This is the template for the 1 page proposal (500-600 words) that presents a solution (new usage or suggest improvements on a new technology).

If your proposal is selected for the second stage of the Challenge, you will be asked to expand the description to 10 pages (5000-6000 words) which should be a development of the previously submitted proposal.

IMPORTANT: Students are strongly encouraged to team up in pairs, finding a partner in a different university or country. Teams will get an additional point in the final score.

A fresh view is valued. Please, defend your proposal by including not only technological, but also socio-economic, political, ethical and/or environmental aspects.

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Scenario specific demining

European Defence Challenge V

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Introduction

Right now, more than 180.000km^2 of the territory in Ukraine is contaminated with mines, and by continuing the current decontamination processes, it will be decades before Ukraine are successfully decontaminated. A new approach to demining is therefore a crucial step towards a safer tomorrow for the Ukrainian people and many more.

According to United Nations Development Programme in October 2024 there were a little more than 4000 deminers in the entire country and more than 2 million mines, which results in a real challenge for Ukraine. (United Nations Deveopment Programme, 2024)

This report covers scenario-based solutions for demining specific anti-personnel mines used in Ukraine, such as pressure-activated mines (PMNs) and tripwire-activated (POM-2). Ukraine has mainly been contaminated with at least 13 different types of mines (Human Rights Watch, 2023), but through our interview limited it to the PMN-2 and the POM-2. Our solutions focus on military and humanitarian demining in mainly forest areas or other poorly accessible areas by either activating or neutralizing the mines. The solutions do not include the detection of mines, solely the demining and neutralization of already located mines.

Our solution will focus on a cost-efficient way of demining the aforementioned anti-personnel mines, with the possibility of a large-scale deployment. If the demining equipment is being utilized accurately it will be possible to re-use said solution.

By developing a simple solution, we aid Ukraine with the opportunity to produce the equipment locally, making it possible to deploy the equipment faster without being dependent on other nations. We envisioned that a further investigation into the main producers of metal parts in Ukraine could be sufficient, to make them produce some of the parts. However, this idea might require small iterations on the current manufacturing processes for the companies in Ukraine.
We strive to create a solution that requires minimum training for the user, enabling more people to help in the demining process.

As a conclusion for the report many different aspects will be discussed to further enlighten the reader.

Scenario 1 – (PMN)

"A PMN mine has been located in a poorly accessible area underground and needs to be cleared."

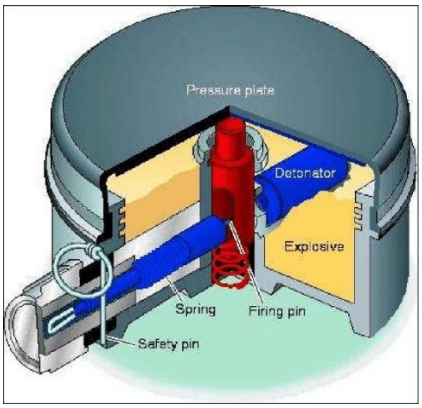

Figure 1 - PMN-2 mine cross section

The PMN mines are pressure-activated and require approximately 2 kilograms of pressure to trigger (Nations, 2024). When sufficient pressure is applied, the detonator is activated, setting off a smaller explosion that triggers the main charge. Although PMN mines are not highly sensitive, they can be approached if spotted in time (Oliver Yanz, 2024). This provides an opportunity to set up a safe, controlled solution around the mine. In this scenario, three methods have been developed to utilize the pressure activation system of the mine for safe detonation:

1. Bullet Trigger
2. Water Trigger
3. Spring Trigger

Our solution consists of three main components: the **trigger mechanism**, the **frame**, and the **trigger interface**.

Frame

The frame is constructed of metal rods, designed to securely surround and support the mine-clearing setup. It can be easily assembled around the mine in difficult-to-access areas, providing stability and ensuring the trigger mechanism is positioned accurately above the pressure plate of the mine.

Trigger mount

The trigger mount is mounted on the frame and serves as the platform for installing any of the three trigger mechanisms. It is designed to be simple and cost-effective, likely constructed from wood or biodegradable materials. This is because the interface will be destroyed during the detonation process, so using environmentally friendly materials minimizes waste in the field. The interface contains a cylindrical slot into which one of the trigger mechanisms is installed, depending on the conditions of the specific demining scenario.

Trigger Mechanisms

Each of the three trigger mechanisms is designed to safely apply the necessary pressure to detonate the mine, each with a unique method. The appropriate trigger mechanism is selected based on the environment, available resources, and other operational factors.

1. Bullet Trigger

The bullet trigger uses the kinetic force of a bullet to safely detonate the mine. This mechanism consists of a cylindrical holder that accommodates a standard military bullet (preferably the most commonly used caliber in the area). The ignition system is designed to fire the bullet directly into the mine's pressure plate, applying the required force to trigger the mine. The use of bullets is advantageous since they are readily available in military zones and cost-effective. The trigger mechanism is operated remotely, using a wire connected to the ignition system to allow safe detonation from a distance. This method is ideal in scenarios where the quick deployment of available materials (like ammunition) is a priority.

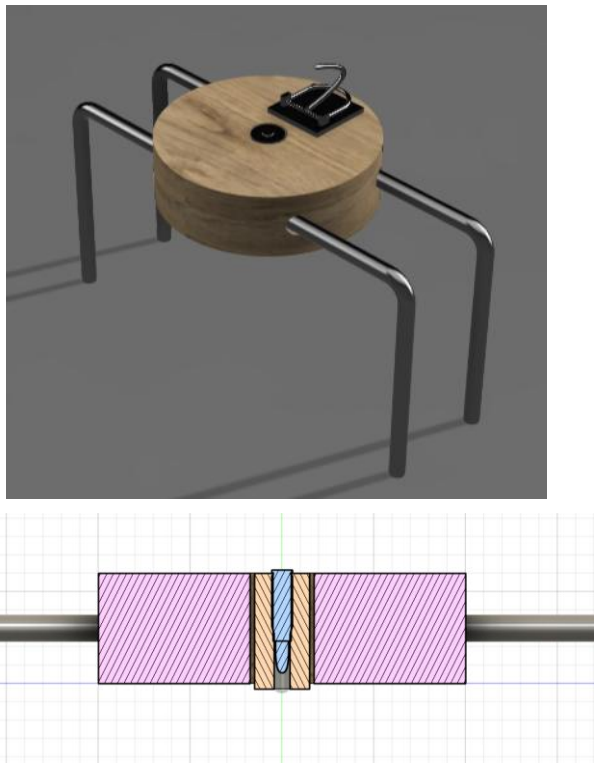

Figure 2 - Bullet Trigger Solution 3D & half section view

2. Water Trigger

The water trigger uses a high-pressure water jet to trigger the mine's pressure plate. The mechanism consists of a cone-shaped mouthpiece that fits into the trigger mount. This mouthpiece focuses a stream of high-pressure water directly onto the mine's activation point. A high-pressure washer or similar equipment would be required to generate the water jet. This method is effective in situations where water is available, and it avoids the use of additional ammunition.
However, it requires access to a high-pressure water source and may be less portable compared to other options, making it more suitable for scenarios where weight and transportability are not major concerns.

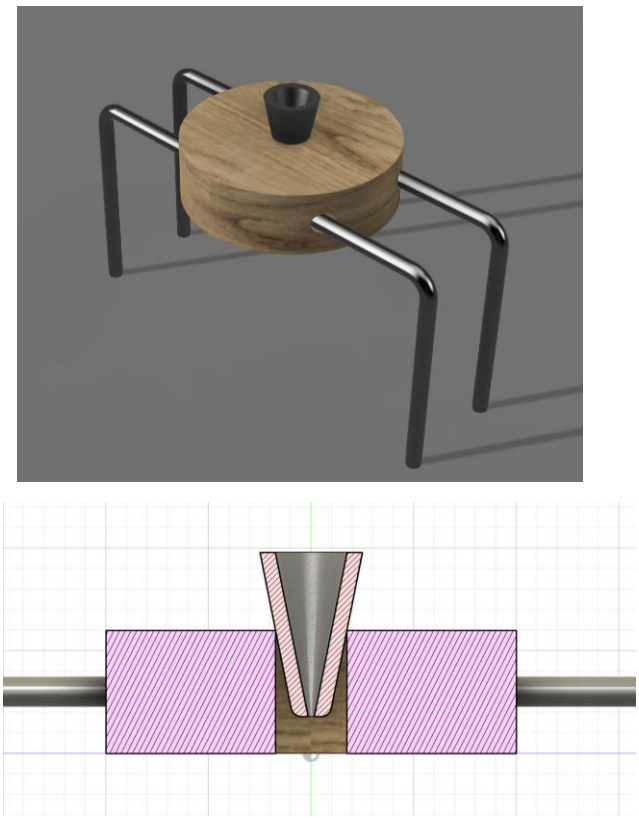

Figure 3 - Water Trigger Solution 3D & half section view

3. Spring Trigger

The spring trigger employs mechanical force from a loaded spring to activate the mine. The spring is held under tension within a priming device, which locks the spring in place until it is triggered. The device is installed in the mount, and like the bullet trigger, it is operated remotely via a wire connected to a release mechanism. This option offers a reusable and compact solution, as the spring can be easily loaded and reset, making it useful in remote areas where resupply might be limited. The spring trigger is particularly advantageous in situations where neither bullets nor water are readily available.

Additional Considerations

Each trigger mechanism has unique advantages based on the specific demining situation:

- **Bullet Trigger:** Quick and cost-effective in areas where ammunition is abundant.
- **Water Trigger:** Non-destructive and reusable, ideal where a reliable water source is accessible.
- **Spring Trigger:** Lightweight and versatile, perfect for areas with limited resupply options.

Before deploying these methods in the field, testing will be conducted to determine the reliability and safety of each mechanism in various conditions, ensuring that the most effective solution is chosen for each specific mine-clearing scenario. By providing multiple trigger options, our solution is adaptable to different environments and operational constraints, maximizing flexibility and efficiency in demining operations.

Scenario 2 – (POM-2)

"A POM-2 mine has been located in a forest area and shall be neutralized."

This product is a remotely activated, **harpoon-like** tool designed to safely detonate a POM-2 mine from a distance. The POM-2 mine is a **tripwire-activated** antipersonnel mine, notorious for firing deadly **fragments** when detonated, posing significant risks to nearby humans (Evans & Seddon, 2022). To address this, our solution utilizes a method to forcefully activate the mine's tripwire mechanism at a safe range, ensuring the mine detonates remotely without putting anyone in harm's way, as it only requires 300g of weight on one of the tripwires to detonate (Evans & Seddon, 2022).

Main components

The main tool resembles a harpoon, designed to be launched over the mine from a safe distance. It is equipped with a modified hook, the critical component that interacts directly with the POM-2 mine's tripwire. Once the hook contacts the tripwire with sufficient force, the mine is activated. Attached to the hook is a string that, once the harpoon is fired, can be pulled so that the hook gets dragged across the ground, catching on to one of the tripwires. This motion forces the mine's tripwire into activation, triggering the explosion at a safe distance.

The most significant risk posed by the POM-2 mine is the fragments fired within its blast radius. The harpoon hook is the only part exposed to the blast, ensuring that only this component would be potentially damaged. The rest of the device remains undamaged and functional for future use. The harpoon is designed to launch from a distance that allows for a safe buffer zone. The POM-2 mine's blast radius is approximately 16 meters to be lethal (Oliver Yanz, 2024), so the harpoon's firing range will ensure the operator stays well out of the danger zone while still activating the mine.

Operation Process

1. **Positioning the Harpoon**: The user, positioned at a safe distance, aims the harpoon slightly above the POM-2 mine.
2. **Triggering the Tripwire**: Once the harpoon overshoots the mine, the user pulls the string dragging the hook along the ground, where it comes into contact with the tripwire.
3. **Activation and Neutralization**: The tripwire is activated, causing the POM-2 mine to detonate. As the hook and the string attached to the hook is the only parts of the device near the explosion, they might endure minor damages, while the rest of the equipment stays intact and functional for future use.

Design considerations and safety

The remote activation feature is the most significant advantage of this system, as it enables safe demining operations in areas that are too dangerous for personnel. The operator never needs to approach the mine directly, significantly reducing the risk of injury or death. This system is designed with modular components: the harpoon, the string, and the hook. If the hook becomes damaged, it can be easily replaced, ensuring the system remains functional for multiple operations. This makes the tool cost-effective and easy to maintain. While some basic training is required for proper use, the design is kept simple, making it accessible to operators with minimal technical expertise.

The simplicity and reusability of the design, combined with its ability to activate mines remotely, could make it a beneficial tool for large-scale demining operations in Ukraine for this specific mine.

Scenario 3 – Disabling

"A mine has been located in an area where demolition is undesired and needs to be disabled."

In this scenario, we focus on mines that incorporate metal detonators or springs within their trigger mechanisms. Many mines contain detonators that are heat-resistant to some extent but rely on a smaller detonation to set off the main charge (Oliver Yanz, 2024). Due to this, the concept behind this scenario involves using controlled heat to disable the mine's internal components, making it safe without triggering the main explosion. The proposed solution involves applying heat, using either an **acetylene torch** mounted on our solution or a **remote-controlled vehicle** equipped with a heating mechanism, to safely neutralize the mine's triggering components.

This approach is ideal for situations where triggering a detonation is unacceptable, such as urban environments, critical infrastructure areas, or near sensitive civilian zones. The goal is to neutralize the internal components of the mine (specifically the detonator or pressure plate) by heating them to a point where they become non-functional, rather than detonating the mine.

The solution involves mounting the acetylene torch on a frame or remote-controlled vehicle, depending on the accessibility of the mine. The torch applies targeted heat to the mine's metal components (such as the detonator or spring), effectively disarming the mechanism without setting off the explosive.

Technical Considerations

The concept relies on the fact that the explosives used in many mines are stable when exposed to heat alone and only require a precise detonation to activate the main charge. By heating components like springs or metal detonators, it's possible to deform or weaken them to the point where they no longer function correctly, thereby disarming the mine. This method avoids the risk of causing an explosion while still neutralizing the threat.
While the method shows promise, testing is required to ensure its effectiveness across different mine types. Some mines are made from materials like plastic, which may not melt or deform easily when exposed to heat (Oliver Yanz, 2024). In these cases, careful testing is necessary to determine if the heat application will successfully disable the detonator or pressure plate without damaging the surrounding environment or causing secondary issues.

Other considerations include determining the optimal temperature and duration for heating, ensuring the heat is applied precisely to the mine's key components while avoiding any unintended side effects. Testing will also ensure that the mines remain stable throughout the process and that no accidental detonation occurs due to improper heat application.

Environmental and Operational Benefits

This approach offers several advantages in environments where explosion-based demining methods are not feasible:

- **Minimized Collateral Damage:** By disarming mines without causing explosions, this method reduces the risk of damage to surrounding structures, wildlife, or vegetation.
- **Stealth Operations:** The use of heat rather than explosives makes the method quieter and more discreet, which is important in sensitive areas or in close proximity to civilian populations.
- **Reusability:** The equipment (both frame and remote-controlled vehicle) is reusable, making this solution scalable and cost-effective for long-term demining operations.

Business case

Cost analysis

As described in the introduction, the solution must be cost-effective. Therefore, we compared the costs of traditional demining methods to set our goal for the unit's price. A traditional deminer costs between $300 and $1,000 per mine, which is far too high when considering there may be as many as 2 million mines in Ukraine (Halo trust, 2024). Our solution, at approximately €20 per unit, presents a significantly lower cost per mine. This low price point allows the unit to be single-use while still remaining attractive compared to traditional demining approaches. We have constructed a cost table (shown underneath) to show the investment required for different quantities of mines.

Mines / Trigger mechanism	Price pr unit [€]	1	100	1.000	10.000	100.000	500.000	1.000.000
Frame + Module	9,2€	9€	924 €	9.236€	92.362€	923.623€	4.618.113€	9.236.227€
Bullet trigger	8,7€	18€	1.790€	17.904€	179.036 €	1.790.358€	8.951.789€	17.903.578€
Water trigger	10,2€	19€	1.944€	19.437€	194.370€	1.943.695€	9.718.476€	19.436.953€
Spring loaded trigger	10,8€	20€	1.999€	19.986€	199.862 €	1.998.623€	9.993.113€	19.986.227€

While these tables focus on unit costs, other costs, such as investment in production equipment, tooling, overhead, and machinery maintenance, are not included in these calculations. However, these are expected to be minimal due to the simplicity of the product. Moreover, given the scale of operations, these upfront costs will be quickly offset as production ramps up. Based on our projections, the break-even point for these additional investments will occur after producing approximately 1000 units.

Supply chain management

One of the major advantages of our design is the flexibility in manufacturing. Parts of the unit can be produced and assembled locally in Ukraine or sourced from external suppliers. Manufacturing in Ukraine offers lower labour and material costs, contributing to a more affordable, adaptive solution over time. This also has the added benefit of supporting Ukraine's economy, creating jobs, and aiding the post-conflict recovery.

Alternatively, if a fast and scalable solution is needed, external suppliers can be used to ensure rapid production and delivery. This approach may help in the early stages when quick deployment is essential. As the situation stabilizes, transitioning to local production will provide a long-term, cost-effective, and adaptable manufacturing process.

However, potential risks, such as geopolitical disruptions in supply chains, must be considered. To mitigate these risks, we plan to diversify our supplier base and maintain stockpiles of key components to prevent production delays. Additionally, should Ukraine prioritize long-term cost savings and adaptability, setting up local production lines offers a more sustainable solution over time, ensuring the units can be customized to meet specific field needs and lowering overall costs as scale increases.

Conclusion

Our solution presents a cost-effective, flexible, and scalable approach to demining, particularly suited for large-scale operations like those required in Ukraine. With a unit cost of approximately 20€, the product is far cheaper compared to traditional demining methods, which can cost between 300$ and 1000$ per mine (Apopo save lives, 2025). The modular design, with multiple trigger mechanisms, ensures that the product can be adapted to various mine types and terrains. However, some limitations exist, particularly concerning the availability of required equipment, such as high-pressure washers or specific ammunition for certain triggers.

1. Ethics

The ethical implications of using our product must be carefully considered. The environmental impact of traditional demining methods, such as explosions, can cause significant ecological damage and affect civilian areas. Our solution aims to minimize collateral damage, with biodegradable materials used in the product design to minimize environmental impact. On the humanitarian side, the product has the potential to save lives, prevent injuries, and enable the safe return of displaced populations to their homes. However, it is crucial to ensure the safety of the personnel involved in demining and that the technology doesn't inadvertently harm them due to potential malfunctions or improper use.

2. Product Adaptability

Our product is designed with adaptability in mind. As demining technology evolves, new methods and materials may prove more effective. Our modular design allows for easy updates and improvements to the system. If more efficient or safer trigger mechanisms are developed or identified, these can be integrated into the product, ensuring that it remains relevant and effective in the long term. Continuous testing will help improve the design, ensuring that the product can be rapidly adapted to meet the changing needs of demining operations.

3. Testing is Crucial

Extensive testing in real-world conditions is necessary to validate the effectiveness and safety of our product. Field trials will allow us to assess how well the product performs across different mine types, terrains, and climates. Testing will help ensure that the product can reliably neutralize mines without unintended detonation and will also provide data to improve the product’s design based on performance feedback. In this project the main focus was on two mines (PMN-2 and POM-2). With further testing the presented solutions could have application for neutralizing a wider variety of mines (Human Rights Watch, 2023). Since there is 13 different anti personnel mines being used in the Ukrainian war. Having one solution that can neutralize a

wider ranger is preferable.

4. Safety

The safety of deminers is paramount. Our product is designed to ensure that operators can remotely trigger the mechanism from a safe distance, minimizing risk. Redundant safety features are incorporated to prevent accidental detonation or failure during the operation. Despite these safety measures, we must account for potential product malfunctions or environmental challenges that could affect performance. A clear safety protocol must be established to guide users in case of failure, ensuring that personnel can respond swiftly and avoid harm. Comprehensive training for deminers is essential to ensure that they operate the technology effectively and safely.

5. Drawbacks

While the advantages of our product are clear, there are drawbacks to consider. Some of the mechanisms, such as the water trigger, require specific equipment, like high-pressure washers, which may not be available in all areas. Similarly, the bullet trigger mechanism relies on the availability of particular types of ammunition, which may pose logistical challenges in certain regions. Additionally, the use of acetylene torches for disarming mines with heat is effective, but may not be suitable for all mine types, especially those with non-meltable detonators. These limitations need to be addressed through further testing and adaptation to ensure the solution is versatile enough for various scenarios. Scenario 1 and Scenario 2 revolves around actively detonating the mine, thus the exploded mine fragments could pollute the environment in the nearby proximity, as well as TNT producing many toxic by-products (Yang, Huan, Zhao, & Xi, 2023).

6. Environmental Considerations

Environmental impact is another critical factor in demining operations. Our solution, by using biodegradable materials in the trigger mount strives to reduce environmental degradation. When using our unit, the trigger mount will most likely be destroyed after use scattering its material in nearby areas, alongside fragments from the mine. Therefore, making it in a sustainable material will have less of a long-lasting impact on the environment. While the acetylene torch method could potentially have negative environmental effects, especially near sensitive ecosystems, using non-detonation mechanisms like the water or spring-loaded triggers helps minimize disruption. A thorough environmental impact assessment could be conducted to ensure that our solution does not create lasting harm to local ecosystems and wildlife. The DCI for the lighters also shows that improvements can be made toward sharing common items in their product systems. Both in using standard parts but also developing parts that can be used multiple times in many products.

7. Logistics and Scalability

Logistics will play a vital role in the success of deploying our product, especially considering the size of Ukraine and the scale of demining required. Efficient supply chain management is necessary to ensure that the units reach their destinations on time and in good condition, even in conflict zones with disrupted infrastructure. The scalability of production is another critical consideration. Our low-cost design allows for rapid scaling, which is essential for addressing the millions of mines in Ukraine. However, scaling production will require careful management of resources, including raw materials and manufacturing capacity, to meet the demands of large-scale demining operations.

8. Collaboration with Existing Demining Efforts

Our solution can complement, rather than replace, existing demining technologies. By collaborating with other demining organizations, including NGOs, militaries, and international agencies, we can create a more integrated approach to mine clearance. Our product could work in tandem with existing machinery, robots, or vehicles to enhance the efficiency of mine detection and neutralization. Since our solution is based on areas where mines are not easily accessible having other demining efforts is necessary to clear all of Ukraine.

9. Local Community Involvement

The involvement of local communities is crucial for the success and sustainability of demining operations. Training local deminers/combat soldiers and offering employment opportunities for those in affected areas can help build capacity and ensure that the knowledge of demining is practiced correctly. Additionally, educating the public about the dangers of mines and how to stay safe can contribute to reducing casualties and improving the overall effectiveness of demining operations.

10. Impact Measurement and Reporting

Finally, tracking the progress of demining operations is vital to understanding the effectiveness of our solution. Collecting data on how many mines are cleared, how quickly they are neutralized, and the cost-effectiveness of the solution will provide valuable insights. These metrics will not only inform future operations but also demonstrate the impact to donors, governments, and international organizations, helping secure future funding and support for continued demining efforts.

References

Apopo save lives. (2025, 02 20). *Apopo save lives*. Retrieved from About landemines: https://apopo.org/what-we-do/detecting-landmines-and-explosives/about-landmines/

Evans, R., & Seddon, B. (2022, August 3). *Explosive Ordnance guide for Ukraine.* Retrieved from www.gichd.org: https://www.gichd.org/fileadmin/uploads/gichd/Publications/GICHD_Ukraine_Guide_2022_Second_Edition_web.pdf

Halo trust. (2024, 11 20). *Halo trust*. Retrieved from Halo statement un US sending antipersonal landmines to Ukraine: https://www.halotrust.org/latest/halo-updates/news/statement-on-us-sending-anti-personnel-landmines-to-ukraine/

Human Rights Watch. (2023, June 13). *Landmine Use in Ukraine*. Retrieved from www.hrw.org: https://www.hrw.org/news/2023/06/13/landmine-use-ukraine

Nations, U. (2024, 11 11). *1*. Retrieved from United Nations: https://ask.un.org/faq/14489

Oliver Yanz, M. P. (2024, Oktober 20). Expert in combat mines. (J. M. Oldenburg, Interviewer)

United Nations Deveopment Programme. (2024, October 14). *In Ukraine, tackling mine action from all sides to make land safe again*. Retrieved from www.undp.org: https://www.undp.org/eurasia/stories/ukraine-tackling-mine-action-all-sides-make-land-safe-again

Yang, X., Huan, Z.-l., Zhao, S.-p., & Xi, H.-l. (2023). *Study on environmental pollution behavior/fate of ammunition soil and microbial remediation of TNT and its intermediates.* Beijing: Elsevier.