to hide faces from all visual data streams with precision blurring, pixelation or masking, to prevent any reconstruction and preserve privacy. Faces in visual data streams are one of the most frequently occurring personally identifiable information and privacy concerns around it make it difficult to access such streams, while still maintaining the compliance to global regulations
- Shutdown, Turnaround, Outages and Projects module provides several automated models for automating safety, progress of schedule, managing occupancy, managing inventory on site and accelerating asset inspection during an ongoing shutdown, turnaround, or construction projects.
- Digital Container Terminal Operations module provides automated models to accelerate loading and unloading of containers at site, while maintaining safe practices to move these containers within the port operations. This therefore is designed to improve overall port productivity while maintaining highest standards of safety.

Noctua.AI™ is an enterprise platform to process and visualize data streams for all types of industrial equipment. The platform is designed to make data processing faster, which in turn leads to quick decision making and predictive actions for any high criticality observation. The AI can integrate to one or multiple data streams such as visual, thermal, UT, electrical and multiple other process parameters. Through these integrations, Noctua.AI can centralize data processing and management and reduce industrial downtime significantly.

- Digital Asset inspection is an enterprise platform that runs on machine learning and computer vision models to automate detection of various high criticality events in multiple applications. It can integrate with both vision and time-series data sources to derive insights on equipment state and output. Through this, overall downtime risk is reduced, and targeted plant uptime is achieved.
- Digital Pipeline Patrol is a module of Noctua.AI™ that sources data primarily from cameras/UAVs or satellite for large spread assets. High precision computer vision models are then used to mine out insights such as pilferage, unauthorized activity, excavation, unauthorized structures etc. This makes the complete task of large asset monitoring in remote thereby reducing time and cost of maintaining such assets.

- Distribution Automation software use voltage and current from distribution boxes as the primary data source from pre-existing or installed sensors to detect patterns in fluctuations and imbalances in real-time. The final output is prediction of input power consumption / load prediction basis the past data and also tagging of causes on power failures for faster actions from power distributors and reduced overall downtime
- Predictive piping leak detection can be useful for the continuous monitoring of the rate at which pipeline corrosion takes place with the aim of reducing industrial downtime. This uses a patented technology, GUMPSTM, which is an ultrasonic guided waves based IoT sensor. The sensor is installed on outer surface of the pipe and can be used to detect defects and corrosion in process pipes.

Detect's products has been deployed in large number of industries in nearly 14 different sectors, including Oil and Gas, Chemicals, Pharmaceutical, Fertilizer, Cement, Construction, Petrochemical, Glass, Renewables, and others. Most industries have found these products unique with no competing solution that can cover the requirement in whole.

BPCL group deployed Noctua.AI™ for predicting piping leakage early, as they saw the uniqueness and usefulness in Detect's offering and could not find any similar existing product. Since then, BPCL group has been active in engaging with Detect in various respects, deploying T-Pulse™ shutdown, turnaround and outages module in multiple projects and expanding the scope of Noctua.AI™ as a 365 day application.

Similarly, Shell's Projects Digital and the Pennsylvania Chemicals project partnered with Detect Technologies to use its T-Pulse™ Digital Workplace Safety module, which is a novel, artificial intelligence (AI) enabled, computer vision technology for identifying safety hazards in near real time. It utilizes visual data captured from project sites and operating facilities, and a high precision deep learning model to make safety observations and identify hazards in line with industry recommended practices.

The Shell team has signed a global agreement with Detect to deploy T-Pulse™ Digital Workplace Safety module in all of their facilities globally and are also testing Noctua.AI™ in various of their facilities.

This report is based on a study of the automated risk intelligence market. This technology is found to have high market potential in the Indian, US as well as other global markets. It was observed that while there are competitors for individual modules including a few large brands, Detect Technologies has been able to provide the technology as a consolidated package that is customizable as per the customer's requirements. The high accuracy, comprehensive coverage and adaptability to the user's requirements gives them a competitive edge. The products that Detect offers bring all disparate, siloed systems that have been causing industrial constraints for decades, on a single unified system. Detect also adds a layer of AI to automate findings and provide unparalleled safety, compliance and increased productivity. The conclusion of the study is that Detect's products and strategy is highly valuable for its customers and for investors.

ABOUT DETECT TECHNOLOGIES

Detect Technologies, an IIT Madras incubated start-up develops innovative and efficient solutions for Industrial Asset Monitoring and inspection of large industries and plants. The solutions composed of IoT-enabled sensors, AI, advanced robotics - Drones, AR/VR, and computer vision – collects and unifies data on workforce, equipment, and processes to provide real time insights on monitoring of assets and equipment, security, safety, schedule controls, etc. The products are AI powered software solutions supported by data from various sources (sensors/camera). The core AI architecture uses computer vision and deep learning models for numerical data.

Detect Technologies presently focuses primarily on large process industries. Its objective is to continuously monitor data and provide actionable insights, in a very cost-effective manner, with different kinds of sensors, namely visual, ultrasonic, current, voltage, and thermal sensors, amongst others which provide different asset data pertaining to vibration, thickness, corrosion, crash etc.; this is combined with robotics to ensure process efficiency, monitoring of assets and equipment, security, safety, schedule controls, real time data and insights on a dashboard and integration into supply chain and inventory management.

The team:

Detect Technologies was founded in the year 2016 by a group of four IITM students. Though the company was formally incorporated in February 2016, the technical and managerial teams had been working and building together since 2013. The key members of this team are Tarun Mishra, Founder & Director, Daniel David, Co-Founder & CEO, Harikrishnan S, Co-Founder & CTO and Karthik Rajasekaran, Co-Founder & CTO.

The company currently has over 300 employees with offices in USA, Singapore, Dubai, and India.

OVERVIEW OF TECHNOLOGY USED AND THEIR DESCRIPTION

Detect Technologies is an Industrial AI and SaaS enterprise with the mission to bring complete industrial automation through cutting-edge patented technology. They harness artificial intelligence, computer vision, cloud computing, advanced robotics, and IoT sensors to connect and unify industrial data, workforce, equipment, and processes. Their unique suite of solutions span across industries such as - Oil & Gas, Chemicals, Construction, Petrochemicals, Pharmaceuticals, Power, Steel, Metals, Ports, etc.

Detect offers a wide range of products for various applications that fall under three risk categories– People Risks (T-Pulse™), Process Risks (T-Pulse™) and Asset Risks (Noctua™).

T-Pulse

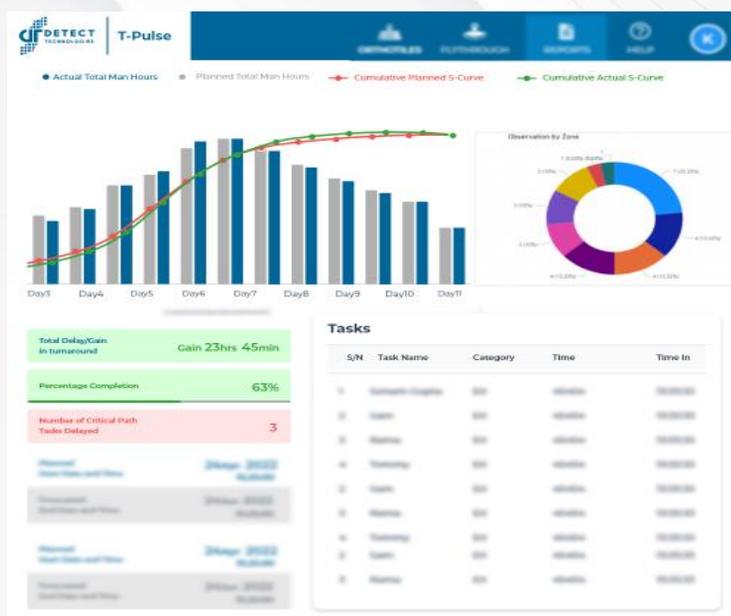


Figure 1: T-Pulse

T-Pulse™ is an end-to-end industrial project management solution, built to provide safe, compliant, and efficient management of industrial assets, processes, and workforce. T-Pulse™ brings various modules and departments involved in an industrial project on a single platform and helps to eliminate all information, data, and team silos. The above Figure 1 shows the dashboard of T-Pulse.

It seamlessly integrates with any visual source such as fixed cameras, body cameras and drones to draw accurate insights and leverages big data and machine learning technology to enhance productivity and reduce project costs.

According to Mr. Rajkumar from Detect Technology, “T-Pulse™ is used to optimize resource management, pre-planning, schedule control, safety and security, asset inspection to provide automated daily reporting and, real-time actionable insights.”

People Risk Management using T-Pulse™:

People risk can be defined as the risk that people do not follow the organization’s procedures, practices and/or rules, thus deviating from expected behavior in a way that could damage the business’s performance and reputation. From fraud to bad business decisions, illegal activity to lax corporate governance, people risk – often called conduct risk – presents a growing challenge in today’s complex, dispersed business organizations.

Using T-Pulse™, companies can ensure proper implementation of all benchmark practices, country standards, norms, and de-risk facilities by leveraging high precision deep learning models across their organization.

T-Pulse™ achieves people risk management by implementing three modules, namely, Digital workplace safety, Digital Confined Spaced Monitoring and Privacy anonymisation.

Digital Workplace Safety:



Figure 2: Digital Workplace safety monitoring using T-Pulse™

T-Pulse™ helps manage occupational risks proactively and identify areas of improvement to track, manage and predict occupational hazards systematically and drive continuous improvement. It ensures efficient work processes and better management of industry-wide projects.

T-Pulse™ is compliant with internationally accepted safety standards such as IOGP and OSHA and can also be configured as per individual processes and standards. T-Pulse™ leverages cameras, sensors, edge devices and drone data to manage safety risks across daily operations, construction projects, shutdowns and turnarounds to empower teams with real-time asset insights for intelligent decision-making.

T-Pulse™ can detect all safety violations 24X7 and 365 days a year while being 100% remote.

It converts all visual devices to a Digital Safety watch that keeps users notified and ensures no unforeseen incidents.

Industries leverage T-Pulse’s high-precision deep learning models to highlight areas of interest and potential incidents on the basis of pretrained observation sets and programmed rules. T-Pulse™ is trained on the largest industrial data set gathered over 5 years and can compute efficient models to make larger number of automated sets that run on data streams and leverage cloud infrastructure to implement assetless processing architecture. It ensures the highest data security through SOC1, SOC2, GDPR compliance and battle-tested by IT teams globally.

Digital Confined Space Monitoring:

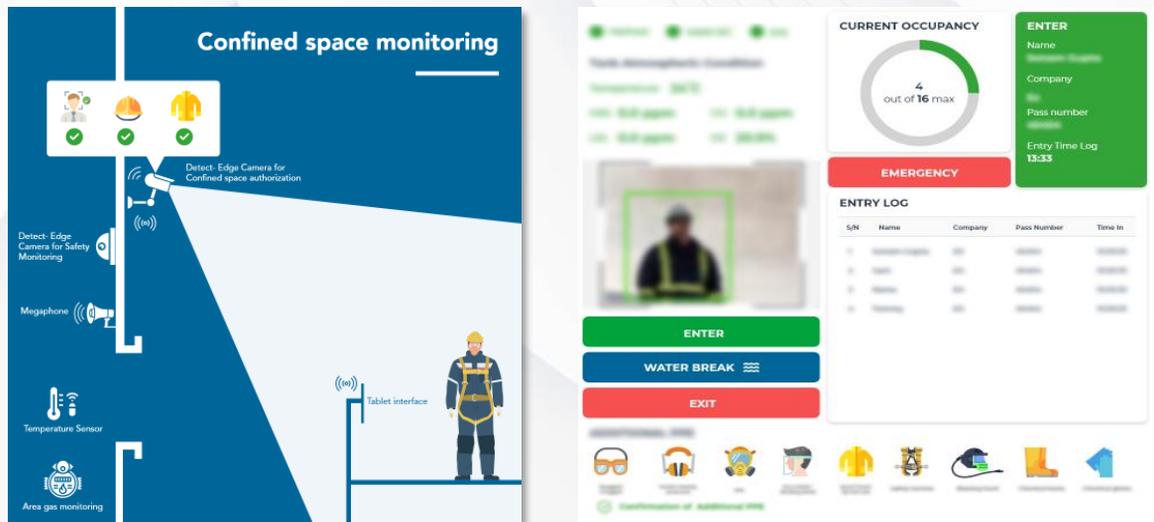


Figure 3: Confined Space Monitoring using T-Pulse

T-Pulse™ can completely automate confined space watch by using technology that provides 360-degree monitoring through which users can maintain automated Entry/Exit event logs from a centralized platform with smart rules, remote supervision from any approved device and reduce human exposure on site by maintaining remote stations to implement compliance with procedures. It achieves this by using cameras, speakers/hooters, remote alarms, people counting, skill and person identification and gas and temperature sensors. Figure 3 displays the confined space monitoring feature using T-Pulse™.

Users can automate comprehensive safety guidelines by leveraging a centralized web-based reporting platform to access processed results on safety guideline compliance and conditions across all mapped risk areas. T-Pulse™ can provide an integrated view as well as an individualized zone/unit-level view, with pre-configured filters for easy search and discovery. Figure 3 describes how Confined space monitoring is done with T-Pulse™.

T-Pulse™ helps users optimize productivity and manage efficiently, i.e., it can both plan the project on track. It maintains an anonymous count of people inside confined space at all times to enables users to take faster decisions to maintain or accelerate projects as per organizational need and provides users with real time trends and insights on a remote platform across any approved device.

Privacy Anonymization :

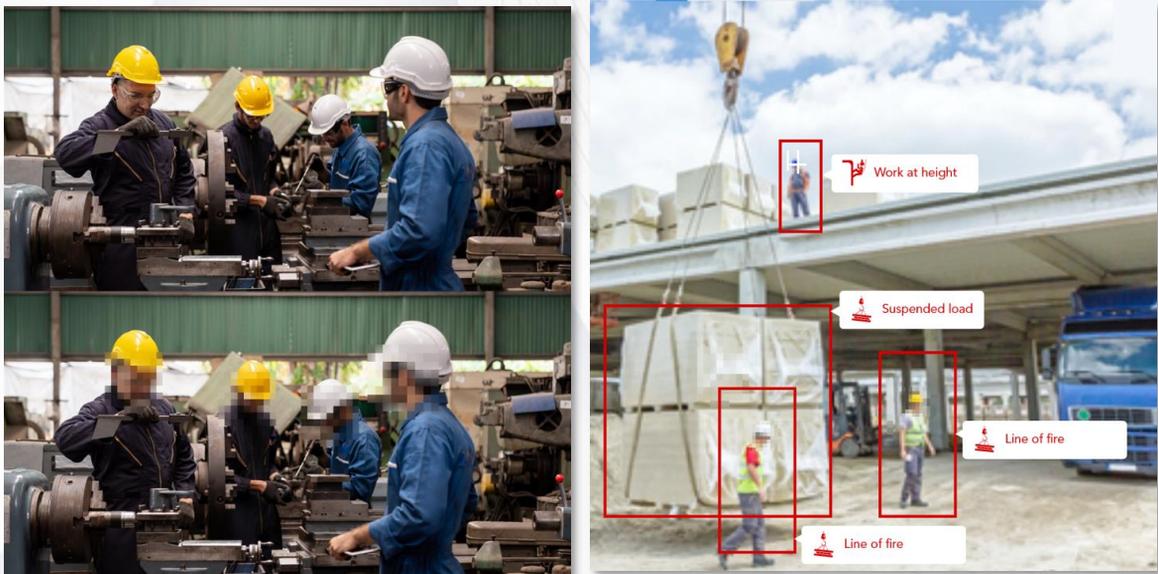


Figure 4: Privacy Anonymization using T-pulse

T-Pulse™ will protect the identity of employees through high precision anonymization. Faces are hidden with precision blurring, pixelation or masking, to prevent any reconstruction and preserve privacy and automate compliance as per international privacy guidelines. T-Pulse™ will also remove personal information from videos and live streams using high precision deep learning software to anonymize people’s faces, which is the most frequently captured personally identifiable information (PII) in images, videos, or live streams. This module is a globally deployed seasoned technology with benchmark accuracy. It uses Proprietary AI models, specifically trained for redaction and it undergoes continuous updates and optimization through secure cloud-based architecture. The Figure 4 above displays how T-Pulse™ anonymizes workers faces.

Using this module, users can access events without personal information of people by configuring a smart API for anonymization layer before running any analytics and obtain only the information that is required. It provides selective anonymization of faces with no removal of any event information as shown in figure 4 and has smart and hassle-free API integration and a light software with moderate compute requirements making it suitable for both - on-prem and on-cloud deployments.

T-Pulse™ maintains an automated platform for the crucial compliance with all international norms and guidelines on privacy and personally identifiable information (PII) and assure compliance to the most stringent guidelines without deviations. It has a strong data protection with the most secure architecture such that no raw data can be accessed to remove any information or lead to a privacy risk.

Process Risk Management using T-Pulse :

The risk management process is a framework for actions that need to be taken to manage risk. These include five basic steps and are referred to as the risk management process. The steps include identification of risks, analysis of risks, prioritization of risks, implementation of a solution, and finally monitoring of risks. In manual systems, each step involves a lot of documentation and administration.

T-Pulse™ enhances efficiency and productivity at industries through AI enabled automation. Users gain complete control of their processes and can smartly program new initiatives through remotely managed intelligent solutions. T-Pulse™ transforms data into operative insights and empowers teams with accurate data for quick decision-making.

T-Pulse™ achieves Process Risk management by focusing on 2 main aspects, namely - shutdowns/ turnarounds/ outages/ projects and digital container terminal operations.

Shutdown/ Turnaround/ Outages/ Projects :

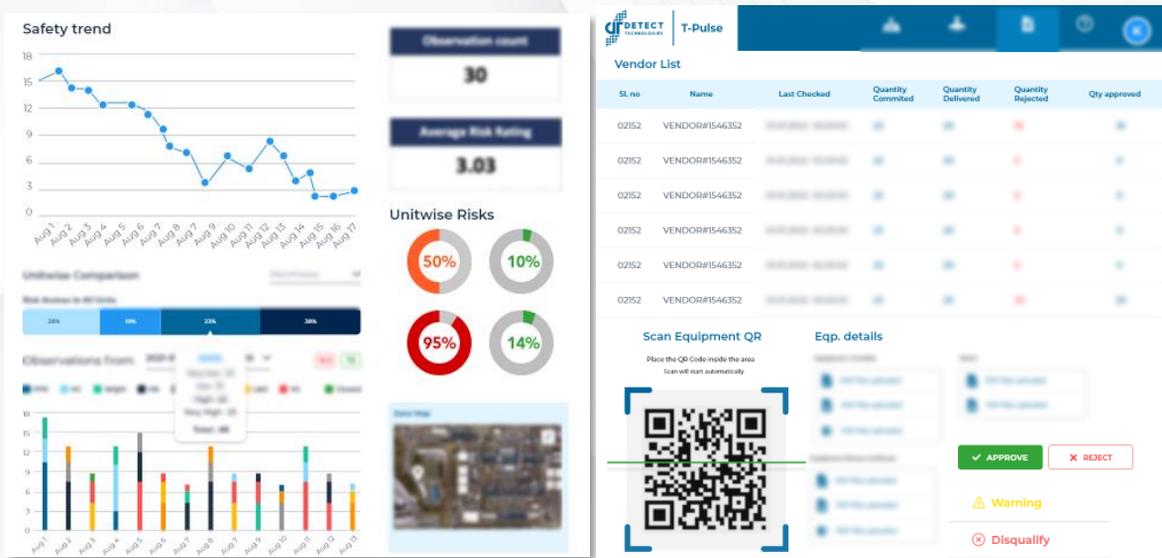


Figure 5: Shutdown, Turnaround and Outages monitoring using T-Pulse

T-Pulse™ enables increased efficiency during Shutdown, Turnaround, Outages and Projects through high precision AI enabled processing of huge data, prioritization of items according to relevance and avoiding information overload. It can potentially save 80% of time currently consumed in manual data acquisition and invest it into bringing strategic improvements in projects. T-Pulse™ is a tool for leadership and managers to gain maximum on-ground visibility and address issues more effectively and measure planned outcomes. It enables users to monitor productivity, safety, resources, and business processes in a single unified platform.

T-Pulse™ is designed to leverage large sources of visual data. The HSSE module ingests data from various visual sources to detect non-compliance in workplace safety, thereby assisting stakeholders working in highly pressurized environments to undertake corrective actions on the go. T-Pulse™ reduces manual efforts for data acquisition and processing to zero, achieve zero incidences on site through pro-active actions on all detected events, implement all comprehensive safety guidelines in a high intensity environment and helps strategize systematic improvement to achieve organizational HSSE goals through deep analytics.

Using Schedule control Module, users can leverage pre-trained deep learning AI models over visual data to track progress of each milestone. It provides unbiased and near real-time data to project managers, enabling them to undertake timely interventions to reduce delays to overall project. It provides users with exact times for task start and completion, time gain/delay, S-Curve, and much more for projects/ processes in operations, helping users flag issues and resolve them with real-time visibility through our issue module, optimize overall project schedule to reduce slack and thereby improve productivity and digitally track complete shutdown, turnaround, and outage (STO) in process units from planning to execution.

Using the Occupancy module, maintain the real-time total count with state-of-the-art computer vision algorithms. The occupancy module feeds data from fixed cameras into a central AI data lake, generating virtual fencing across the site, and automating occupancy management to minimize risk at site. It enables users to anonymously count and smartly plan workforce to a threshold within a predefined area. It enables users to manage risks within a controlled area on a running plant, offshore platforms, or an industrial project and creates intuitive dashboards, custom analytics, and emergency evacuation plans with occupancy module.

Using the Vendor Inventory Management System users can track inventory and resources from all vendor partners. It monitors planned vs actual resources mobilized at site using a smart platform. It enables users to track all documents at site through QR codes and approve/reject inventory upon verification at site and access all important data at site through any approved device and centrally visualize and track all inventory available at site as shown in Figure 5.

Using the Inspection Module, users can now reduce inspection time with fast processing, visualization and reporting of observations and recommendations. The module generates fast observations that run on both images and video data being processed through computer vision and deep learning algorithms to automate detections. Users get a comprehensive list of observations and recommendations in a short span of time. enhances efficiency and productivity at industries through AI enabled automation. Users gain complete control of their processes and can smartly program new initiatives through remotely managed intelligent solutions. T-Pulse™ transforms data into operative insights and empowers teams with accurate data for quick decision-making.

T-Pulse™ achieves Process Risk management by focusing on 2 main aspects, namely - shutdowns/ turnarounds/ outages/ projects and digital container terminal operations.

Digital Container Terminal Operations :



Figure 6: Digital Container Terminal Operations

T-Pulse™ enables users to monitor, control, and automate the entire container handling process, reduce the total cycle time for container loading with a novel vision-based terminal automation system and improve productivity and safety. It helps maximize container crane performance through complete automation.

Using T-Pulse™, users can achieve alignment automation with a visual 3D positioning system and enables users to manage port operations with real-time visibility. It uses a vision-based 3D positioning system to position single and multiple trailers of trucks and cranes effortlessly. Users can accurately track where containers are placed and their time on a unified dashboard. Guide operators can get visibility of all markers with a visual 3D guide marker, and it notifies to slow down, continue forward, align, or stop.

T-Pulse™ is a simple, rapid, safe, and effective way to ensure safety and productivity on ports. It helps position multiple containers across an entire port easily. Detect Technologies combines state-of-the-art AI on camera with positioning algorithms to make positioning containers effortless. Users can position trucks at the right place at the right time before the spreader arrives with no intervention from the crane or truck driver. T-Pulse™ also provides complete visibility into loading and unloading – safety, presence of workforce, and more. T-Pulse™ improves turnaround time and runs safety checks with end-to-end automation. It enables users to position containers effortlessly with real-time visibility into the port infrastructure.

Noctua.AI

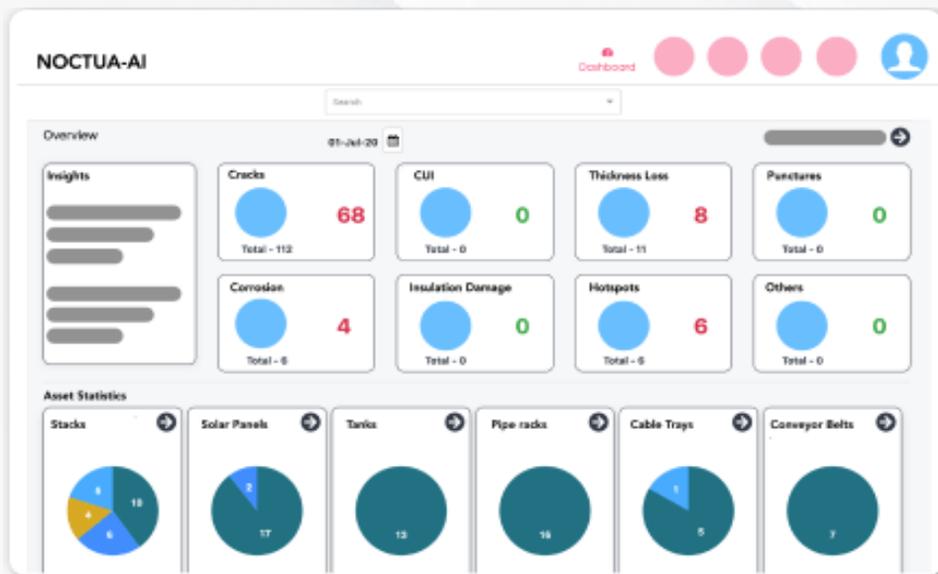


Figure 7: Noctua.AI

Detect uses Artificial Intelligence in the backend to perform analytics and create a Digital Twin of the asset for easy visualization of the asset and monitored parameter. Noctua.AI™ is an asset performance management solution that enables users to calculate plant performance effortlessly with industrial AI. The AI combines visual, thermal, UT, electrical and other process parameters. Figure 7 is an image of the Noctua.AI dashboard.

Asset Risk Management using Noctua.AI :

A risk is any potential occurrence that could cause an undesirable or unwanted outcome—such as destruction, damage, or loss—for an organization or an industrial asset. Risks may originate from people, other organizations, hardware, networks, or even nature. So how do we mitigate risk to industrial assets? Through safeguards or countermeasures. Using Noctua.AI™ users can reduce unplanned asset downtimes and accelerate decision making through actionable and fast insights and ensures continuous runtime and increased asset availability and reliability.

Noctua.AI™ integrates deep learning models to gain real-time insights on process safety, mechanical integrity, visual and thermal inspection, maintenance, corrosion, risk analysis, and more. It seamlessly integrates existing visual, thermal and time-series data to Detect’s proprietary AI data lake to achieve component-wise analysis quickly.

Noctua.AI™ achieves Asset risk management by offering four modules, namely, digital asset inspection, digital pipeline control, predictive piping leak detection and distribution automation software.

Digital Asset Inspection :



Figure 8: Digital Asset Inspection using Noctua.AI

Noctua.AI™ is an enterprise AI software solution designed to optimize the performance of industrial assets. Noctua.AI™ is a high precision deep learning platform that enables users to effortlessly process and visualize visual, thermal, and time-series data with risk categorization to mitigate asset downtime risk. Noctua.AI™ is linked with any robotic, UAV and asset data source, making it fully remote. It is also capable of managing multiple industrial assets on one platform. The AI easily predicts faults and anomalies using machine learning. It helps in generating actionable insights for higher industrial productivity and generating accurate data and quick reports. Users can automate and visualize the processed output in the format of traditional manual reports created by experienced engineers, by leveraging globally tested deep learning models in Noctua.AI™. The customer gets component and section wise analysis of the assets, using which they identify anomalies in all categories and find the most frequent damage mechanism. Risk categorization on each observation provides actionable insights to the user.

Noctua.AI™ identifies all observations on assets with a unified 3D interface from which users can track location, operational exposure, and maintenance history of critical components, and strategically plan enterprise maintenance activities. Noctua.AI™ can be used to monitor a wide range of industrial assets such as chimneys, flare stacks, pipe racks, cable trays, columns, vessels, compressors, conveyer belts, motors, pumps, heaters, furnaces, cold storage tanks, insulated pipes, civil structures, and a lot more.

Digital Pipeline Control:

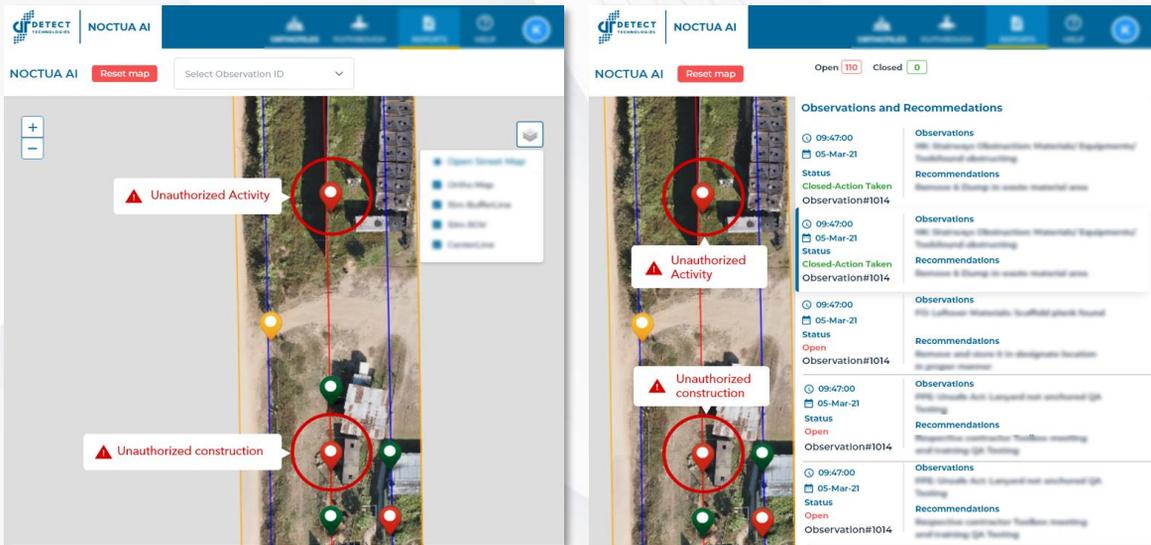


Figure 9: Digital Pipeline Control using Noctua.AI

Digital pipeline patrol platform leverages visual data from cameras, satellite or UAVs and pre-trained AI based algorithms to detect unauthorized events such as presence of heavy machinery, excavated earth, exposed pipelines, leakages, theft, missing signages etc. On detection of such an event, an immediate alert is generated in the form of an application-based notification, e-mail or text message.

This module provides intelligence for surveillance, security, monitoring and managing various working and non-working assets on a unified web platform. Users can detect and log illegal activity, excavation, drilling, digging, mining, blasting, encroachment, pipe leakages, exposed pipelines, miscreant activity and much more. Users get insights with associated time, geo-location stamp and associated image/video feed from an automatic email alert to relevant executives' basis detection/non-detection of miscreant activity/event (along with date, time stamp) as shown in figure 9.

The module helps users make informed and faster decisions through processed information provided by digital pipeline patrol and track closures of all observations and log actions for efficient closure of all events. Using the data, users can align actions better and assign them to relevant people. The module sends emails about specific location details and deadlines with location information where action is required and ensures escalations are made when there are delays.

According to Mr. Ramachandran, former Director in BPCL, over a deployment of Noctua.AI™, he found that it helps to track location, operational exposure, and maintenance history of critical components, and plan enterprise maintenance activities more strategically.

Predictive Pipe Leaking Detection:



Figure 10: Pipeline Integrity Monitoring using GUMPS

Pipelines are monitored by Detect's pipeline integrity monitoring sensor - GUMPS. GUMPS™ or Guided Ultrasonic Monitoring of Pipe Systems is Detect's high temperature guided wave ultrasonic inspection system for pipelines. It is a first-of-a-kind fully automated and permanently installed guided wave sensor. It can also predict future outcomes and pipeline risks using historical data combined with data models and machine learning algorithms for better planning. It is engineered for pipeline health and integrity monitoring in real-time and designed to work at extreme temperatures. Researched for more than 8 years, GUMPS™ generates continuous, real-time corrosion insights over long-range pipelines. It uses a combination of industrial IOT with cloud analysis and is designed for scale. It is weatherproof, operates in a temperature range between -30 deg to 200 deg C (-22 deg to 392 deg F) and uses only a single pulser for multiple sensors.

GUMPSTM works with Noctua.AI™ (Asset performance management solution) for Pipeline Integrity monitoring in particular. GUMPS™ is designed to continuously monitor pipeline corrosion rates and reduce industrial downtime. It helps in identifying the location and degree of potential pipeline corrosion in real-time which helps in eliminating potentially hazardous leaks, proactively. Chemical plants, nuclear power plants and other industrial customers who process and transport high temperature fluids (>125 deg C) through insulated pipes are the target customers of this technology.

According to Tarun Mishra, Director of Detect Technologies, GUMPS™ uses historical data combined with data models and machine learning algorithms to identify potential risks in the piping systems. GUMPS™ helps in pinpointing potential leaks, corruptions, and faults in pipeline infrastructure quickly and helps plan the pipeline integrity management strategy better, thus helping in preventing incidents before they occur and extend the lifetime of the pipe systems. GUMPS™ allows the users to move beyond real-time corrosion monitoring and see how defects and corrosion areas grow in the pipeline facilities with 3D models from which users can access accurate and consistent data. It also alerts on potential pipeline failures in advance using which users can make autonomous decisions with the right information.

Mr. Ramachandran, former Director of BPCL mentioned that one of the main advantages of using GUMPS™ was the continuous measurement of corrosion in hostile fluids environment. He had first noticed this benefit with their installation at BPCL, Kochi. Traditional practices for checking pipeline integrity were being done using spot measurements, but GUMPS™ enabled measurements over a distance of 50-60 m. It is currently used for pipes of diameter ranging from 4 - 48 inches and can go up to 70 inches. GUMPS™ is also able to parallelly monitor the impact to the thickness of the pipeline with the injections to optimize the injections as well.

Distribution Automation Software :

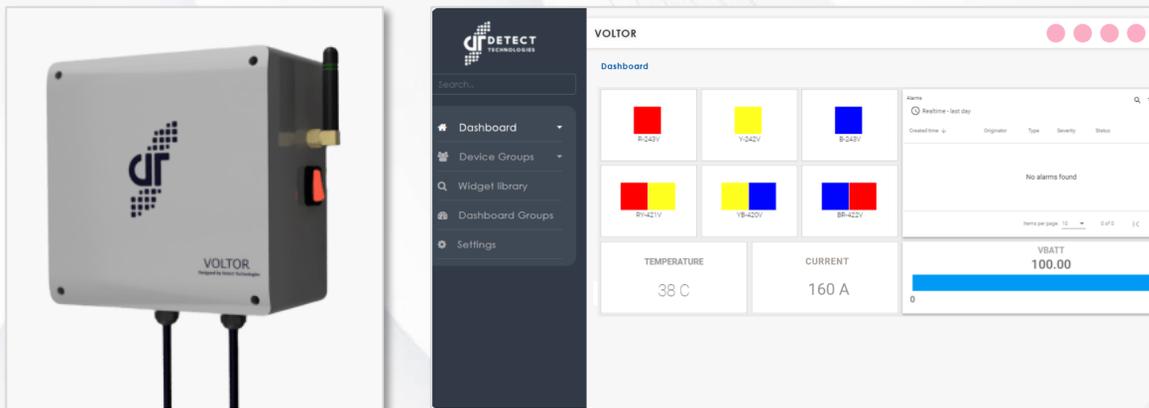


Figure 11: Distribution Automation software monitoring using Voltor™

Detect's Voltor™ is an industrial IoT sensor that detects fluctuations and imbalances between voltage, current and power in real-time. It can monitor all parameters of electrical distribution like voltage, current, temperature, water ingress, and energy consumption. One can analyse trends and patterns and utilize algorithms to detect operational anomalies and data issues in advance. It can be used for electrical asset monitoring across assets such as LT distribution transformers, LT network pillars, and junction boxes.

Being very compact and weighing only 700 grams, this product can be deployed in tight spaces. Voltor™ is secure, all acquired data is encrypted on an HTTPS connection. The device can remain connected with up to 5 hours of battery backup. It is also easy to install and works for single phase and three phase power supply and consists of a local storage with an upload frequency of 1 Hz. Voltor™ helps in maximizing uptime and operational efficiency.

Voltor™ identifies fluctuations in real-time and sends instant notifications to managers on a cloud based IoT platform. It is designed to continuously monitor voltage, current, and power supply. It tracks the reliability and availability of low-tension network assets.

Using Voltor™, users can get valuable insights and reduce outage duration by 25%. It also helps in keeping track of voltage, current, and power fluctuations and predict fault and outages effortlessly. This product can identify power event patterns to avoid future outages, find new opportunities for power efficiency enhancements and make informed decisions and improve performance with the right data.

Voltor™ detects faults and outages and notifies users with asset details and fault location attributes for quick resolution. It tracks the reliability and availability of low-tension networks and assets and also helps users identify power event patterns to avoid future outages. Voltor™ notifies users on any fluctuations and outages and helps maximize uptime and operational efficiency. Users can download daily, weekly, or monthly reports with period voltage fluctuations and supply trends.

Detect's Predictive maintenance solutions:

Predictive maintenance is useful for monitoring, assessing, and determining viable courses of action for facility equipment, computers, and machinery. The use of predictive maintenance provides numerous benefits, from saving on labour costs to reducing risk and wear and tear on machinery over time.

When creating a predictive maintenance program, the following steps are required to ensure a successful and accurate program - Identification of critical assets, creation of a comprehensive asset database, establishing fail models, implementation of measurement tools, apply to pilot asset, establish implementation, and improvement workflow. Detect is one of its kind in providing the maintenance to the facility. Products like GUMPS™, Voltor™, Noctua.AI™, T-Pulse™ help in monitoring the assets such as pipelines and electrical equipment as well as labour and safety regulation.

CASE STUDIES

Detect's products have by now been deployed in large number of industries across India, USA, Middle East, Singapore, and Southeast Asian regions with clients such as Shell, Exxon, Chevron, Vedanta Group, Adani, DP World, Tata Steel. This report studied four specific deployments, which are elaborated in the following pages –

1. Deployment of GUMPS™ and Noctua.AI™ at BPCL Kochi, India
2. Deployment of T- Pulse™ in BPCL DHDS complex
3. Deployment of T-Pulse™ in SHELL, Pennsylvania, USA
4. Deployment of NOCTUA.AI™ at Iron and Steel Industries at Jharkhand, India

1. Deployment of GUMPS™ and Noctua.AI™ at BPCL Kochi, India (Oil & Gas)

a. GUMPS™

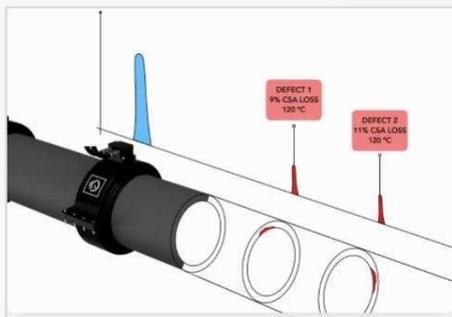


Figure 12: Working of GUMPS™

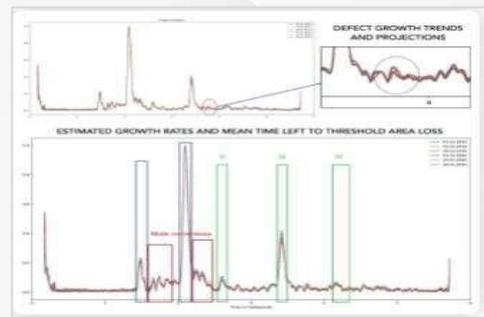


Figure 13: Data Gathered by sensor

Problem :

The reliability manager at one of the biggest Oil and Gas downstream facilities in India wanted to address the challenge of accurate inspection of corrosion in pipelines and optimization of the reliability process of the pipelines with technical intervention. They also wanted to use real-time data and information to support reliability-centred maintenance and monitor pipelines proactively.

Solution :

Detect's product GUMPS™ was the innovative solution identified to solve the posed challenges. BPCL acknowledged the patented and unique nature of Detect's offering which had the capability to continuously monitor pipes in real-time. The data was analysed using intelligent algorithms, ensuring early detection of defects being formed and their growth rates.

Outcome :

As a result of installing GUMPS™ into the oil and gas facility, the overall pipeline life increased by 2 years. Real-time information made it possible to minimize maintenance activities that were being conducted on-site during operations and scaffoldings of manual UT thickness for all locations in the pipes were avoided since only affected areas were being analyzed.



Figure 14: GUMPS™ Dashboard

With GUMPS™, the oil and gas enterprise saw an impact immediately. They identified 2 indications in less than two months, and overall, 8 indications within a year. In addition, GUMPS™ empowered them to increase their pipeline life by creating proactive inspection/maintenance strategies, instead of doing replacements during regular operations.

Mr. Ramachandran, former Director of BPCL, stated that “GUMPS™ gave BPCL an opportunity for continuous measurement of corrosion in a hostile fluid environment. The product is primarily used by process industries as by taking real-time measurements on a continuous basis they are assuring themselves of asset integrity, hence it is implemented as a defensive tool.”

b. Noctua.AI™

Problem :

BPCL wanted to deploy a product for inspection of chimneys and furnaces which are 150-200m high. Historically, whenever these chimneys were to be monitored, the equipment had to be shut down and scaffolding had to be erected to reach the required height. This process alone took about 10 days which would be followed by manual inspection through sample measurements to check the integrity.

Solution :

BPCL implemented a combination of Detect’s drone and Noctua.AI™. BPCL leveraged the fact that the drone could fly up to the necessary height and capture the whole area. Using Noctua.AI™, BPCL were no longer dependent on inspection small sample patches but could monitor the whole area. Additionally, the need for scaffolding and the associated lead time of 10 days disappeared.

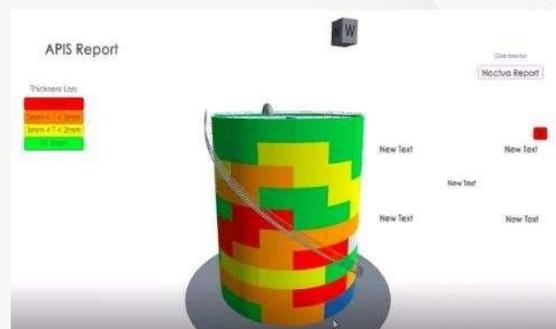


Figure 15: Digital Twin of Reactor – Regenerator unit



Figure 16: Flare stack GUMPS™ Dashboard

Expansion of Noctua.AI™ within BPCL :

The successful application of Noctua.AI™ spontaneously led BPCL to experiment with inspection of flares. Flares are customarily shut down once in 4-5 years because they are associated with all the plants in a refinery. Flares ensure that all excess gases are burnt, and the appropriate balance is restored in the plant.

The challenge with inspection of Flares is that they are tall structures and wind speeds are high at the given height. As a result, inspection of flares was difficult for the company. A combination of visual and thermal videography and drone-based inspection from Detect gave BPCL a solution to monitor the flares. This could address any concerns regarding the performance of flares and spot issues if any.

Detect was able to measure thickness using ultrasonic sensors for all the static equipment. Usually, the equipment would be checked manually with an ultrasonic device, and scaffolding would be used to access higher points. The process had a low-mobility and was time-consuming. After Detect's offerings were approved, BPCL could measure the thickness of tanks, vessels, and even equipment inside the hazardous areas of the plant. Hence the safety inspection inside the plant became more automated.



Figure 17: Flaring video and analytics

Mr. Ramachandran, former Director of BPCL, stated that *“With regard to drone management, there were a lot of restrictions put on drones in the country, but recent amendments have improved this and allow us to use the drone more effectively.”*

Mr Prudhvi Teja, Head, Business development, Detect Technologies, stated that *“Earlier an inspection engineer would carry a hand-held thermography camera to take readings once a month and the entire site was being manually monitoring in accessible locations. If the team found any hotspots, the engineer would record that. However, this process didn’t allow the company to record everything completely. Detect is doing a complete survey every three months with the drone.”*

2. Deployment of T- Pulse™ and Digital Asset Inspection using Noctua.AI™ in BPCL DHDS complex (Oil & Gas)

a. Shutdown, Turnaround, Outages and Projects management using T-Pulse™

BPCL’s Diesel Hydro De-sulphurisation (DHDS) complex, which comprises multiple units like hydrogen generation unit, sour water stripping (SWS) unit, amine treating unit (ATU), or amine regeneration unit (ARU) has deployed Detect for two purposes, Shutdown/turnaround management and asset integrity tracking. T-Pulse™ is deployed for the first purpose.

Problem :

Any Turnaround is a high-risk event for a process unit and the magnitude of deployment makes it challenging to monitor and control hazards everywhere. The BPCL team was looking for a solution to effectively monitor safety violations and monitor manpower during a project to improve productivity.

Solution :

Detect deployed visual cameras to monitor the number of people present in the control area. The cameras consider the peak manpower that has been deployed in a specific work area and checks if actual number of people working on the grounds has been above the defined cut-off criteria (e.g., 80% of the peak manpower), and the duration for which it was maintained at that level. The instantaneous manpower trend is analysed against the peak manpower and the allowable tolerance, to compute effective manpower hours.

Outcome :

T-Pulse™ ingested real time feed from cameras and UAVs to capture all the violations at site. The system captures all safety violations and categorizes it on various parameters like height, confined space, vehicle safety etc. as per IOGP 577 and OSHA standards. It generates real-time alerts with risk level and recommended actions. HSSE managers can use this data to undertake focused intervention and record the gains through these interventions using the same module.

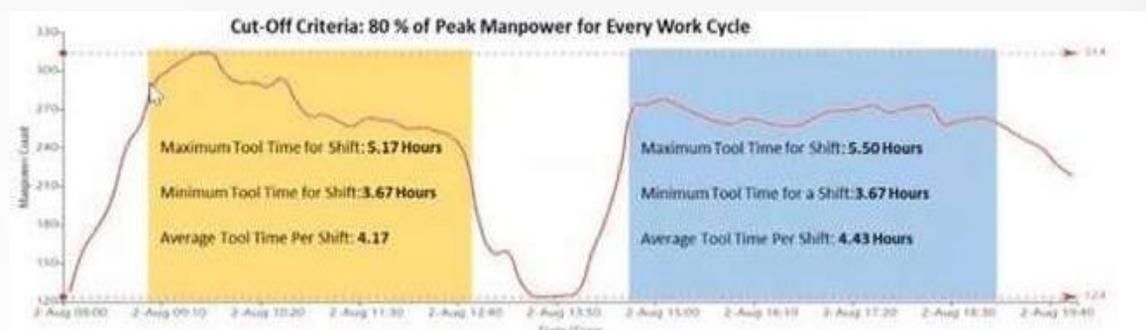


Figure 18: Manpower mobilization trend

The deployment provided a comparison between number of people before and after the shift changeover. Ideally an efficient work front will observe the same number of people before and after the changeover. However, in most instances this number is not the same due to various inefficiencies. The monitoring module measures the number of people within the control area before and after the change. Based on the analysis, the turnaround manager can identify opportunities for enhancing productivity without increasing manpower, by increasing the active man-hours and reducing shift variances.

Mr. Ramachandran, former Director of BPCL, stated that “T-Pulse™ which is used for safety can help in real-time decision making in an environment where one is dealing with hazardous equipment. For every process company, safety and productivity are of critical importance, and these solutions are directly towards applications in those areas.”

Mr. Rajkumar, Lead, Applications, Detect Technology stated that “Safety violations occurring during turnarounds were manually addressed by deploying safety officers in site. Controlling safety violation has always been a problem and there hasn’t been a proper solution for this problem. While T-Pulse™ has a safety surveillance module, it doesn’t have any specific problem statement. If we apply our product in this problem statement, we have a proper solution and that is how T-Pulse™ was used for this particular purpose. T-Pulse™ was first deployed in June 2018 and is now being deployed in industries across the Middle East, North America and South America.”

b. Digital Asset Inspection using Noctua.AI™

Application of Noctua.AI™ :

In this project, Detect deployed Noctua.AI™ to focus on two areas:

- i. UAVs to identify defects in assets and which can be taken up for maintenance. This could be places where there is corrosion, insulation loss etc.
- ii. UAVs to map thickness using ultrasonic sensors. This is done for tanks, and is now being extended to columns, vessels, and reactors.

UAVs are used to capture the data for high rise assets, hard to reach assets and confined spaces. The system uses visual, thermal, and ultrasonic sensors for inputs to locate the defects. These images are then processed through the proprietary algorithms to detect anomalies such as cracks, refractory damage, hotspots, insulation loss, etc. These defects can then be tracked, and recommended actions can be communicated to the relevant stakeholder. Additionally, risk scores are awarded to each identified observation.

Monitoring by thermal cameras:

Thermal monitoring is done during the cool-off period of asset. At steady state, it’s not possible to identify defects using thermal monitoring as defective parts also acquire the same temperature as rest of the parts. It is when the asset is cooling down that parts with material loss, corruptions, etc. are identified. Further it is also used for high temperature circuits to identify localized rise in temperature. This localized temperature rise is generally due to internal defects such as refractory damage, due to which these points start to act as a heat source.

Generally, measurements were taken from a distance of 3 – 4m from the asset due to temperature losses that happen due to distance. With Noctua.AI™, it can be taken up to 15m away as the system is able to correct for temperature losses that happen due to distance.

UAVs are also used to map the thickness of metallic assets. Currently the UAV can autonomously acquire data up to a height of 30m. In another BPCL turnaround, Detect is trying to increase the flight height of semi-autonomous drones to 60m from 30m by implementing a new technology. With 30m high flights, Noctua.AI™ could do perform inspections only for tanks, but at more heights, it can be extended to other assets.

Limitations that exist on the type of container that can be monitored could be in terms of the diameter of the container, but not by the material that it contains. BPCL is primarily deploying Noctua.AI™ primarily on liquid containers.

The monitoring can be performed while the containers are live as well, but the company is planning to do it along with other turnaround activities. The exercise is being conducted for tanks and soon will be extended to vessels, columns, and reactors. As assets apart from tanks are being inspected for the first time, there are risks associated and hence ultrasonic monitoring is being planned during the turnaround when assets are offline.

Temperature constraints

Tanks usually don't have high temperature, but columns and reactors have high temperatures during operations and need to be taken offline before monitoring can be done using drones. Design temperature for drone operations is 70 degrees Celsius but Detect tries to operate it at 50-55 degree Celsius. Drones must touch the walls for taking ultrasonic measurements and hence high temperature assets have to be inspected offline.

Measurement points

Each asset is divided into multiple shells, and for each shell, readings are taken at 5 points – 4 edges and 1 centre. Shell dimensions can vary, could be 1m x 1m or a bit lower or higher. There could be 400-500 points in total. Detect can inspect up to 180 points per day.

Based on analysis of data captured, Detect classifies the plates into three risk categories – high, medium, low. As BPCL has a good maintenance practice, number of 'high risk' plates range from 4-5% of the total plates and plate change is recommended for these plates. While Detect highlights these findings, the client takes a decision on which ones to change. In the high classification, some alerts may be escalated if thickness loss is beyond the safety limit. A turnaround typically takes place every 4 years, so changes in plates are done at that time.

Magnitude of data handled

Images are taken continuously from cameras and algorithm then divides it into images for analysis, identifies sections of the asset and maps them accordingly. Total data captured from various sensors would be approximately 70 TB for BPCL alone. As the agreement required Detect to delete the data after 90 days, so historically total data would have been even higher than 70TB. For each 30-day period, 4-5TB data is captured for only safety monitoring. Detect can perform analysis on vast volumes of data and is this is another major strength of the company.

3. Deployment of T-Pulse™ in SHELL, Pennsylvania, USA (Chemical industry)

Digital Workplace Safety using T-Pulse™

Problem:

SHELL, Pennsylvania was undergoing a large construction projects with thousands of people make safety monitoring a challenge. 7,500 people were on-site every day, with thousands of activities happening concurrently. The main challenge was to focus on preventing the most consequential safety incidents.

Solution :

The T-Pulse™ solution was first demonstrated to the project team in late 2019 in a one-off trial that generated serious interest in the technology. That led to an extended pilot study that started in February 2020 but was soon interrupted by the COVID-19 pandemic. The pilot study eventually concluded in September 2020. In the T-Pulse™ system, UAV video imagery of the area of interest is captured on-site and uploaded to Detect Technologies' cloud environment. There, the images are processed in less than an hour, and the results are returned to the site team in the form of observations through a web portal (dashboard).

Detect Technologies uses computer algorithms to identify and to highlight areas of interest and identify potential hazards, on the basis of pretrained observation sets. It leverages a "human-in-a-loop" approach for processing the source imagery. In this project, the algorithm provides the first pass to generate initial results quickly; these are then vetted by humans to improve the AI system's capabilities through machine learning continuously



Figure 19: Typical daily observations and trend during the pilot study

Human vetting of the results generated by AI helps to improve the algorithm so that it becomes more intelligent with each cycle. Detect Technologies' safety officer annotates observations and shares the results, along with marked-up images, video snippets and recommendations, with the site team via the dashboard. The site health and safety team then proceed to assign criticality ratings to the observations, review the recommendations and execute remedial actions. Meanwhile, the AI feedback loop is closed.

Outcome:

After the successful completion of the pilot study at the Pennsylvania Chemicals project, the project's digital innovation steering committee decided, in late 2020, to make T-Pulse™ available for deployment at Shell sites. Currently, a new service is in development to cater to demand at green- and brownfield projects as well as turnarounds.

4. Deployment of NOCTUA.AI™ at Iron and Steel Industries at Jharkhand, India

Digital Asset Inspection using Noctua.AI

Problem:

The maintenance team at one of the prominent Steel production facilities wanted to completely automate the reliability of their civil structure and chimneys via digital platforms and robotics. They could not predict degradations or track assets end-to-end and wanted to automate visual, thermal, and thickness-based inspection for their assets.

Solution :

After understanding the needs of the Steel production enterprise, Detect understood their workflows, unified their data, and completely automated their inspection processes with Noctua.AI™. They automated UAV-based thickness data acquisition with APIS technology.

With Noctua.AI™, reliability engineers or asset managers at this steel facility could

- Make sense of unstructured data.
- Analyse all the data to pinpoint areas that need further assessment
- Track maintenance items up to the component level
- Identify anomalies and deviations proactively
- Share relevant information with experts who can populate recommendations and provide guidance for rapid and safe repairs
- Take corrective measures for improved asset availability and production yield
- Implement change management policies and track progress in real-time
- Take actions related to each component of the asset
- Notify maintenance engineers about upcoming or delayed tasks on a centralized platform

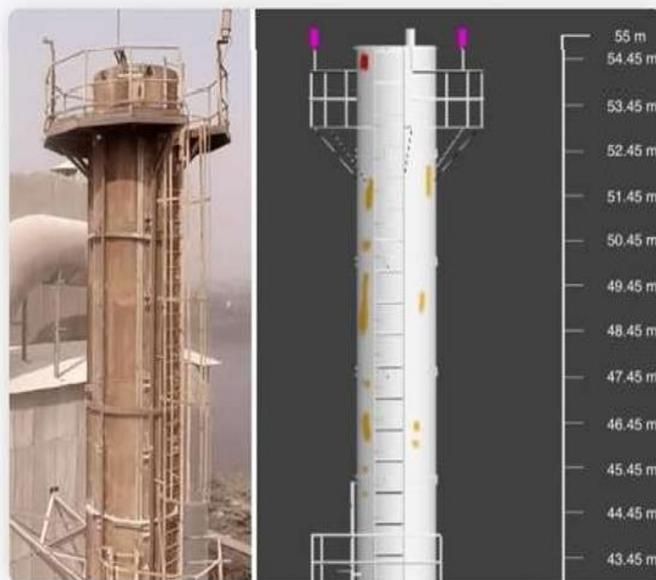


Fig. 20 Digital Mapping of Chimneys

Outcome:

Over 500 civil structures and 100+ chimneys were selected to be managed. Noctua.AI™ aggregates and extracts intelligence from asset monitoring data sources as shown in figure 21 and provides a centralized asset performance management platform that converts recommendations to an intelligent maintenance plan.

The client could manage the health of their complete plant on a single unified dashboard. They experienced a 200% increase in data retention and references. From inspecting an asset weekly, they could now inspect 5 assets daily and make quick decisions. Within six months of implementation, the client identified 300+ critical observations with Noctua.AI™. They conducted more than 150 maintenance activities and saw a 2X increase in decision-making. more than 150 maintenance activities and saw a 2X increase in decision-making.

Noctua.AI™, combined with APIS and Drone sensors, played a significant part in improving client’s asset availability and production yield.

STATUS OF THE INTELLECTUAL PROPERTY

Detect technologies currently holds four patents for the technologies it has developed, with a further 12 that are awaiting approval

SL.NO.	APPLICATION NUMBER	FILLING DATE	PUBLICATION DATE	PATENT TITLE
1	PCT/IN2014/000229	10.04.2014	04.12.2014	Novel segmented strip design for a magnetostriction sensor (mss) using amorphous material for long range inspection of defects and bends in pipes at high temperatures
2	201941029898	24.07.2019	22.07.2020	An arm mechanism for docking an unmanned aerial vehicle to a structure for non-destructive testing
3	202141053683	22.11.2021		System and method for determining magnetostriction of a ferromagnetic material
4	202241016284	23.03.2022		A device for detecting defects in structures by active thermography

POTENTIAL MARKET AND INTEREST

Asset Performance & Integrity Management solutions have a wide range of application and are used in asset heavy sectors such as Oil & Gas, Chemicals, Fertilizers, Pharma, Steel, Cement, Power, and Construction industries. These solutions apply to the entirety of an asset's operation, from its design phase to its decommissioning and replacement. The convergence of cloud & AI technologies with asset integrity management services ensures better access to data, storage of data, analytics and allows operators to access details from anywhere in the world.

For this report the asset performance & integrity management market was studied. Based on the feedback received, it can be assumed that the subject – Detect technologies products are likely to have potential in India, the US, and Middle East markets. There are, however, a number of new competitors who currently have competing technologies in the market, though in silos. The company has estimated a market size of USD300 Bn+.

Direct Competition/ Niche service providers :

- ❑ While the sector has more than 20 industry participants, it is predominantly dominated by companies that provide niche services and products that have focused solutions.
- ❑ Five companies have been identified that offer high temperature guided wave ultrasonic inspection capabilities, product range similar to GUMPS™.
 - Corrosion RADAR29 in providing “Corrosion under insulation (CUI)” monitoring systems based on unique patented technology known as Electromagnetic guided radar (EMGR).
 - FEBUS Optics, France uses optic fibre technology for monitoring
 - Carbic, USA
 - Hifi Engineering, Canada
 - AVEVA, USA
- ❑ Few larger companies also provide niche solutions in the category of asset integrity management solutions similar to that of Detect technologies T-Pulse™ and Noctua.AI™
 - Corrosion RADAR29 in providing “Corrosion under insulation (CUI)” monitoring systems based on unique patented technology known as Electromagnetic guided radar (EMGR).
 - Aspentech, USA
 - GE digital, USA
 - ARMS Reliability, USA
 - ABB, Switzerland
 - Yokogawa, Japan
 - Atonix Digital, USA
 - Bentley system, USA
 - Emerson, USA
 - Apergy
 - DNV GL

□ Companies that offer products similar to that of Detect's edge AI camera, are

- Ability enterprise
- VSBLTY
- Gorilla Technology
- ADLINK
- Panasonic i-Pro
- Asmag
- vMukti

Market Size :

The global Asset Integrity Management Market is estimated to be USD 3.8 Billion in 2022 and is expected to reach USD 6.6 Billion by 2026, growing at a CAGR of 11.5% according to data gathered from Research and markets.

Key factors contributing to the growth of this solutions are the rising need for risk-based maintenance devices in asset-intensive industries. Such solutions can be helpful in delivering critical insights into the productivity of the assets in the organization.

- The global market for guided wave ultrasonic pipeline testing was estimated to be ~\$100M USD, which includes a combination of system sales and inspection services.
- High temperature pipeline inspection and monitoring is a small but potentially growing subset of this market
- Similarly, the market for industrial IoT sensors for detecting imbalance in voltage and current is also a small but evolving market, with potential for lot of product innovation.

The cost of implementing these solutions is comparatively high. Thus, it has resulted in less deployment among SMEs. Also, a lack of awareness about cybersecurity is likely to hamper the growth of the market.

Strength of Detect :

- Detect Technology focuses on a Unified experience & services according to the requirement of the customer. Unlike most competitors who have niche products
- The main advantage of Detect over competitors in the market is that they provide integrated software solutions, with customizable AI models which cater as per the clients' requirement. They can modify existing solutions as per clients' requirement. T-Pulse™ is one such product which was modified according to the client's need
- One of Detect's biggest strength is their AI algorithm that can process huge data and simultaneously notify users accordingly
- The amount of data collected and stored by Detect technologies is the largest in the industry. 4-5 TB data is collected in 30 days only for safety monitoring and the total data collected by the sensors is approximately 70 TB
- The solutions that Detect offer consist of an ecosystem of products in which one product is directly or indirectly dependent on the other and they all combine and work together. This ecosystem consists of the hardware component that works to collect the data that is then being processed by the software or edge processor used and the processed data is stored in the dashboard. These components are flexible and at the same time they also complement each other.

Mr. Ramachandran, former Director of BPCL has stated that *“Detect’s team is very interactive and sensitive to the customer. Anything which is an adaptation or customization of an existing product, the speed at which they respond is fast. In one instance the customer interface was the sales and technical team, their response to the situation was very good.”*

Mr. Rajkumar, Lead, Applications, Detect technologies mentioned that *“There are few companies that provide similar products for surveillance and do asset inspections, but they don’t provide complete solutions like we do, or they don’t provide end to end service like we do. They don’t add AI in their module, they don’t do customizations, they don’t provide complete service support after the sales. One of our USP is that all our solutions are unique and attack the core problem statement of the industries.”*

Ease of new entrants :

- There are quite a few companies that have similar products like Detect, but they do not offer a combination of services similar to that of Detect technologies.
- Detect’s products complement one another in the asset integrity management service, which makes it difficult for competitors to replicate.
- Operating the equipment and maintain huge data requires skills and specialization.
- Catering solutions according to customers need is one of the main reasons why Detect has an edge over competitor companies.
- Detect’s algorithm is one of the key components of their service and replicating something like this isn’t quite possible in the upcoming years.

Mr. Ramachandran, former Director of BPCL, stated that *“It’s not that other can’t do it in terms of camera, or fly a drone and capture data, but to have all the skills and focus it on a domain requirement requires some specialization. There have been many people who have been trying to do it, but not many have succeeded in doing a complete sweep. Some can fly a drone, some can build a good dashboard etc, but there are not many who can do all these things. Therefore, Detect has the first mover advantage for several years.”*

Mr. Rajkumar, Lead, Applications, Detect Technologies stated that *“When we had to execute our products, we found out about competitors who provide similar solutions, but do not provide complete solutions that we provide. For example, if we take T-Pulse™, there are other similar products where they install cameras for surveillance, but they might not have an informative dashboard like us or they might not have the live monitoring module that we have. So, there are competitors with similar products, but they can’t provide complete solutions like we do.”*

Mr. Shubham, Lead, Operations, Detect technologies stated that *“Our solutions consist of an ecosystem of products. These components are flexible at the same time they are also complimenting each other as a part of an ecosystem, and we are continuously expanding this ecosystem. This is how we are ensuring an edge for us in these sectors.”*

Market Interest :

There have been rising investments in cloud-based applications such as AI based applications which can be a growth driver to the Asset Performance & Integrity Management market. Application of IT and OT (Operational Technology) in the manufacturing industries and rising demand for improving machine efficiency, productivity, and performance are factors driving the growth of the market.

There is a rising need for Risk-Based Maintenance along with the need to maximize Economic Return on Assets. Implications of Industry 4.0, IOT, growing use of Analytics among process industries are also a major reason for interest in asset integrity management solutions. Government regulations for manufacturing plants amidst Environmental Concerns have also accelerated the use of these solutions.

SUGGESTION FOR IMPROVEMENTS

- Lack of awareness amongst target companies is one of the biggest barriers for Detect Technologies. Many companies lack awareness of the existence of such methods of inspection and asset integrity management, thus restricting them to operate and inspect using the traditional methods.
- Since these are new technologies that have previously not been used in the industry, they have a longer awareness and conversion cycle. For example: T-Pulse™ goes through a pilot for one unit where the ROI is established, after which most plants go for a multi-unit deployment. This cycle can take 4-6 months.
- In countries like US, there are established digital twin solutions. Creating valued differentiators from these solutions will be a challenge
- Similar products are being developed by other companies in the market which would be a barrier for Detect technologies in the upcoming years.
- Operating these products require skilled technicians, and there aren't many skilled technicians in the field of asset integrity management services.
- Deploying of automated inspection results in a reduction in the number of labours employed in the company, thus affecting employees in these large industries.

CONCLUSION

Detect technologies uses AI and advanced technology in the backend to continuously monitor data, ensure asset monitoring and security, schedule controls, people safety, real time data dashboard, and also integrate into supply chain and inventory management in a very cost-effective manner, with different kinds of sensors, and has been able to create a niche in the process.

Detect ensures 100% safety compliance and eliminates asset downtime. The company offers a wide range of asset integrity management solutions such as Pipeline integrity monitoring, Asset performance management, Electrical asset monitoring, Surveying, Mapping and Remote inspections, UAV-based process optimization and Thickness monitoring.

They've successfully deployed their products in global brands like Shell, BPCL, HPCL, Siemens and is currently working to deploy their product in multiple sectors around the globe. After the initial deployment in these global brands, their products and services were deployed in major companies in the oil and gas sector around the globe.

Detect has a methodology/algorithm to measure, analyze and apply data that was hitherto not being measured. The ability to make these measurements greatly enhances the productivity of the client company.

Detects product line has had good applications and they have tested these products in several industries with excellent results.

One of the major differences between Detect and other companies in this sector is that others offer niche solutions for a particular problem in industries, whereas Detect provides multiple solutions for multiple problems that exist and also helps with preventive measures to avoid future problems in the industry.

They can further make improvements in branding their product and their company's name because there has been a lack of awareness amongst industries in multiple sectors who aren't aware of the existence of such advanced solutions. Instead of waiting for customers to reach out to them, they can start by advertising their products and solutions.

For customers, the benefits include:

- Continuous planned operations with remote visibility
- Reduced risk of in-service failure
- Longer asset life driven by predictive maintenance
- Higher safety standards and compliance to codes
- Better inventory management and schedule control

Some of the products provide significant Rol for clients :

- T-Pulse™: 90% decrease in safety violations with 6% increase in overall productivity and 70% schedule certainty
- Minimum savings of \$12 - \$15 Million per site on full fledge deployment
- Noctua: 60% decrease in manual inspection costs with \$20 million savings on outages of assets
- GUMPS™: 100% pipe coverage with real time defect identification. \$6 million saving per critical fault. There are nearly 50-60 leakages in a year at a single site.

Founder's growth vision :

The founding team of Detect envisages to grow to a USD 150 Million company by 2025. They also aim at IPO listing by 2026.

The company's R&D goal is to add new products to their range of solutions and target international clients.

In the interviews conducted with customers and employees, we were able to identify that all of them are satisfied and happy with the solutions and services provided by Detect technologies. We feel that Detect has come up with a unique solution that should be adopted by the industry at large. The improvements in productivity and cost reductions achieved is significantly higher than the cost of deployment.

APPENDIX ONE: INTERVIEW NOTES

INTERVIEW NOTE 1

Name: R Ramachandran

Title: Former Director (Refineries) in BPCL, Managing Director of Bharat Oman Refineries Ltd, Bharat Oman Refineries Ltd. (BORL)

Interview Date: 4th September 2021

The committee interviewed Mr R Ramachandran, the Director (Refineries) at BPCL in Kochi, for his expert opinion to be included in the technology validation report. Detect is working with BPCL on monitoring a reactor regeneration system in the Kochi refinery catalytic unit, where the health of the refractory is checked during start-up and shutdown. Similarly, a drone surveys the overall circuit – the unit and associated pipes-- then monitors temperature changes using thermal cameras to identify refractory degradation.

Q. Where all can Detect' product be useful and what is missing in these products? Will the labour be upset with these tools?

Fundamentally, two things came out of this application – monitoring through fixed and drone-based cameras. Drone-based cameras can fly over a larger area and capture a large plant. Drone cameras could be used to monitor an entire site. Locations should be identified by the customer and detected while using fixed cameras. This enables companies to survey areas identified explicitly with a better focus. While using a drone-based application, it is impossible to cover areas where visual access is limited, ex: a shed. However, fixed cameras can be placed strategically at any location as per the company's decision. A drone is a more robust approach when a more extensive application like manpower productivity is considered. The drone- based camera captured a large area of the plant, and the company could monitor the footage of people from different directions. Hence, data is consistently collected and analysed to provide utility to the customer. This was majorly done to manage contractor employee nuisance because the company used to see contract employees enter the plant and then stay away from the work area. Detect's product worked as a surveillance tool to know whether they were within the work area.

When BPCL started using the application, they found that Detect's applications were more powerful, and the data could be used for different types of analysis. If the contractor employees came in for a 12-hour shift during the turnaround, the contractor and the management would believe that these people were there for the whole period. But through the tool, they could see that employees were drifting. For example, some employees would go away after lunch break or didn't report on the mandated time. They realized that about 30% of the workforce would disappear between 2-5 pm. This insight made the management accept the product, and it became a valuable tool to assess along with contractor the surveillance of the workforce and deployment to various areas. BPCL, as a result, could realise better productivity through the same contractor and the same number of people.

Another thing the company was able to address, which is typical in such large sites, is that several contractors enter the plant with the same people. If it is not known who has entered, Management may have a false sense of security that work is happening in multiple areas, but it would happen in only one place. This application allowed the management to overcome these challenges. It moved from only keeping people to considering people as entities and identifying entities as individual contractor people. This created a new paradigm of productivity in turnaround at project sites. This shows the value created from Detect applications.

Q. Is it useful for only turnarounds or can it be useful for large plants in day-to-day operations?

It is useful for any situation where monitoring of a large workforce is needed. Typically, in any project site or plant area, if movements of people have to be monitored, this application can be used. In commercial project site, refinery or petrochemical plant, or any process plant site, the major value is during turnaround and during project implementation. For projects and turnarounds, as far as manpower productivity is concerned, it's the same application.

If it's a large site where there is huge activity, and people have assembled who are not as organized as a company employee, and there is no organized control over labour or people or activities, this application becomes much more specifically useful. During Covid, the BPCL management wanted certain important projects to move, so they wanted to get outside people who could have been carriers of infection as company might not be able to make sure that they are Covid negative. But they had to work in the same environment as the company employees, who were very apprehensive and were afraid of dealing with the external people even from a distance. The management created designated areas where they could use this tool and external people were contained within those areas. This provided assurance to the company employees that work by external individuals is happening only in those sites and the company has control over it, and unauthorized movements will not happen.

This was also used for crowd control elsewhere by the Telangana government. This solution was deployed in district and police could identify anyone violating the Covid protocols. It could make announcements on the mike system on the drone. So, violators could be identified, and instantaneous action could be taken.

Q. This is a system based on cameras and analytics. How easy is it for another company to replicate it and slowly take over the market?

This application requires a camera that can fit into a hazardous environment. We need people who can position those cameras effectively – this is a skill. But the key thing is the artificial intelligence algorithm, which works with a huge amount of data. For Health and Safety detection, Detect products can identify violations. For this, the AI algorithm has to process terabytes of data. This means that all the skills for hardware are needed, need to position it properly, and more importantly, gather that data and have sufficient domain knowledge to differentiate it and train the AI.

It's not that other can't do it in terms of camera or fly a drone and capture data, but to have all the skills and focus it on a domain requirement requires some specialization. Many people have been trying to do it, but few have succeeded in doing a complete sweep. Some can fly a drone, build a good dashboard etc., but few can do all these things. Therefore, Detect now has the first-mover advantage for several years.

Detect has also improved its cameras and introduced recently, what is called 'Trueview™ camera'. This is an improvement over previous cameras, brought on through research. This is where Detect has an advantage. It started with the question of how to position cameras in a process plant. Originally when company started looking into this product, owners' inhibition was that with cameras, wires have to be brought into the process plant, and data transmission was through a third-party server or cloud. Frequently, there was also a challenge of getting sufficient bandwidth and good Wi-Fi connection in the plant for data transmission because of various obstructions present within the premises. Trueview™ camera has the ability to have its own server and also own power generation through solar energy or other sources. With its own power generation and processor, Trueview™ camera could improve performance capabilities compared to a standard camera. This was another element of what Detect could do, and as we go forward and customers use these cameras further and understand the value derived, we could see a more powerful tool.

Q. Do you find Detect people very responsive? Do they listen to the customers and keep on changing the solution? What has been your experience in this regard?

This could be a slightly biased opinion as Mr Ramachandran has been associated with the company from the first product. For over four and a half years now, he has worked with different people from Detect. One of the reasons for the success of Detect is that they have been very sensitive to customer thinking. They have added applications or features to their products coming out of customers' expectations most of the time. When they start engaging with start-ups and exploring possibilities, most companies become very enthusiastic and ask start-ups if they can do something more than what has been done earlier. Detect has followed an excellent listening process with the customers over the years; that has helped more products come into the market, and in turn, more value has been created for the customers. For example, the local plant people at BPCL created the video on Detect, which went viral in the Oil and Gas industry.

Detect's team is very interactive and sensitive to the customer. But at the same time, when we look at products in the long-term, success will be driven by how they will realise it and provide the same customer services across all customers. Right now, there are two types of products on offer. One in the market has been tested and approved by most customers. The second one is something on which development is ongoing. For ongoing development, there is a lot of engagement for ongoing development, while for tested products, it's more of a transactional engagement between customers' needs and Detect's proposal.

Q. When a new demand comes up, how agile do you find the Detect team? How fast are they able to respond? Do they take a long-time or are they able to revert fairly quickly?

There is a fast response for an adaptation or customization of an existing product from Detect. In one instance, the customer interface was the sales and technical team; their response to the situation was perfect. But in case of a dream/vision of the customer, e.g., Mr.Ramachandran aimed to replace manual inspection in the plant area with automatic inspection, it becomes a long-term thing. One thing on which Mr Ramachandran would complement the team is that they have been engaged with the customer to make things happen. The interface between Detect's team and customers to develop a new product has also been very good. So overall, they have been agile. They are far more agile than a legacy company.

Q. What are the cost savings in a year from these solutions (camera, analytics? Are savings because of these products significant to the customer?

The cost savings are significant, and more than that, it is about the value created for the customers. A customer pays for the product, which is the cost and gets value from it. If we take the example of manpower productivity, recently in one of the Kochi refineries, they had employed Detect for monitoring. During the process of monitoring, Detect's analytics gathered an additional observation. In the morning, when turnaround work is started, there is a clearance that has to be given by the operating team to ensure that all process and safety needs are taken care of before the work is started. This is an engagement between several parties – the contractor, operating, technical, and project team. Detect observed in the first 7-8 days that they are getting clearance to start work almost 2 hours after work for the day. After the first week of engagement, they had a meeting with the management, presenting this insight with the data.

Management realised it had to make changes as it wanted to cut this two-hour time lag to as minimum as possible, and they were surprised that such a gap is there between the time they expect and the actual time. They could reduce the two-hour delay to come down to a half-hour delay. Cumulatively, the 1.5hr saving every day saved the company one day's turnaround time; one day for a large plant like a crude unit is about Rs 2-3 crores. When we talk about the cumulative hours, it converts into a more considerable value on a project site or refinery site.

The most practical example is the use of some of these tools to monitor activity when the plant is operational, and then management can decide whether it wants to push the plant to its limit or not. This is a typical example. The first time a thermal vision camera was used for the flares, the management thought of shutting down the plant for five days because they had to shut down the flare and get people on top for repair works. When they used the thermal cameras, they found that they need not do this, and they could wait for another year before they had to shut down; that would have coincided with the plant turnaround time. These are the types of opportunities that exist, and it is up to the companies to grab them. Daily, this can give strength to the operating team to push the assets to the limit. That means that there would be extra production, which means creating value. The important thing is that the customer needs to look at it not as a monitoring product but as a product of value creation.

Q. What if the product goes wrong somewhere? Can the product go wrong in measuring a parameter and can that cause serious problems? Are there any checks? Possibility can be that the sensor goes wrong in taking readings, or the analytics going wrong with computation to come to wrong conclusion. Can it give a false sense of security when things are actually going wrong?

For any measurement at a commercial scale, 100% accuracy is non-existent. We create redundancies as a defensive design mechanism to overcome something we feel could go wrong. Plant operators are trained to be suspicious of anything which they are doing. When such technologies are introduced, it comes with a lot of engagement, resistance, apprehension and then belief. So, there is a risk-analysis always in place by most customers when they introduce a product into the company. POCs are very useful for the customer to test that.

Reliability and repeatability are also a percentage of what one could assure. Over time, one can see an increase in reliability, e.g., in the safety tool; it would have improved from 80-85% earlier to 95% over time as sensors are made more definitive, and AI is trained better. Similarly, when Detect made the Noctua.AI™ IT tool for ultrasonic measurements, BPCL saw the reliability and repeatability of the thickness measurement and improved it until it met the statutory bodies' requirement standards.

If we take the example of a safety measurement tool and say someone is wearing a cap that the system can consider as wearing a helmet – can the product distinguish between a cap and a helmet? This will be debatable. Similarly, if it's of consequence, alternate solutions need to be found to differentiate between an approved helmet and other helmets through RFID or some different measurement. Technology is available; based on the accuracy requirements of customers, these can be included in the solution.

For the second part related to sensors, if there are multiple sensors related to drone flights, the frequency of drone flights can be increased to see whether we get repeatability. BPCL found that this provides it with an opportunity that is several times higher than what human beings can do. Alternative to these systems is the manual solution. If we consider a safety site, there may be 20 safety officers, but they will take breaks and may not climb 20 floors to check a safety violation. With these systems, companies have easily overcome such limitations. In that sense, they are much better off than average.

But if we ask if there is a 100% guarantee that something will not fail, the answer to that will be no. The ability of the customer to use the product well allows them to understand the risk that exists and come up with alternate ways of doing things. Ultrasonic measurements are a perfect example. We can take complete measurements of a vessel, as against the company opening up sample windows on the vessel. Even if 20 readings are wrong and we have got 80 reliable measurements, it's still better than expected where we would have got only 5 or 10. Overall, nothing can be 100% ideal.

Q. What are the improvements that can be made to the product?

First thing is in drone management; there were a lot of restrictions put on drones in the country, but recent amendments have improved this. It allows us to use drone in a more effective manner.

Second is the ability of the cameras to be able to see under different light conditions. Trueview™ cameras have the potential to have that capability which means that we have cameras that are able to capture happenings at the site better, then there can be better analytics available based on that. Third thing is domain expertise, which is an endless process. From Detect's perspective, as they become more expert in the domain in which they are operating, they will understand more and will become more intelligent to get the right perspective. So, domain expertise in start-ups is another area where improvements can be brought going forward.

In terms of technology improvement, there is no end to it. Mr. Ramachandran was looking for technology to replace the inspector in the plant, which is the ultimate goal possible with technology improvement.

Another thing is in the digital twin regime, where some work has now been done by the company. The plant model can be had elsewhere in which all sorts of things can be tried and be assured of results before it's tried in the plant.

These are some areas where improvements can happen. Grab the essence of the time and move forward

Q. As some of these measurements like from drones are not going to be continuous, is it possible to integrate them with other standard measurements that are taken in a plant? Can it be used for making real-time decisions e.g., push more Crude or change the product mix?

A live example is from a catalytic cracking unit in the Kochi refinery, where first time Detect products were tried. Generally, hotspots are generated in various parts of the reactor or regenerator because of the refractory failure, depending on where it is failing. Typical understanding comes from a visual inspection and measurements from a distance randomly. Invariably it happens that when companies see the red-hot embers coming up on the metal wall, only then do they realise that they are in a zone where they ought to be taking some serious risk measurement and preventive measures.

When thermal imaging was done, BPCL was able to look at the whole vessel, 60-70ft tall. They were able to see the temperature at different spots and conclude regarding the formation of red-hot spots. The second thing is that these are all very strenuous activities and access for human beings is also less. The ability to make it happen manually regularly is lower. When such tools are available, companies can do it any number of times in a month, even every day if they want to.

As an operator, one will act very conservatively and say that if they find a temperature change, they will reduce what it takes to bring that balance back, which could be a crude throughput of feed throughput or catalyst circulation rate. This finally ends up in production reduction. But if one can monitor every day, which is what is tried in most operations of process plants, one can maximise the asset's value by pushing it to the limits within the norms of safety. This provides a persuasive answer to understand in this context: what is happening to the asset if one is pushing to the limits.

One can realise whether one should be operating at a particular level or a bit lower than that. In most cases, we tend to be very conservative and push it down to a zone where we are very comfortable. So, this delta one can achieve through Detect products is a value that one can create. The reverse of this is that many times there is a choice of a turnaround to be done now ten months later. The management keeps debating on how risky it is to postpone in terms of the equipment status. Such tools make this decision very objective.

Q. In real-time, readings like temperature and pressure etc. are typically obtained by operators, which allow operator to control the operations, while this kind of data may be residing in some other silos. Is it possible to integrate both?

If one is in a position called advanced control optimiser in a process plant, one will be driving the plant to the limits within the present constraints. Besides the process-oriented things, which one cannot change but probably can decide where to operate between the operating and design limit, what is the gap and how to reduce that. That means that one can change the constraint controller to a different level on the parameters that one is monitoring. But more importantly, if one of those things, e.g., if regenerator temperature is the constraint in pushing the feed to the catalytic tracker unit, and that constraint is lowered in the advanced feed controller, the company will be losing throughput.

Normally BPCL does not do it online; it is offline that an operator can translate into a constraint controller. So far, using asset managed integrity tools to run a plan directly online optimisation hasn't been tried. But the interface is not so excellent as one gets data on the panel. If the operator is good, he can always take advantage of that. But in a process plant, BPCL usually has a consensus from a process technologist, operating team, and an inspection team. So, it does not allow such things to be put directly on online operations. But it could be a semi-online tool.

Q. For asset tracking industrial IoT sensor, how familiar are you with the product GUMPS™? Where can it be used?

Mr Ramachandran is familiar with the product. Very simply put, this is an online corrosion monitoring tool. The industry hasn't had online corrosion monitoring till the advent of such systems, which is very recent. What used to happen in process industries – refineries, petrochemical plants, gas plants, upstream, downstream – environment largely related to corrosive fluids, is that companies used to take samples of liquids which are emanating from the process and analyse in the lab for corrosion product like chloride, acidity etc. This was old- world practice. The next level of change happened when they started inserting coupons of appropriate metallurgy at a point on those lines and getting those coupons to be looked at during a turnaround. This was used to measure at what rate the change was happening.

The third level of change came when they could find solutions to make retractable coupons that could be removed from the process online. Then they started increasing the frequency of measurement of those coupon corrosion rates, and this practice is currently prevailing. Detect's a product brought it into the picture because they brought it online, and secondly, they got not spot measurements but reasonable length measurements. Practical length measurement means measuring process plant pipelines and not long-distance transmission or product transportation pipelines.

For process pipelines, 50-60m is a significant pipeline length for a particular service operating in an environment. Then the environment may change with a change in the state of the fluid, say from gas to liquid or vice versa. GUMPS™ gave BPCL an opportunity for continuous measurement of corrosion in a hostile fluid's environment. This product is primarily used for process industries currently. What is the significance – when this corrosion was happening, BPCL didn't have tools to measure run lengths of corrosion and was only able to get spot data and that too on an infrequent basis. This tool allowed them to monitor continuously, and they started using this as a defensive tool. There have been many incidents worldwide where the corrosive fluid has eaten into the pipeline, and the operator hasn't understood it.

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They can position this product on pipelines suspected of having corrosive fluids and have a continuous measurement of what is happening within the pipe for a significant distance of 50-60m unless it sees some bends or walls. Most of its applications are on overhead lines till they come to an exchanger or something, so such obstructions are rare. So, these are uninhabited and undisturbed

pipeline lengths. Therefore, what happens is that by measuring this continuously, they are assuring themselves of the asset integrity, and this is how it was started as a defensive tool.

The second level of interest came when – this is more to refineries and petrochemical plants – BPCL was able to look at different feedstocks into a particular unit. There are different types of crudes, and other feedstock with high or low H₂S content, naphthalic acids, fluoride corrosions, and units are designed for certain limits of these parameters. In course of time, they do not know whether they are valid or not because base conditions are also changing. So, when they are able to measure this on a regular basis, it goes back to the same thing – monetizing by pushing the plant to its limit, in this case, it's the process fluid.

A good example is the crude unit, where processing of different crudes at different sulphur levels, ammonia levels and H₂S levels is done. Plant may have been designed 20 years ago for 1% H₂S, but they need to know currently how much it can operate on and whether corrosion is happening or not. So, when they are able to measure on a continuous basis, they can get confidence on usage of different crudes they buy with different levels of particular parameter limits, as the more complicated the crude, the cheaper it is. The whole business of running the refinery is to buy the cheapest crude possible and try to get the products needed with the lowest cost. Then from the defensive, they became more aggressive to look at how they can take advantage of this data. So, they started looking at how they can improve their performance.

The next thing they realized was about chemicals being injected to neutralize these things. BPCL was being assured by chemical vendors that when they inject these chemicals, many of which were quite costly, the corrosion rate control will be less. But 3-4 years down the line when they opened up the plant, they would not be happy and would fight with the vendors, leading to a dispute or sometimes there could be a safety issue. Today, what is happening is that they are also able to parallelly monitor what is happening to the thickness of the pipeline with the injections which are there and then they can optimize those injections also. The vendor may be telling the company to inject 100ppm when 10ppm is sufficient. These sorts of opportunities are being created by Detect's product.

BPCL used this data to question a particular supplier of crude. The company had purchased crude from Brazil and that crude failed badly in one of its plants because it corroded. The crude supplier was Shell, who said that there was nothing wrong with the crude. Then BPCL actually found out that it was not a crude supplier but the trader who was injecting pour point depressants to improve fluorides, was also injecting some chemical which caused the failure. Therefore, there are immense possibilities for the products, depending on the ability of the customer to be leveraging the technology and ability of Detect to keep on improving domain expertise.

Q. Are these products also useful in larger things like kilns that are used in cement industries where there is fair amount of monitoring of kilns needed? Is there a limitation on the diameter?

Currently, GUMPS™ has been used from 4 inches to 48 inches. The patented material on which the sensor has been built can go up to 70 inches in diameter. Still, kilns have a higher diameter (2-3m) and operate at a higher temperature. The operating temperature is around 400 degrees and has a big refractory. It is not specifically for that location, and hence Detect is focusing more on pipeline application.

Q. Is there some work already ongoing for water pipelines – looking at corrosion in water pipelines?

In pipelines, there are two perspectives – in some cases, if there is water leakage, people may think that amount of loss is less and may use simple techniques like stopping by sealants. But suppose a

a water pipeline is associated with a pharma unit where the water pipeline is critical for the process. In that case, even small leakage will impact their production. In that case, they are also interested in deploying Detect's solution. In the end, it comes from the value or loss that customers may incur because of leakage. Water leakage is a critical process that can have a direct impact. Still, civilian usage would not be considered of that much value because they think there are cheaper options to close the leak or are ok with the leak happening. So, it differs from an application perspective.

Till now, Detect largely touched upon and started with deploying in the Oil and Gas industry. With more and more adaptability, the idea is that it will be expanded to other sectors like steel pharma. Detect has started getting footprints in these different sectors. With all the case studies and success, they are getting from critical factories, they are looking to expand into other process units. For every processing company, safety and productivity are vital, and these solutions are directed towards applications in those areas. So that's the primary forward path where Detect is going ahead. The company is expanding into different regions and different kinds of environments, and other sectors where they can directly add value.

Q. Does Detect help in giving any additional information for effective decision making for the operator in real-time?

Most of the examples given above are real-time decisions – examples of flare operation, hotspots measurement in the regenerator, and GUMPS™ to vary crude throughput (worse quality crude going to the unit). These are all real-time decision making using real-time data. T-Pulse™, which is used for safety, can help in real-time decision making in an environment where one is dealing with hazardous equipment. In a catalytic cracker unit, there is something called a vapour blind. This vapour blind is where companies allow the blind to be put in between oxygen and, on the other side, a hydrocarbon at high temperature. This is typically a cocktail for fire. The arrangement is always on tenterhooks when sensor activity is going on. Companies want to ensure that all SOPs are followed, safety conditions are followed, and precision at the insertion point. That is a typical example where this camera can give directions, support, and monitor such extremely complex real-time issues. There are plenty of examples like this – in the last 2-2.5 years, once BPCL understood the product, they started looking for applications and solutions in various aspects of operations and other activities. So, it will only keep on increasing. More the customer is knowledgeable about the subject and more domain knowledge of Detect increases by higher engagement or employment of specialists; we will see more opportunities. As they seize more options, they create more value for the organizations. Accordingly, we will see better prospects for Detect.

Further, the previous write-up read as they came with a product. Then, later on, they moved on to providing solutions to customers because a customer understands solutions more than products. It was not to say that Detect was inept. It was more to compliment them that, unlike many other people who are focused only on their products, Detect learnt about the customer companies. It shows the agility of the company.

INTERVIEW NOTE 2

Name: Prudhvi Teja

Title: Head, Business development, Detect technologies **Date of interview:** 4th September 2020

Q. In real-time, readings like temperature and pressure etc. are typically obtained by operators, which allow operator to control the operations, while this kind of data may be residing in some other silos. Is it possible to integrate both?

Not only from a process perspective but also to the next level where Detect uses this video equipment to improve the process plant, like if there is a truck loading planned in the loading bay and the truck has come from outside. There is not always a person available to monitor how much time it has taken to load the truck and the different activities. It could be in ports also where there are double charges in case of delays in loading and unloading. Using the same video analytics, Detect can see how much time it has taken for each milestone, and this is being updated in a real-time dashboard. So, there will be a real-time productivity measurement of every activity, and the company can plan the truck turnaround time. In case of delays, they can look into a delay in a specific action – it could be an operator-specific cause or environment-specific cause of delay so that further analysis can be done. Therefore, it can also consider productivity from other perspectives as well. Detect is working with ports or logistics companies to check where delays are happening and effectively reduce the time for container loading. The system is the same, but the application can be looked at from a monitoring and productivity improvement perspective.

Q. How frequently is the inspection done?

Earlier inspection engineers used to carry hand-held thermography cameras to take readings once a month and monitor manually wherever they could access. If they found any hotspots, the engineer would record that. However, this process didn't allow the company to record everything completely. Detect is doing a complete survey every three months with the drone.

After the reaction is completed in a reactor, the catalyst gets regenerated by removing CO. Hot gases generated in the process are used to recover power and then it goes through the stack. These types of equipment are critical for any cracking unit. To monitor them, Detect has created a digital twin of the unit. Periodic visual and thermal analysis is done using a drone, and all data is added on the same circuit. So, it is then possible to compare thermal profiles over time, and the management can regularly monitor critical portions or high-risk areas. In case of any hot spots found, management can plan for an emergency or early maintenance shutdown, and then thickness measurements can be taken during the turnaround.

INTERVIEW NOTE 3

Name: Rajkumar B & Shubham

Title: Lead, Application, Detect Technologies & Lead, Operations, Detect Technologies

Interview date: 27th January 2021

Q. How do you usually assess the requirement of a client?

Whatever we have as products and services are unique products. We identify problem statements that are common across all process industries. We apply these in specific sectors and modify existing solutions as per the client's needs. For example, T-Pulse™ is our safety surveillance module, and it doesn't have any particular problem statement. Safety violation during turnaround was addressed by manually deploying safety officers on the site. No other solutions have been implemented for this issue. Controlling safety violations has always existed, and there hasn't been a

proper solution for this problem. If we apply our product in this problem statement, we have a suitable solution, and that is how T-Pulse™ was used for this particular purpose. The solution is designed as per the client's requirements.

Q. In terms of identifying the problem statement, is a visit conducted in the facility or does the client come up with problems to you for which you provide solutions?

The general process is that the client comes up with a problem statement. We visit the site, assess other client sites, find out other existing problems, and offer them better insight into what further improvements can be made. Both are done; when clients come up with a problem statement, we expressly do a site visit for that problem and look at other issues.

Q. Predominantly this is a combination of multiple products. For instance, for pipeline monitoring, you use a particular product, other than that how do you implement other products in the industry?

All these are common problem statements that exist in all process industries. Let's go into a particular pipe monitoring segment. They might also have other requirements, such as safety module problem statements in the facility, so we combine our solutions.

Q. So, I've also noticed that many of your clients are large process industries like oil and gas or manufacturing plants and other government entities. They also approach your competitors with the similar problem statements. What are your USPs that you use primarily to get a hold on the market?

I'll give you a recent incident in which we worked with xxxx, one of the world's largest oil and gas manufacturing companies. When we had to execute our products, we found out about competitors who provide similar solutions but do not provide complete solutions. For example, if we take T-Pulse™, other similar products install cameras for surveillance. Still, they might not have an informative dashboard like us, or they might not have the live monitoring module that we have. So, there are competitors with similar products, but they can't provide complete solutions as we do.

Q. Who do you think are the major competitors in this market for you who provide similar niche solutions in the market?

I'm not sure about the name of the competitor companies. Still, few companies provide similar products for surveillance and do asset inspection, but they don't offer complete solutions as we do, or they don't provide end-to-end service. They don't add AI in their module; they don't do customisations; they don't provide complete service support after the sales. One of our USPs is that. As well as our solutions are unique and attack the core problem statement of the industries.

Q. When we talk about USPs, is pricing also a standard thing that you try to project, or in other words, do clients understand the cost benefit of deploying your products?

Let's retake T-Pulse™. We submit a final report which has different modules. What equipment needs optimisation, which particular site has to be optimised, how many people have to be deployed to reduce their cost, and other details are included in the final report that indirectly gives the client a cost-saving factor and gives them a standard benchmark for the next turnaround.

Q. Generally, what is the most common problem that clients come up with. Are they looking at asset monitoring or people safety or any other issues?

Let's take a particular facility, BPCL Kochi refinery. It consists of multiple components like chimneys, tanks, pipelines, and other equipment. They need drone inspections and GUMPS™

sensors for a pipeline, and during turnaround, for maintenance activity and other work. So, at different times, they have additional requirements. It's not like the client is focusing on one particular product. For example, turnaround takes place twice a year or thrice a year, and they use T-Pulse™ at that time. Similarly, if they need to monitor pipeline 24*7, they use GUMPS™ sensors, and there are different products as well, so they try to opt for another solution at different times.

Q. Is there a standard timeline for the contract? Is it for a year or 6 months?

There are 1 time inspection and contracts, as well as annual contracts. The business team would have a better idea about this, but it would be lesser than the usual prices.

Q. In terms of timeline of deployment, is there an expectation from the client side that the deployment must be done within a particular period of time and have Detect been able to meet that timeline?

Definitely for shutdown and turnarounds, there is a timeline. The client usually informs us a month before or 1 and half month before the shutdown. There are lots of things before the shutdown like a site visit; cameras need to be setup, people have to mobilize and Detect has always been able to match with the timeline even for deployment abroad; people have been able to move to the country. For example, there was a recent deployment in US, for which people have been able to move to US, setup everything successfully. So, we've been able to complete it within the timeline.

Q. What is the usual team size for the deployment of a product in client facility?

There are different teams involved in the deployment. One team works on-site, and the other team works from the office to provide support to the on-site team by gathering data and other works. It depends on the unit size and the number of equipment involved. For a smaller plant, it would require around 10-15 people.

Q. What is the success ratio in terms of client conversion?

I'll tell you from my experience. Talking about T-Pulse™; it started on 2018 June and so far, we've been successfully delivering all of the projects. We've also had lots of demos. Lots of these demos were converted to main projects and we are right now scouting the global market looking at clients from middle east, north America, south America. As to success ratio, I would say, there hasn't been no major failures that I've noticed and many of our demos are converted into main projects, and we are working on them as well.

Q. How quickly can a competitor find a replication of your product? Can your products be copied by competitors, and can competitors provide similar services like you?

Answering that question, it's a total combination of different modules and different teams. It isn't something that can be purchased and fixed; it involves lots of processes. There are many steps like setting up the camera, internet availability needs to be checked, people on-site and in-office will have to coordinate to process the data stored in the cloud platform. There is a lot of steps that are involved. It can't be purchased from the market, and it doesn't include one particular piece of equipment, but it has a whole process. It might look simple from an outer perspective, but it consists of multiple steps and processes.

Subham: I just wanted to add here that our solution consists of the ecosystem of products. What it looks for a client might be particular products. Still, as a whole, if we consider the whole value chain, considering the hardware on the ground, the software component being processed on edge or the cloud, the dashboard component can host entirely on the cloud. These components are flexible at the same time. They complement each other as a part of an ecosystem, and we are continuously expanding this ecosystem. This is how we are ensuring an edge for us in these sectors.

Q. Do you get a lot of referrals from your clients? Do they give repeated business opportunities?

To support that statement, I can tell you that over 4-5 years, we have been able to cover the complete Indian market, including multiple states and multiple industries. Our clients - BPCL, HPCL, ONGC have referred us to other partners and due to which we've been able to spread out in the country. This also gives us courage and conviction to expand to the middle east, north American and south American market. We've made a global contract with shell which started from our shell facility in Bengaluru. This global deal is a 21 million USD deal which we've signed, and we are going to deploy in all the shell facilities across the globe. We are the first Asian assistive tech company to sign such a deal.

Q. Is shell your first international client or are there other international clients before?

Shell is our first major international client if we consider the magnitude and scope of the project, but this isn't the first one. We've done projects from Southeast, Singapore, Malaysia, and the Middle East. Additionally, we have done projects for Exxon in North America and also for other clients.

Q. What are Detect's plan for the future, what new sectors can you enter into? what other products that can be researched and get engaged in?

We don't focus on a specific problem statement, rather we try to focus on problems that are common across all industrial processes and that is how we've come with these products. We continue researching on different problem statements, and when such problem statements come, we don't leave it as such; if our solutions can't cater to a particular problem, we take it to the R&D and try to come up with a solution for that particular problem(s). That way, we try to address that problem statement within a year or two and try to come up with solutions.

Q. Why do you think it would be replicate the whole process and create a similar ecosystem of products?

Let's take T-Pulse™ as an example again. As I said, the process doesn't stop just after installation. Instead, the setup must be there for the next 30-60 days; the data has to be collected, and the processing has to be done on cloud or edge continuously for the next 60 days. Hence it is imperative to have continuous support, power supply, and coordination to make the whole process successful. It's not going to be like purchasing a product, setting it up, and the process is done; but it involves all the processes, from the camera to the dashboard to the client's laptop, and I think no one has done something like this yet. People might generally get live streams or have relayed the data to a particular website before. Still, on top of this data, there is an algorithm running in the cloud that detect all the violation that happens on the site. No one has done it yet, and that is our core competency. Even if someone replicate the camera and the dashboard, the algorithm which we've trained over 300TB's of data in the cloud can't be replicated or purchased! So, with that, we can tell that it won't be possible to replicate our product for at least a decade.

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