Validation testing of the APT-796 (Area Preparation Tractor)

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Building a community of practice is not an easy task but would ensure that mine action technology moves forward in terms of cost effectiveness and deminer safety.

..., the low probability of getting past the research stage to a production prototype, ...

Perhaps the most important question to ask is why millions of dollars is available for research into technology that is unlikely to succeed ...

It’s time to end the current situation where huge expenditures have achieved so little, and technology research continues to deliver poor value for money.
Generally, the demining market is always so small that

- Either commercial viability requires a product to have uses outside demining
- Or cost must be very high compared to similar equipment for a (normally) wider market → special machines

Role of donors

- Demining projects funded by donors: donors influence on choice of the equipment (by country, manufacturer)

A very conservative environment

Until today

- Minor feedback from demining agencies/companies back to donors on preferred methods and equipment
- Poor transfer of new technology from researchers to machine manufacturers and demining agencies/companies
- Slow innovation
TARGET DEMINING MARKET

Machines on the market (for on site processing or preparation operations)
• Almost all for use in demining only, a few converted plant machinery but these not commercially available
• Commercial machines designed to intentionally detonate mines
• No truly flexible or multiple-use machines
• Autonomy or even partial automation far off and not currently wanted.

Room to innovate the operative procedures in use
• But suitable equipment should come at the same time

Similarity with agriculture and construction to be exploited (especially agriculture)
• Demining equipment adapted from mass manufactured equipment

But you have to choose the right machine to adapt

Ideally there should be room for back transfer of technology from the demining application back to the application of origin
**SEEN BY THE DEMINING USER**

**Other advantages of a larger market**

- Not only cost (of the equipment)
- Reliability and stronger continuous product and process innovation with no influence on cost
- More people and more ideas involved
- More case history
- Lower cost of spares and support
- Network of dealers and suppliers already developed and with costs distributed on a higher number of units
- More sensitiveness to technological development and more open to transfer from pure research

**The demining user wants more than in the machine of origin**

- Teleoperation and driving assistance. Armouring. Special wheels allowing it to roll over live mines. Georeferencing and off/online planning.
APT – Area Preparation Tractor

APT is a flexible multiple-use carrier for area preparation in humanitarian demining

- All features of a vineyard tractor (agile, simple, robust, effective)
- All additional features to operate in mined areas, especially in forest and on slopes
- Designed to assist manual deminers by cutting undergrowth and preparing the ground surface in advance of Technical Survey or area clearance
APT – Area Preparation Tractor

- Radiator
- Engine
- Fuel and hydraulic fluid
- On-board driver controls
- Left access hatch
- Forward
- Mulcher
- Chain curtain
- Right access hatch
- Forward
- Vegetation guide
- Radio control antennae
- Diesel primer access
- Mulcher skids
- Three-point linkage
- Chassis articulation
APT – Area Preparation Tractor

Produced by a tractor manufacturer established more than 100 years ago

- Uses an agricultural chassis
- Low cost with low maintenance cost (cheap spares)
- Low skills to operate it (basic training of an operator in a few hours)
Associated with the agricultural market (wider, with many players and tough competition compared to the demining market)

- Faster continuous innovation. Rate of development iterations as agricultural machines
- More use-records and case history. More people and more ideas involved
- Network of dealers and suppliers already developed and with costs distributed on a higher number of units
- More sensitiveness to technological development. More open to transfer from research
- Immediate access to a wide set of tools and implements used in agriculture
APT – Area Preparation Tractor

It can drive over roads like an agricultural tractor (can be registered and have a plate for circulation on public roads)

- Standard tires quickly mounted on the blast resistant wheels
- Easy transfer from camp to operational area at up to 36 km/h
- Can be remotely operated and also driven from on-board like a normal tractor
- Can carry a trailer with anything inside: equipment, materials, tools
APT – Area Preparation Tractor

Unpaired agility and flexibility of use

- Can climb mountains and work while doing so
- Can maneuver tight between obstacles (trees in a forest)
- Can carry different tools for site preparation: for ground processing as well as for vegetation cutting
- Can carry sensors and equipment for detection and data collection
- Can carry a stretcher
APT – Area Preparation Tractor

Can carry any tool in a range of mass and size

- Standard agricultural three point linkage, PTO, hydraulic pump and hefty generator allow fitting with a very wide range of commercially available agricultural and construction-site tools. (1.7 ton lift; 1 ton at 1 m offset.)
- Bolting flanges and tow hole at engine front and engine and cab sides
- The main tool is a mulcher for cutting of vegetation
- Can carry sensors at all sides (GPR array widely tested; large loop detectors)
APT – Area Preparation Tractor
APT – Area Preparation Tractor

Armored and with blast-resistant wheels

- Protected against blast and frag mines (survivability in Croatia with PMA-1A, PMA-2, PMA-3, PMR-2A, PROM-1)
- Mounts special wheels designed to resist and damp the energy of a blast (preserving driveline and chassis)
- Redundancy in the remote operation systems for high confidence that it always gets out the suspected area by remote operation after any blast
APT – Area Preparation Tractor

Setup with mulcher specifically tested

- Mulcher design specific for use in hazardous area: derived from a forest mulcher for chopping of undergrowth and small trees
- Carbide teeth with virtually no need of maintenance or replacement also in presence of stones
- Tested with blast and frag mines
- Tested for overall resistance, resistance of rotor assembly and teeth
APT – Area Preparation Tractor

Simple operation and interfaces

• Simple but complete set of commands in the robust (industrial grade) remote controller
• Additional commands in the remote controller to operate different implements (fully customizable on user needs)
• High-level functions for easier driving (load sensing hydrostatic drive, speed control on tool power requirement, self adjustments)
APT – Area Preparation Tractor

Market availability

• **The APT** model tested on 2015 by CTRO is available after a final set of improvements decided during the certification.
• It is for cut of vegetation below 5 cm diameter, for any handling and delivering operation on suspected area, to carry sensors.
• Example use is in forests over hills (even very steep) to cut the undergrowth around trees, to carry a magnet, any sensors, and to move equipment: in this it is unpaired by other machines on the market.

• A **heavy-duty model** is in preparation and expected to undergo certification in Croatia on 2017.
• It is for cutting of vegetation up to 10 cm diameter, with higher payload and tool carrying capacity, up to 140 hp engine, and same architecture and agility as the current APT model.

• Both machines are highly customizable, with the possibility to adapt to specific tools, specific weather conditions, specific terrains.
APT – Area Preparation Tractor

The family of machines of the APT-796 (the technology back transfer)

→ P796v evo
   Agricultural onboard driven new base-machine with improved performance and hidden self management (onboard control architecture)

→ P796v evo RC
   Like the P796v evo + Driven onboard and from remote. Slave ready. Tool plug-and-use ready. Driving assistance. 30% more expensive than the base version

→ APT-796 (Area Preparation Tractor)
   Like the P796v evo RC + Toughened with armoring (for frag mines) and blast resistant wheels. GIS functions (available as optional on the P796v evo RC). Onboard diagnostics and recovery procedures. SOPs. A set of tools selected for area preparation in demining. 45% more expensive than the RC version and 85% more than the base version – half the cost of the cheapest alternative on the demining market

[PIERRE Trattori as machine manufacturer + KOHLER Engines as engine manufacturer + University of Genoa as system designer and engineering + FAE for mulcher tool]
APT – Area Preparation Tractor

Developed under the EU supported TIRAMISU research and development project with guidance of independent demining experts and of end-users and staff of the Centar Za Testiranje, Ravoji Obuku (CTRO - Centre for Testing, Development and Training).
**Steps and the Background**

- 2004 and before: concept design and attempts at making blast resistant wheels with layered architecture
- 2005, Sri Lanka: attempts to make demining machines out of agricultural machinery
- 2010, Italy: the Locostra project and the idea to convert the machine back to agricultural use afterwards. First proof of concept
- 2014, Burma: application of the idea of agricultural to demining and wayback (two-wheel rice tractor)
- 2011 to 2015, Europe: the Tiramisu project and the way to a competitive commercial product. The APT-796 machine with FAE mulcher

Development of the paradigm: from *converting back the machine to agriculture* to parallel product development and tech back transfer from demining to agriculture (parallel exploitation of the technology)
• Above, the teleoperated Locust in Florida in 2002 – it was only ever a concept piece

• Right, the Groundhog in Myanmar/Burma during 2014 – made for a single job, it is now back in use as a two-wheel rice tractor

• [http://www.vimeo.com/102096029](http://www.vimeo.com/102096029)