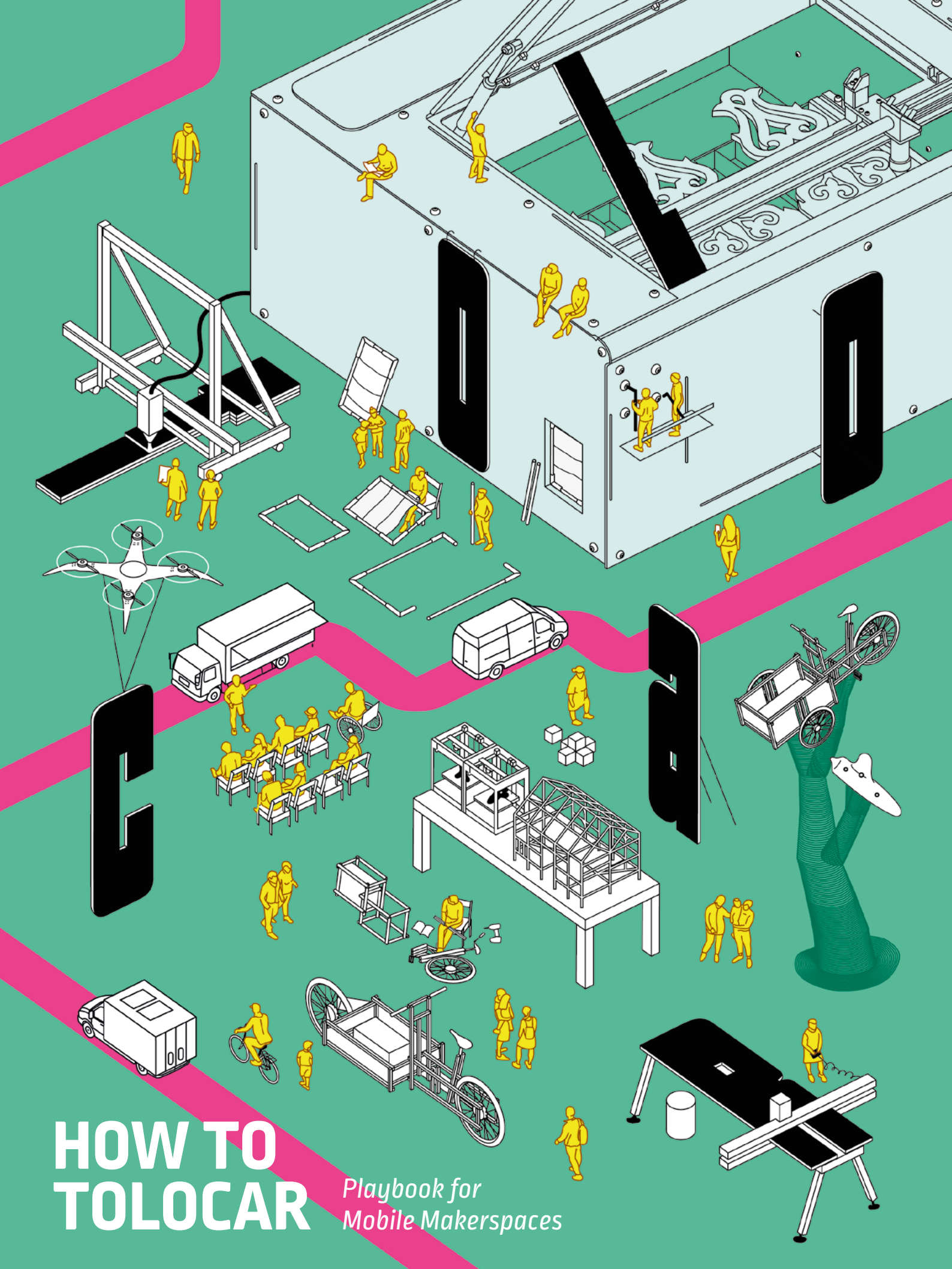

HOW TO TOLOCAR

Playbook for Mobile Makerspaces

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

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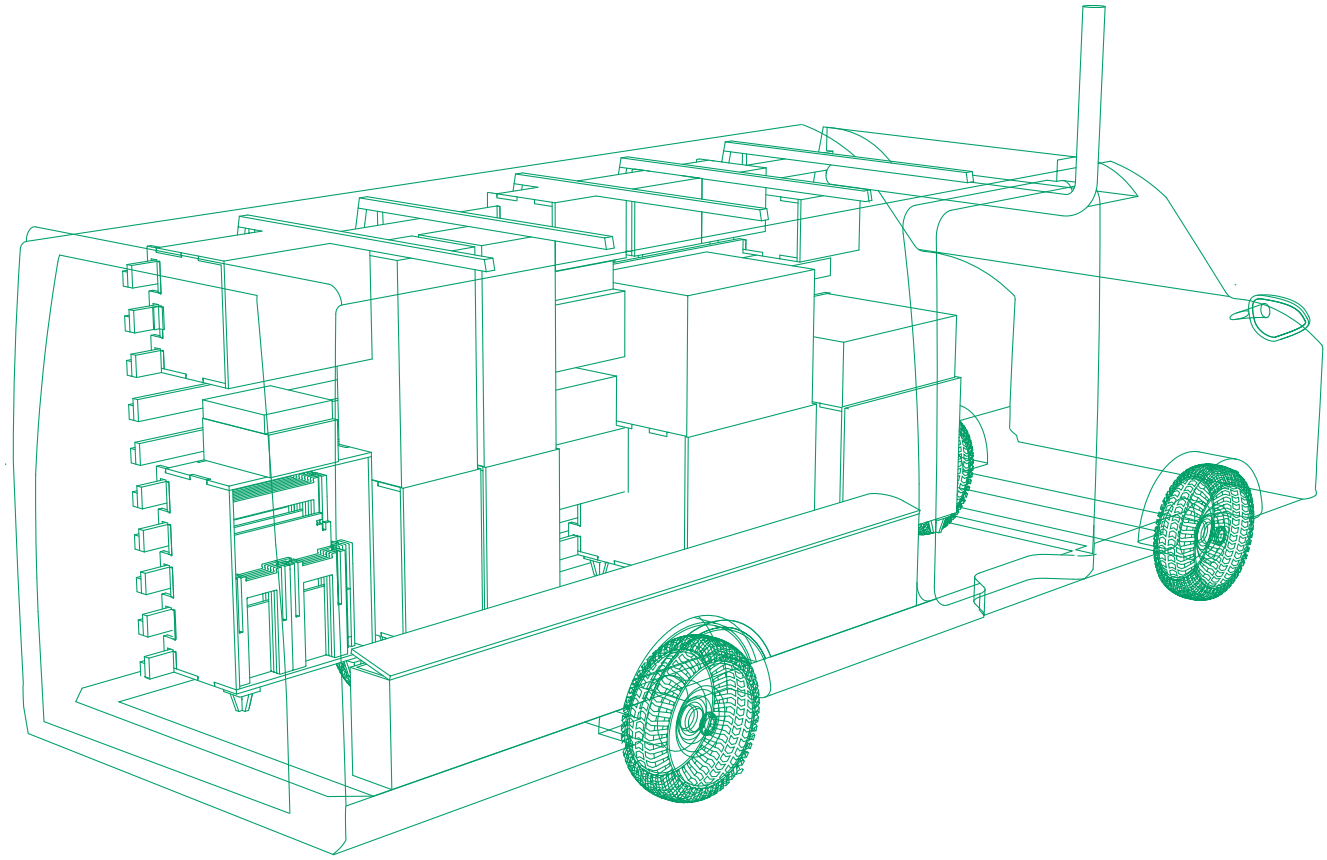
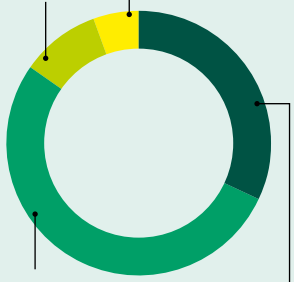


**This is one of our Tolocars.
A mobile workshop with a lot of digital fabrication tools. But in reality it is so much more…
It is a community!**

146
ACTIVITIES
Interventions and Projects



300
Hand Tools

15
Prototypes
DEVELOPED

21
Machines
REPLICATED

12,000
m Filament

10,000
Machine Hours

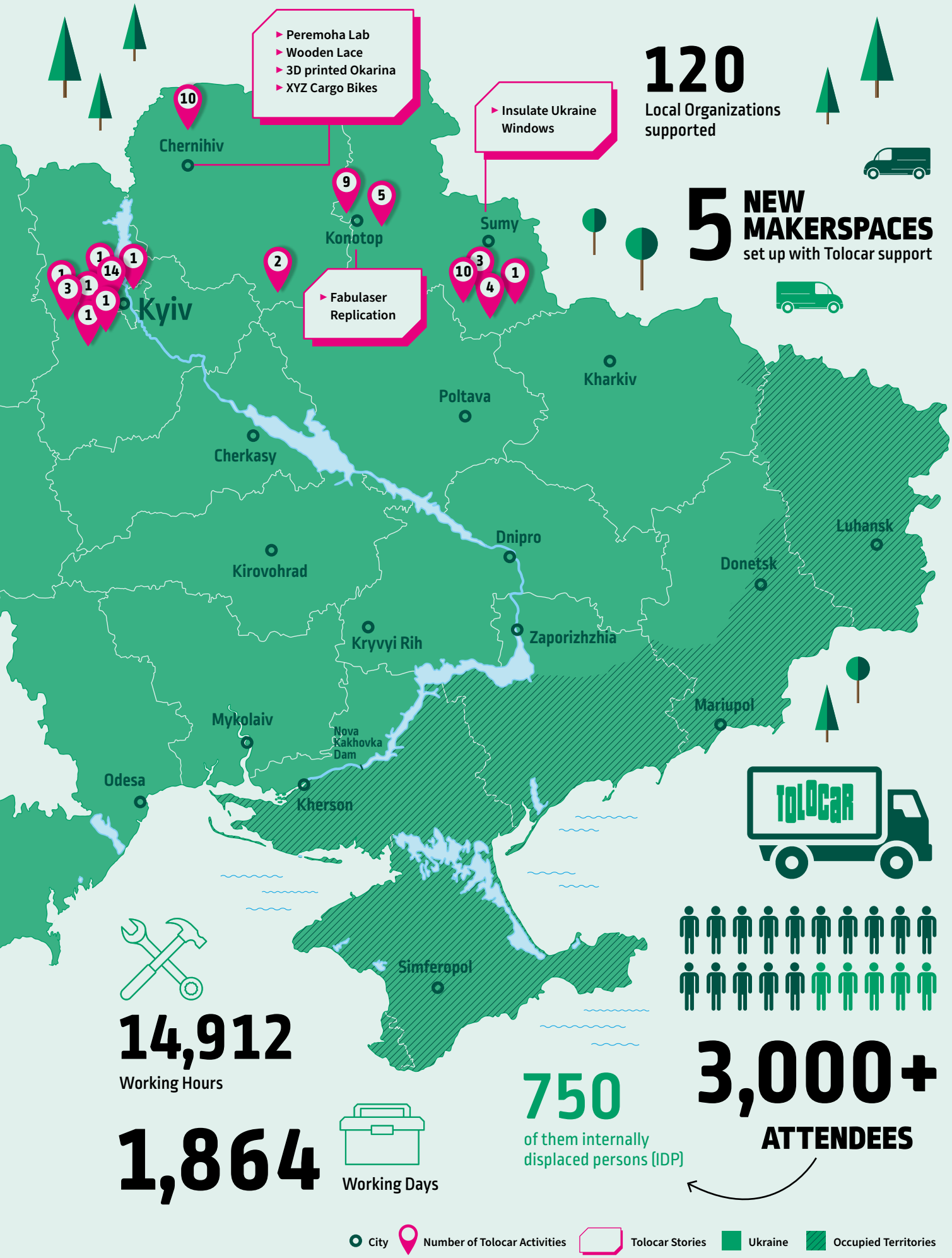
34,267
kilometers driven

TOLOCAR
MOBILE MAKERSPACE

The Tolocar project sends mobile makerspaces to Ukraine to support, train and equip local communities.

5
VEHICLES

All data as of August 06, 2023


Peremoha Lab
Wooden Lace
3D printed Okarina
XYZ Cargo Bikes
Insulate Ukraine Windows
Fabulaser Replication
120
Local Organizations supported
5 NEW MAKERSPACES
set up with Tolocar support
Chernihiv
Konotop
Sumy
Kyiv
Poltava
Kharkiv
Cherkasy
Dnipro
Kirovohrad
Luhansk
Donetsk
Kryvyi Rih
Zaporizhzhia
Mariupol
Mykolaiv
Nova Kakhovka Dam
Odesa
Kherson
Simferopol
TOLOCAR
14,912
Working Hours
1,864
Working Days
750
of them internally displaced persons (IDP)
3,000+
ATTENDEES
City
Number of Tolocar Activities
Tolocar Stories
Ukraine
Occupied Territories

FOREWORD

© by Jochen Flasbarth, State Secretary in the Federal Ministry for Economic Cooperation and Development, Germany

Jochen Flasbarth

Jochen Flasbarth is the State Secretary in the Federal Ministry for Economic Cooperation and Development. He represents the German government as Senior Government Representative (SGR) on the international donor coordination platform.

Makers on four wheels: mobile makerspaces are helping to strengthen the resilience of Ukrainian society

Russia's war of aggression against Ukraine has not only brought suffering to the people in Ukraine, it has also destroyed large parts of the country. Rebuilding Ukraine is a whole-of-society task, which Germany is supporting together with its partners. It is not just about rebuilding infrastructure, it is also a question of supporting the Ukrainians as they attempt to deal with the trauma of the war, and fostering social cohesion.

Ukrainian society has shown its resilience in the face of Russia's war of aggression. We all acknowledge and admire their fortitude! One reason for this resilience is that, because so many services are already digital, the Ukrainian

government has largely been able to keep functioning despite everything. Official buildings may have been destroyed – but it has long been possible to sort out almost all administrative business online. Social services, a digital passport, a new driving licence – public services are available via “Diia”, an uncomplicated citizens’ app. It is now even possible to apply for recovery assistance via the app.

The Ukrainians have taken charge of their own fate in a remarkable way. They are true “makers”. With the Tolocar project we are supporting the Ukrainian maker community. With the help of open source building plans, machine tools like 3D printers or laser cutters are being built cheaply in Ukraine by Ukrainians, which means that they can also maintain and repair them themselves. Moreover, the mobile makerspaces are strengthening practical skills on the ground.

That way, people are able to transform their ideas into tangible reality. Faced with energy shortages in the first winter of war, they were able, for example, to manufacture transparent window insulation panels quickly and cheaply in Ukraine. But the Tolocar project is also helping with people’s mental resilience – by bringing together veterans and young people as co-creators or by working with local associations to reproduce ornamental fixtures for historic wooden houses.

Tolocar is doing pioneering work. It is promoting decentralized production processes, collaborative product development and knowledge sharing, and supporting the networking of the Ukrainian innovation ecosystem. The next step will be for Tolocar to investigate extended services beyond the current mobile solutions; these include manufacturing-as-a-service, hardware-co-working and incubation programmes in selected super-labs or micro factories. These digitally supported solutions serve to strengthen local capacities and will play an important role in the recovery on the ground.

Germany has been supporting Ukraine through development cooperation in a range of different areas for many years. They include strengthening civil protection, energy supply and providing accommodation for people who had already been displaced from their home region in 2014. With the start of the war it was clear that these programmes would not be able to continue as planned. The Federal Ministry for Economic Cooperation and Development (BMZ) has therefore undertaken enormous efforts since then to provide the people in Ukraine with quick and flexible assistance. In accordance with the wishes of Ukrainian partners in the government, municipalities and civil society, ongoing cooperation activities have been adapted. At the forefront of these activities now is meeting the acute needs of the people in Ukraine, always looking forward and towards Ukraine’s recovery.

FOREWORD

© by Valeriya Ionan, Deputy Minister for Eurointegration at the Ministry of Digital Transformation of Ukraine

As Deputy Minister for Eurointegration at the Ministry of Digital Transformation of Ukraine, Valeriya is in charge of the national program for the development of digital literacy, digital transformation among small and medium enterprises (SMEs), regional digital transformation, and leading both the Eurointegration and international relations teams.

Valeriya Ionan

Innovating Amidst Adversity: Ukraine's Agile Systems of Distributed Manufacturing

Ukraine's strategic resilience in the face of Russia's war of aggression has been guided by an agile mindset that mirrors that of a cutting-edge technology company – quick thinking followed by even swifter actions. The heartbeat lies in our adept application of distributed manufacturing driven by digital technologies.

Central to the success of our initiatives is Дія (Diia), which means "Action" but is also an acronym for Держава і Я (Derzhava i Ya), which means "State and Me". Launched in 2020, the Diia portal champions accountability and transparency by extending access to over 100 government services and the Diia smartphone app with 19,5 million users, 14 digital documents and almost 30 digital services, which empower Ukrainian citizens. The groundbreaking potential of Diia is poised for replication in diverse countries.

The Tolocar project seamlessly aligns with the aspirations in particular of Diia.Education and Diia.Business – promoting digital skills development and entrepreneurship. As Tolocar fortifies communities and the innovation ecosystem, our recently launched "Міцність" ("Strength") initiative supports individual entrepreneurs and nurtures economic resurgence within regions impacted by conflict.

We also embrace the Tolocar project's distributed manufacturing approach and its spirit of global knowledge exchange and co-creation. Amidst these trying times, Brave 1, a defense-tech cluster initiated by the Ministry of Digital Transformation of Ukraine in close cooperation with all six key state bodies, which are responsible for the security and defense in Ukraine, and the Army of Drones, led by Mykhailo Fedorov, Vice Prime Minister for Innovations, Development of Education, Science and Technologies – Minister of Digital Transformation of Ukraine, are reshaping production paradigms within our nation.

With an initial focus on the defense sector, our forward-looking approach involves numerous contributors across Ukraine and beyond, diverging from traditional dependence on external supplies or centralized production.

Aligned with these principles, the Tolocars and their dedicated teams uplift Ukraine's makers, civil society, and the innovation ecosystem across various sectors. Concurrently, they play a crucial role in supporting essential restoration endeavors and safeguarding our vibrant Ukrainian culture. We wholeheartedly endorse the Tolocar project, appreciating its dedication to both Ukraine, and the global pursuit of peer-to-peer digital capacity development, distributed manufacturing, and agile project management.

FOREWORD

© by Daniel Busche, GIZ Country Director Ukraine

Daniel Busche has been in management positions at GIZ for more than 15 years, managing complex portfolios from Germany and abroad – with a strong focus on sustainable infrastructure. As Country Director of GIZ Ukraine, Daniel Busche leads a team of 550 staff. He sustains an active network to a wide range of bilateral donors and multilateral actors.

Daniel Busche

In its role as a highly effective implementing organisation, GIZ is already supporting Ukraine's reconstruction efforts. Our focus is on the development of municipal and social infrastructure, a secure energy supply and strengthening the resilience of Ukrainian companies. GIZ is supporting Ukraine on its path to EU accession. It advises the country on necessary reforms and drives forward the modernization of public administration. Thanks to its decades-long record of cooperation and a network spanning the entire country, GIZ is well placed to offer tailored support that is both forward-looking and responsive to local needs. In Ukraine, around 440 Ukrainian and over 70 international employees are currently working for GIZ in 45 ongoing projects. The total volume of commissions amounts to around 625 million euros.

Immediately after Russia started its full-scale invasion of Ukraine, the Tolocar project emerged through a co-creative team between Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and committed Ukrainian and German partners. Initiated as a testing ground with an open-ended approach without a predefined roadmap, it has since evolved into a beaming example of improvisation and collaboration, shared among makers worldwide. Since its initiation, the impact of mobile makerspaces within the Tolocar project has rippled across Ukraine, spanning all three stages of GIZ's support: immediate relief, sustainable recovery, and paving the way for EU accession.

For Ukraine's recovery, Tolocar's mobile makerspaces can play a pivotal role in empowering communities to establish resilient local production systems, providing support in rebuilding houses, infrastructure, machinery, and appliances. Mobile makerspaces offer hands-on training and consultation so that communities gain critical skills related to disaster response, local production, and optimizing resources. Furthermore, participants in Tolocar workshops experience belonging and self-efficacy. While this may not be a quantifiable goal, it strengthens personal resilience and mental health in the target groups.

In times of crisis, GIZ reaffirms its commitment to support communities in recovery, with Tolocars offering a nimble approach that delivers hands-on results where needed most. While we at GIZ together with our partners are looking into the upscaling potential of the Tolocar approach, we hope that this Playbook allows readers to explore the transformative potential of mobile makerspaces, not only but particularly in war-affected communities. May these insights inspire others to take innovation and collaboration a step further. Together, we can build a brighter future for all.

FOREWORD

by Neil Gershenfeld, Director of MIT's Center for Bits and Atoms, Leader of Fab Academy, and Chairperson of Fab Foundation

Neil Gershenfeld directs MIT's Center for Bits and Atoms, leads the Fab Academy, and chairs the Fab Foundation.

Neil Gershenfeld

Building a Better Future in Ukraine

Out of the thousands of fab labs around the world, one of the most impactful and hopeful activities is now happening in Ukraine.

Their flourishing fab labs (and so much else) were early casualties of the war. But rather than accept defeat, just a few weeks after the invasion a group of Ukrainian and German makers, policy-makers, researchers and activists teamed up to launch the Tolocar program with support from the German Federal Ministry for Economic Cooperation and Development (BMZ) and the Gesellschaft für Internationale Zusammenarbeit (GIZ).

Tolocar has created and sent 5 mobile makerspaces that have traveled over 34,000 kilometers, to support, train, and equip local communities. These have been used for meeting immediate medical needs, from assistive technology to making a mobile intensive care unit. They've been used for reconstruction, including producing furniture and creating construction material from building debris. They're being used for economic recovery, from making cargo bicycles to supporting distributed manufacturing to replace severed supply chains. And perhaps most important of all, they're helping maintain Ukrainian culture and the arts, supporting artisans and musicians.

At the heart of the project is the goal of making the interventions both sustainable and viral. Key to that is the Open Lab Starter Kit, part of the Fab City project at the New Production Institute at Helmut Schmidt University Hamburg. This is developing and deploying open designs for all of the digital fabrication tools, so that rather than being scarce resources it's possible to come to a lab to make a lab.

All of this is being done with a thoughtful combination of bottom-up, top-down, and middle-out organization, a model for combining the fast pace of a rapid response with the more deliberate pace of open community engagement.

The war in Ukraine is an appalling intrusion of history. But Tolocar is showing that it also contains the seeds of an opportunity. Rather than simply recovering what was, the project is building a better future in which it's possible for everyone to think globally and fabricate locally.

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Part 02

INTRODUCTION TO THIS PLAYBOOK

Tolocar
Virtual Playbook

In its virtual form, the playbook is a living document that will evolve as the project progresses. We encourage continuous learning, experimentation, and adaptation to achieve sustainable and impactful outcomes. Please join the conversation online!

***Toloka* is a traditional way of showing solidarity through the provision of physical support in Ukraine. With that in mind, German and Ukrainian partners with support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) co-created the Tolocar project just a few weeks after the start of the full-scale Russian* invasion of Ukraine. The goal of the project is to support both the emergency relief activities, and the development of a participatory innovation ecosystem for the socio-economic recovery of Ukraine.**

With a fleet of mobile makerspaces at its core, Tolocar brings together experts from the fields of making, distributed manufacturing, and urban planning with civil society organizations in Ukraine to:

- Harness Ukraine's digital innovation capacity to meet urgent humanitarian needs
- Strengthen decentralized production systems at partner locations, such as displaced businesses, makerspaces or community workshops
- Support both new and existing stationary makerspaces
- Develop the capacities of Ukrainian makers and maker-space managers
- Expand the reach of Ukrainian makers by connecting them to national, regional, and global maker networks

This book is written with two audiences in mind: As an unprecedented project, we lacked a road map that we could turn to – so we wrote one for other practitioners. Furthermore, the process of producing the playbook allowed us to reflect on the potential of mobile makerspaces to make a significant impact at relatively low costs. Our aspiration is to position mobile makerspaces as valuable instruments for those funding innovative humanitarian emergency responses and development cooperation globally.

A playbook is a collection of strategies, tactics and moves of a (sports) team, and thus by definition not meant to be normative or prescriptive in any and every situation. This playbook thus reflects our iterative and pluralistic approach. By offering our best practices, lessons learned, as well as specific challenges that we faced and solutions that we came up with (sometimes through multiple iterations) we aim to initiate conversations with others who are interested in the topic: makers, humanitarian and development practitioners, researchers, product and process innovators, civil society organizations and the private sector.

Our conversation starts with Why Tolocar in order to lay the foundation by introducing key terminology, as well as the concept of distributed manufacturing and its requisite enabling technologies. Our approach How To Tolocar is detailed in the second part of the playbook along with insights into our fleet and team, and our comprehensive checklist. We illustrate the impact of the Tolocar project on Ukrainian makers and civil society through Tolocar Stories. Here we focus on various interventions in diverse locations, spanning over a year of operation within a nation fighting against the invasion of its former imperialist ruler. Finally, we provide an outlook on our future plans to support the Ukrainian innovation ecosystem for the inclusive socio-economic recovery of the country – and how we hope that the Tolocar project will inspire others worldwide.

But first, let us take you to Chernihiv in the north of Ukraine through a Tolocar Story.

**We are aware that in Ukraine, the convention is now to use lowercase letters: "russia". As a federally owned entreprise, GIZ follows the spelling of the country list of the German Federal Foreign Office.*

Creativity, Culture, Compassion

Chernihiv on the Desna River has always been known for its rich history, cultural heritage, and architectural landmarks. Now it is also known for its citizens, whose remarkable courage and determination – to the point of blowing up their own bridges – halted the advance of Russian forces. The Tolocar project worked with the local community on several projects, e.g. to build a new innovation hub.

Maria-Elizaveta Kozhedub a volunteer at Peremoha Lab.

Peremoha Lab

Local administrators, the Polytech, and civil society organizations came together to create a new Fab Lab in an old cinema – inspired by the Tolocar project.

Ostriv Platform, a dedicated partner of the Tolocar project since its inception, introduced us to the vibrant civil society of Chernihiv. In April 2023, our first interventions with two Tolocars – making wooden lace, e-cargo bikes, and musical instruments – ignited enthusiasm in the local IT Cluster, Polytech, and the entire community. They all had long envisioned transforming an old cinema into a dynamic Fab Lab and running a Business Incubator Program there: Peremoha Lab was established in 2023.

Renovation, Replication, Rave

After careful planning, a *toloka* united the complete fleet of mobile makerspaces and over 100 volunteers in July 2023, collaboratively building and equipping the lab with several replicated machines. Bearing the name “Victory” from the original cinema, Peremoha Lab stands as a testament to the power of making, fueled by the united spirit of a community driven to rebuild the city through creativity and innovation. Chernihiv's journey toward renewal and prosperity has just begun, inspired by the boundless potential of collaborative making.

Peremoha Lab

Merezhyvo Wooden Lace

Ornate wooden decorations on traditional Ukrainian buildings called merezhyvo have deep historical significance in Chernihiv. Tolocar's digital fabrication capabilities significantly expedited the process of creating these intricate decorations.

The portable CNC router can turn any yard into a high-tech workshop.

Volunteers from Chernihiv support the recreation of traditional wooden lace.

Wooden Lace of Chernihiv online museum

Reviving Tradition

The Chernihiv Region boasts abundant forests, giving rise to traditional wooden architecture unique to the area. The merezhyvo or “wooden lace” ornaments which adorn these distinctive single story houses are characterized by floral and geometric designs, animals, birds, and musical instruments. Despite the architectural and historical significance of these structures, they face threats due to a lack of awareness and preservation efforts. In response, a team of volunteers, led by the Wooden Lace of Chernihiv online museum, has been restoring and documenting these buildings.

Using Digital Technologies

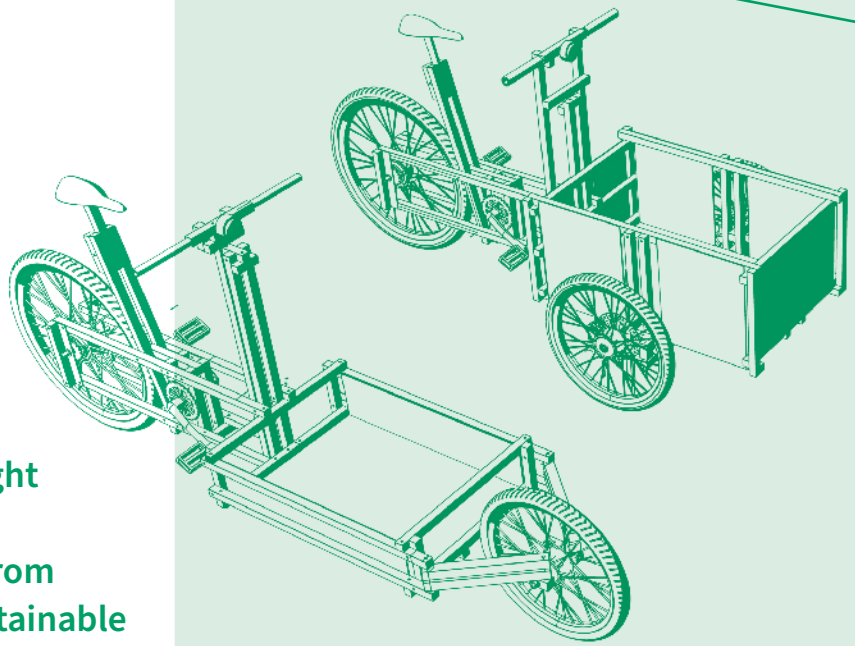
The museum's mission is not just to preserve the artifacts, but also to revive the cultural practice of manufacturing wooden lace. In collaboration with the departments of Mechanical Engineering and Woodworking at Chernihiv Polytechnic National University, they have started to use CNC routing as a digital alternative to handcrafting the decorative pieces. The Tolocar project supported the restoration of one house during our initial visit in April 2023. Utilizing CNC equipment directly on site, a Tolocar team and local volunteers created ornamental pieces with precision and accuracy. They also scanned several buildings as a first step to creating digitized models of valuable buildings. A catalog of wooden lace designs will be made available online, ensuring that this treasured art form, which is making a resurgence in Chernihiv, will now be accessible and replicable worldwide.

Eco Misto and Tolocar team members build E-Cargo Bikes with Till Wolfer and Linus Capellaro from XYZ Cargo in Hamburg.

Learn more about XYZ Cargo

Wheels of Progress

The Tolocar project brought together XYZ Cargo from Hamburg and Eco Misto from Chernihiv to promote sustainable transportation with bikes.



"This trip was important, impressive and in a way also surreal to me: Meeting so many great and forward-thinking people while there is so much destruction to be seen."

Till Wolfer, XYZ Cargo

Fostering Urban Mobility

Eco Misto (meaning "EcoCity") is a local champion of cycling-focused urban transformation in Chernihiv. Over the years, the organization has successfully carried out numerous initiatives, including the delivery, repair, and redistribution of EU-donated bicycles among local residents, police, and civil servants, along with the creation of dedicated cycling lanes on public roads. Beyond mere transportation, this initiative advocates for improved cycling infrastructure and urban planning in Chernihiv.

Eco Misto's centrally-located community bicycle repair workshop is a buzzing hub of activity right in the middle of the only pedestrian street in Chernihiv. Over the course of four days in April 2023, a joint team of members from Tolocar, XYZ Cargo, and Eco Misto, supported by a group of local volunteers, assembled three open-source electric cargo tricycles, drawing considerable attention from the locals.

The XYZ Cargo bikes boast a striking DIY-friendly, and locally-reproducible design, reinforcing Eco Misto's advocacy for cycling-focused living. From personal health to community empowerment repairability, these bikes embody the essence of sustainable urban mobility. With production centers in Copenhagen, Hamburg, Edinburgh, and now Chernihiv, their versatile design can adapt to diverse local requirements, fostering community expertise with each build.

The profound impact of this endeavor resonates far beyond mobility, encouraging Chernihiv's community to embrace cycling as a way of life. One of the cargo bikes now serves as a mobile bike repair workshop, while the other two were thoughtfully adapted to cater to specific priorities set by the local community: repairing homes destroyed by Russian attacks and delivering food to vulnerable members of the community.

3D Printed Ocarina

Collaborating with Oleksandr Beshun, one of the last students of renowned instrument maker Oleksandr Shlionchyk, the Tolocar project created 3D printed flutes and percussion instruments, which were played by Onuka on stage.

Video of Tolocar at Shlionchyk's workshop (Facebook)

3D rendering of an ocarina.

Harmonizing tradition and technology

Chernihiv was home to the late master instrument maker Oleksandr Shlionchyk, who is known all over Ukraine for crafting wooden flutes and percussion instruments. A daring project led by Konstantin Leonenko, the Tolocar Team Lead with a master's degree in algorithmic composition, sought to honor this musical heritage by 3D printing plastic replicas of a wooden ratchet and the beloved ocarina, a traditional Ukrainian flute. This endeavor was not just a replication of instruments, but a profound effort to revitalize Ukraine's rich musical tradition, bringing music and magic to those who are enduring the hardships of war.

Nata Zhyzhchenko, Oleksandr Shlionchyk's granddaughter and the lead singer of the popular Ukrainian band Onuka, invited Tolocar into her grandfather's preserved workshop, steeped in history and memories. Within these sacred walls, the team embarked on a meticulous process, employing 3D scanning to preserve every intricate detail of the existing instruments and prototypes. Through 2D scanning of drawings, they paid homage to Oleksandr Shlionchyk's artistic vision, ensuring authenticity in every note.

With Konstantin's skilled redesign, the prototypes emerged, embodying the soulful essence of Ukrainian music. Nata even preferred the plastic ratchet over a wooden one.

However, preserving the authentic sounds of the ocarina required the deft touch of Oleksandr Beshen, the last student of Shlyonchyk. With careful tuning and a keen ear, he carried forward the legacy of his masterful craftsmanship.

Promoting Ukrainian culture in the digital age

Tolocar's innovative use of 3D scanning, design, and printing technology breathed new life into these timeless instruments, making them accessible to a wider audience and infusing Ukraine's cultural heritage with contemporary resonance. Beyond preservation, the project aims to popularize this musical legacy by hosting local workshops, which engage students and music enthusiasts. Once shared in an online repository, the digital designs can echo far beyond Chernihiv, allowing plastic replicas of once-crafted wooden instruments to be played at concerts, schools, and libraries.

In a resounding celebration of Ukrainian heritage, Onuka played an improvised concert to mark the culmination of the two-week series of Tolocar interventions in Chernihiv. Nata and her husband and producer Yevhen Filatov brought the plastic replicas to life, enchanting the audience with melodies that bridged the chasm of time and adversity. The Tolocar team was deeply touched by this demonstration of their impact, harmonizing tradition and technology to preserve Ukraine's musical heritage. As the 3D printed ocarina and triskachka (ratchet) took center stage, the beauty of this project shone through, giving voice to a nation's history and resilience, and spreading the healing power of music.

“I think my grandfather would have been astonished that you can take all the scans like this and the miracle machine will just print it out.”

Nata Zhyzhchenko, Onuka

Part 01

WHY TOLOCAR

In February 2022 Russia launched a renewed invasion of Ukraine – this time as a full scale war. After the successful defense of Kyiv and an impressive counter-offensive in late 2022, the front now runs through the southern and eastern oblasts of Ukraine. Despite those successes, war is still a reality throughout Ukraine. Frequent Russian air raids aim to damage and destroy both civilian targets and critical infrastructure even in places far away from the frontlines. Despite all of Russia's efforts, Ukraine has proven to be an extremely resilient and tenacious nation. Ukraine's digital and innovation ecosystems hold large potential to both address urgent humanitarian needs and to drive the country's sustainable recovery in the medium to long term. The Tolocar project was initiated to support the full realization of this potential.

ASKotec
One of the first and smallest mobile makerspaces.

Tolocar website

Mobile Makerspaces

A Tolocar is a converted van or truck that offers the possibilities of a mobile makerspace. Equipped with tools, digital production technologies, and consumables, and operated by a team of makers, Tolocars enhance the potential of digital and innovation ecosystems in Ukraine. Connected to the international maker community, mobile makerspaces enable the creation of on-demand, flexible, and temporary production systems for distributed manufacturing at various partner organization locations – a digitally amplified version of a traditional *Toloka*, through which almost anything can be made.

A prerequisite to describing the Tolocar projects is a shared understanding of some key terms, which we define in the Text Box on the following page. The main goal of a mobile makerspace is to make hands-on learning and creative activities more accessible to a broader audience, especially those who may not have easy access to a stationary makerspace. This ultimately empowers communities and enables people to help themselves. With access to a wide range of innovative technologies, educational opportunities and creative activities, mobile makerspaces make use of community-based resources. By bringing tools, resources, and experts directly to communities, mobile makerspaces inspire innovation, promote STEAM education (Science, Technology, Engineering, Arts, and Mathematics), and drive economic development. They serve as hubs equipped with various tools, including 3D printers, laser cutters, robotics kits, as well as spaces to conduct workshops and events in collaboration with local community-based organizations. In conflict-affected areas, mobile makerspaces can play a pivotal role in promoting social cohesion, providing psychological relief, and addressing urgent needs.

The smallest unit of a mobile makerspace is a box or case filled with materials and tools. Such cases are curated and equipped for specific use cases, can be applied in a variety of settings, and transported on foot, by car or by bike.

Larger mobile makerspaces are vehicles that can be driven by people with a regular driver's license. The largest units are buses, trucks and container trailers, for which a bus or truck driver's license is required.

The spectrum of possible use cases for mobile makerspaces is very broad. In recent years, they have been employed especially in rural areas, either to extend the reach of interventions by local makerspaces, or as stand-alone mobile makerspaces that offer workshops for children and youth. While mobile makerspaces have not been extensively utilized in emergency response and development cooperation projects, they hold significant potential for generating impactful outcomes with relatively low funding. In ongoing conflict zones like Ukraine, the reach of mobile makerspaces may be limited to not directly affected areas. By concentrating efforts on relatively safe regions, mobile makerspaces can lay the foundation for post-conflict recovery and development, fostering a more resilient and innovative society in the whole country once peace is established.

Fabmobil A mobile art, culture and future laboratory.

GETTING STARTED IN MAKING: KEY TERMS

A **maker** is an individual who engages in do-it-yourself (DIY) or do-it-with-others (DIWO) activities, particularly in the fields of engineering, electronics, and crafting. Makers are often enthusiastic about creating, inventing, and building things using various tools, materials, and technologies. They are driven by a hands-on approach to learning and problem-solving, and they often share their projects, knowledge, and ideas within the maker community.

Makerspaces also known as open labs, hackerspaces, or Fab Labs, are collaborative workspaces that provide makers (and anyone who is interested) with access to a wide array of tools, equipment, and resources to bring their projects to life. These vibrant spaces cultivate a spirit of collaboration, networking, learning, and creativity, allowing makers to explore their interests and transform their ideas into tangible creations. Equipped with 3D printers, laser cutters, hand tools, and other advanced machinery such as milling machines and band saws, makerspaces offer ample room for experimentation. This empowering environment fosters a sense of self-determination and discovery, enabling individuals to strengthen their own abilities and gain a sense of support and accomplishment.

Makers often contribute to open-source projects, participate in maker fairs and events, and share their knowledge and experiences offline and online, creating a vibrant and supportive community of like-minded individuals. This **maker community** has gained significant popularity globally, thanks to the increasing availability of affordable technology, such as 3D printers, microcontrollers, and other electronic components, which has made it easier for individuals to engage in various DIY and DIWO projects and innovations. The maker community's influence extends beyond its popularity, with makers often driving innovation, inspiring educational initiatives, and fostering community development through their collaborative and hands-on approach to problem-solving and creativity.

> *"Equipped with 3D printers, laser cutters, hand tools and other machines, makerspaces offer space for realization and networking. This is often accompanied by the desire for self-determination and the discovery and strengthening of one's own abilities. This is an approach that can give children and young people in particular support and perspective."*
>
> From the Fabmobil Handout

As versatile entities, mobile makerspaces can serve different purposes, further enriching their impact on communities.

Skills development and education: Mobile makerspaces provide access to tools, technology, and resources that facilitate hands-on learning and skill development. This can enable individuals, especially youth and members of marginalized communities, to be better equipped to contribute to their community and country's social and economic development. They gain knowledge in fields like engineering, design, electronics, programming, and other subjects related to STEAM (Science, Technology, Engineering, Arts, and Maths). The Fabmobil is one prime example of a mobile makerspace focused on this goal.

Problem-solving and innovation: Makerspaces – both mobile and stationary – encourage creative problem-solving and innovation. Individuals working in these spaces can develop solutions for local challenges and find ways to improve daily life in regions not actively engaged in warfare. Utilizing repositories and social media, these innovations could extend to conflict zones, benefiting the entire country in the long run. The #ASKotec suitcase developed by r0g_agency for open culture and critical transformation, for example, contains tools and materials for repairing technical equipment, flanked by customized repair instructions made available as Open Educational Resources (OER) on the Internet.

Community building and social cohesion: Makerspaces often serve as community hubs where people from diverse backgrounds come together to collaborate, share ideas, and learn from one another. In a (post-)conflict setting, mobile makerspaces promote social cohesion and unity, which can be vital for healing and rebuilding trust among different communities.

Psychological impact: Engaging in creative activities and having access to mobile makerspaces can have a positive psychological impact on individuals who may be experiencing stress and trauma due to war. It helps to refocus on and engage in constructive activities, increasing self-efficacy and hope.

Humanitarian assistance: Mobile makerspaces can also serve as a means of providing humanitarian assistance. They can be utilized to create and repair essential items, offer technical training to aid workers, or even produce prosthetics and other medical devices to support people and communities affected by conflict or natural disasters.

Cultural preservation: Makerspaces can help preserve and promote traditional crafts and cultural practices that might be at risk during times of conflict. By encouraging the continuation of these practices and using mobile makerspaces as vehicles for their promotion, cultural heritage of communities and countries can be safeguarded.

Economic development: By fostering innovation and entrepreneurship, mobile makerspaces can create opportunities for local businesses and startups. This can lead to job creation and increased economic activity, even if conflicts have limited overall economic growth. Supporting local and displaced businesses can help in building decentralized production capacities and ultimately resilience. Distributed design and manufacturing play an instrumental role here. Embracing concepts of the circular economy, such as re- and upcycling, further bolster sustainability and resource efficiency.

Toloka: SOLIDARITY IN ACTION

***Toloka* is a traditional form of solidarity support in Ukraine. Customarily organized in villages, a *toloka* brings together communities for one-time, unpaid collective labor that requires a significant number of people. Tasks like harvesting, forest felling, and building barns, schools, libraries, community halls, and even roads are common *toloka* endeavors. These labor efforts are often accompanied by folk festivals filled with dancing and singing. Inspired by this rich heritage, the portmanteau "Tolocar" was created by combining *"Toloka"* and "Car." This term refers both to the project and to our mobile makerspaces (the Tolocars), embodying communal objectives and taking the timeless tradition of community solidarity into the digital age.**

Virtual *Toloka:* Distributed Manufacturing

"Although there is no generally accepted definition, distributed manufacturing can be understood as a decentralized approach to production that enables smaller-scale manufacturing much closer to the end-user, often leveraging recent breakthroughs in production and infrastructure technologies – such as repositories for (open source) designs, and easily accessible (digitally controlled) machines in makerspaces. Products are designed, produced, and distributed through a network of local or regional manufacturers, rather than being manufactured at a centralized location and shipped to customers. Distributed manufacturing thus has the potential to reduce costs, lead times, and environmental impact while enabling the production of customized or small-batch products tailored to local needs and preferences." [3]

The best-known example of globally distributed manufacturing remains the production of personal protective equipment (PPE) during the Covid-19 pandemic, when traditional globalized supply chains faced challenges in meeting the increased demands for PPE. Makerspaces, community workshops, and even individual makers with laser cutters and 3D printers stepped up to respond to the urgent demands for essential items. Open-source designs for PPE (Personal Protective Equipment) were sourced locally and produced on-demand, playing a crucial role in meeting the increased needs of frontline workers and healthcare facilities: Face Shields were made locally to protect healthcare workers all around the world.

Distributed manufacturing is now emerging as a compelling solution to address the interconnected constant crises of the anthropocene, such as climate change, resource depletion, land degradation, water shortage, food insecurity, and socio-economic inequality. The Tolocar project adopts a similar decentralized approach to address supply chain gaps, and support innovation and production in Ukraine. By sourcing adaptable designs, connecting Ukrainian makers to international networks such as GIG the Global Innovation Gathering, and establishing both mobile and stationary makerspaces, the project helps to create a more resilient and versatile production ecosystem.

Large industrial organizations with highly efficient global supply chains often struggle to envision and implement distributed manufacturing, while small-scale operations face challenges due to the availability and cost of technology as well as the need to trust open source machines. The Tolocar project serves as a successful pilot, showcasing the effectiveness of local initiatives, mobile makerspaces, and open-source technologies in facilitating knowledge and technology transfer, thus enhancing production capabilities where they are needed most. Especially in Ukraine, with its strained or interrupted supply chains as a result of the war, distributed manufacturing approaches can fill gaps in supply chains and production capabilities, provide quick and flexible responses to local needs, and support the establishment of a more resilient post-war innovation and production ecosystem.

Ukrainian makers are key actors in the digital and innovation ecosystem and face immense challenges due to the devastating impact of war. With makerspaces destroyed, internal displacement of makers, travel restrictions, and limited networking opportunities, the Tolocar project expands the scope for action of Ukrainian makers.
The project not only works with makers on site, but also provides connection points to virtual maker networks on a national, regional, and global level. Existing hubs and networks can thus more effectively engage in the improvement of the humanitarian situation, civil protection, and the reconstruction of Ukrainian society and its innovation ecosystem.

While the physical production and building primarily occur on-site in Ukraine, the sourcing and support activities predominantly take place online. The project actively involves makers worldwide through a support project by GIG the Global Innovation Gathering, and the Tolocar Maker Academy. The enthusiasm shown by the global maker community to contribute remotely in support of Ukraine highlights the potential for virtual collaboration in advancing distributed manufacturing.

Globally Distributed Projects

The Global Innovation Gathering (GIG) is providing support to the Tolocar project by facilitating collaboration between eight makers in Ukraine and thirteen makers from the GIG network and beyond. Together, they are working on the co-design of essential open-hardware products, workshops, and service kits aimed at addressing local needs. Guided by the principle of "Make Things That Matter," maker teams from various countries including Bangladesh, Scotland, Uganda, Philippines, Brazil, USA, and Kenya are joining forces with Ukrainian teams. Teams were selected and formed based on shared innovative concepts.

These diverse teams are actively engaged in knowledge sharing and skill exchange as they collaborate on the development of various machines and products. The collaborative process encompasses ideation, design, prototyping, and rigorous testing to validate and realize their concepts.

The outcome of these projects will be made accessible to the public through the widely recognized Appropedia platform. This platform will allow individuals to access and replicate the documented projects, as well as utilize the training kits within Ukraine and around the globe. Appropedia is more than just a wiki for appropriate technology; it serves as a comprehensive living resource and covers a wide array of topics related to sustainability, international development and humanitarian aid. Serving as an open hub, Appropedia brings together stakeholders to discover, create, and enhance scalable and adaptable solutions.

The projects being facilitated by Tolocar and GIG are:

Business Model Toolkit **Project 01** is all about rebuilding businesses on the ground through providing support networks, mentoring and training and catalyzing reconstruction efforts through providing new tools to restart makerspace businesses during and post-war.
Team: Anna Sera Lowe (Scotland) and Yuri Vlasyuk (Ukraine)

Maslow CNC **Project 02** is working to refine the design of an affordable CNC router which can cut full sheets of plywood. The goal is for this to become a viable tool for the maker community in Ukraine and around the world.
Team: Bar Smith (USA) and Roman Fomov (Ukraine)

Rebirth Brick Housing **Project 03** aims to enable the reuse of construction debris for reconstruction in populated areas, and to promote the development and growth of reuse and recycling culture. ***Team:*** Yan Kormilitsyn (Ukraine) and Vuga William (Uganda)

3D Print Needed Objects **Project 04** aims to create a working prototype of a printer that can print weatherproof objects (chairs, tables and other outdoor furniture). The first batch of weather proof objects will be provided to social and cultural centers and shelters in Kyiv through in-kind donation. ***Team:*** Skoblia Bohdan (Ukraine) and Roman Sakh (Ukraine)

Compact Bio-Digester **Project 05** is an online set of video instructions with the purpose of teaching participants around the world how to build a compact bio-digester and cooker, a gadget to help people to cook when natural gas service is not available or too expensive. ***Team:*** Maria Augusta (Brazil), Samaa Faraj and Nawres Arif (Iraq)

Restart Admin Model **Project 06** aims to restore open access to makerspaces by ensuring stable work and management through capacity building and strategic personnel onboarding for people involved in administration and management of makerspaces. ***Team:*** Oleksandra Tretiakova (Ukraine) and Mariana Baran (Ukraine)

Internet of Things Training Kit **Project 07** is an open-source workshop on IoT based on smart houses. It includes development boards, sensors, and a complete functional house model to enable any maker to create necessary connected objects to keep lights on, create security measures and communicate with neighbors when the internet fails. ***Team:*** Martin Oloo (Kenya) and Rabina Tinto (Kenya)

Rebirth Brick Housing

Yan Kormilitsyn, a student at Kyiv National University of Construction and Architecture (KNUBA), and Vuga William, founder of the Youth Empowerment Foundation (YEF) work together remotely to develop solutions for recycling bricks. Forming the bricks is done differently in Ukraine and Uganda – but the mixture is the same: 1 wheelbarrow of grained broken bricks, 1 wheelbarrow of husk, 1 wheelbarrow of river sand, 1 bag of cement, and water. Yan and his colleagues are working on a mixture which will be over 90% composed of recycled materials.

Making bricks with the tools at hand in Pagirinya Refugee Settlement in Uganda.

Yan Kormilitsyn and fellow students prototyped a 3D printer to recycle the rubble of buildings that were hit by Russian attacks in Kyiv.

Creative E-Waste Products Project 08 is a workshop to discuss the growing ubiquity of e-waste, diving right in to demystify the internal contents of a laptop together and exploring creative ways to salvage, repurpose or reuse some of its parts. ***Lead:*** Saad Chinoy (Singapore)

Possibility Design for Children Project 09 is an online set of classes and workshops introducing children to the co-creation process. The information shared provides participants with the tools and information needed to build ideas into tangible products in Tolocars and associated makerspaces in Ukraine using available materials. ***Lead:*** Rosanna Lopez (Philippines)

Tetra Solar: Standardizing the Production Process of Solar Powered Water Filters for Open Source Makers Project 10 will develop a standardized process of localizing, sourcing, and manufacturing of solar powered water filters with a manufacturing manual and a product guideline for open source makers in Ukraine to support survivors in need of drinking water in the conflict zones. ***Team:*** Melnyk Artem (Ukraine), Faria Alam Ria and Kuldeep Bandhu Aryal (Bangladesh)

Tricycle Mini Mobile Repair Lab Project 11 develops a tricycle as a mobile makerspace to provide resources for fixing and enhancing everyday (electronic) items to forcibly displaced persons. Through bringing together communities and connecting to the larger scale Tolocars in Ukraine, resilience can be built also in Uganda. ***Lead:*** Matthew Lubari (Uganda)

Open Source Machine Tools

Open source hardware (OSH) plays an important role in distributed manufacturing, global collaboration and knowledge sharing. Similar to open source software, where the source code is openly available in an online repository, open source hardware designs are fully documented and published under an open source license as a digital commons. The documentation entails any information that is needed to replicate the physical artifact, for example the computer-aided design (CAD) file, bill of materials, assembly guide, or firmware. The goal of open source hardware is to enable and allow anyone to study, modify, maintain, repair, and monetize the design.

The advantages of open source hardware are evident:

- Knowledge sharing, feedback and open source licensing foster rapid innovation cycles.
- Access to technologies and affordable (machine) tools has democratizing and emancipatory effects.
- Critical components' design flaws are identified early by peer reviews, reducing waste and preventing poor quality.
- Access to the full documentation can be used for training and learning experiences towards technological literacy.
- Editable design files enable adaptation/customization.
- Makers and users of hardware gain full control over the technology which reduces dependencies and vendor lock-ins.
- The right to repair becomes a reality: anyone with the skills can repair products and extend their shelf life.
- Open documentation fosters local knowledge and global collaboration.

Open source machine tools are a subset of open source hardware. The designs of these machines typically follow an appropriate technology approach, embracing affordability and modularity, in addition to using off-the-shelf components or DIY 3D printed parts to support user self-sufficiency and autonomy. The impact of open source machine tools (e.g. 3D printers, CNC mills, laser cutters) is multiplied by the above benefits as they are able to provide distributed and decentralized production capacity to communities in Fab Labs and Makerspaces worldwide. By enabling self-replication - using machines to make new machines – the dissemination of goods and products can be accelerated.

Open Source Machine Tools on Appropedia

MAKING, BUT WITH CRITICAL THINKING

The term Critical Making originates from academia. It is the practice of combining critical thinking and rapid prototyping not to create feasible products, but to help engineering students better understand complex issues, and thus solve wicked problems – complex, interconnected issues that lack clear solutions due to their ambiguity, uncertainty, and conflicting perspectives. Exploring what this academic term means in the real world gives us an opportunity to look beyond the "business as usual" of making in Western makerspaces, where it is most often used in education, hardware startups, or for leisure time by hobbyists.

Such critical technical practice can be found all over the world. Some makers are highly political: they develop prototypes for the purpose of raising awareness around issues their communities face. Others are hardware hackers: they take apart the black box of technology to understand how it works, and expose dark patterns. Finally, we have our social innovators: they operate out of scarcity, especially in situations of uncertainty, and develop solutions for their communities. While these practices might differ, they share a lot of values. They deploy community-based critical thinking in their making practice, and are inherently collaborative and human-centered. They are early adopters of new technologies, and they are also early warners. This stems from being embedded in the local community, with frequent exchanges about what goes well and what is needed. Finally, they care little about securing their intellectual property to gain potential profits, but generously share low-cost, low-resource open source blueprints both locally in workshops, and globally, via online repositories.

These shared values explain why critical making can be found all over the world. Critical makers can act fast because they are warned by their communities, they can access well documented blueprints for essentially any need, and they have rapid prototyping tools to produce whatever people might need in the moment, be it a digitally fabricated shelter, 3D printed casts for broken bones, or DIY filtration systems for drinking water. These might seem like quick fixes, but cover essential services for people who need them in humanitarian situations.

In the long term, when solutions are not urgently needed, critical making can help build and rebuild better, more sustainably, and more equitably. When makers think big on a small, human-friendly scale, technological ecosystems built on sustainable energy sources, and developed and maintained by local communities become possible.

By Dr. Regina Sipos

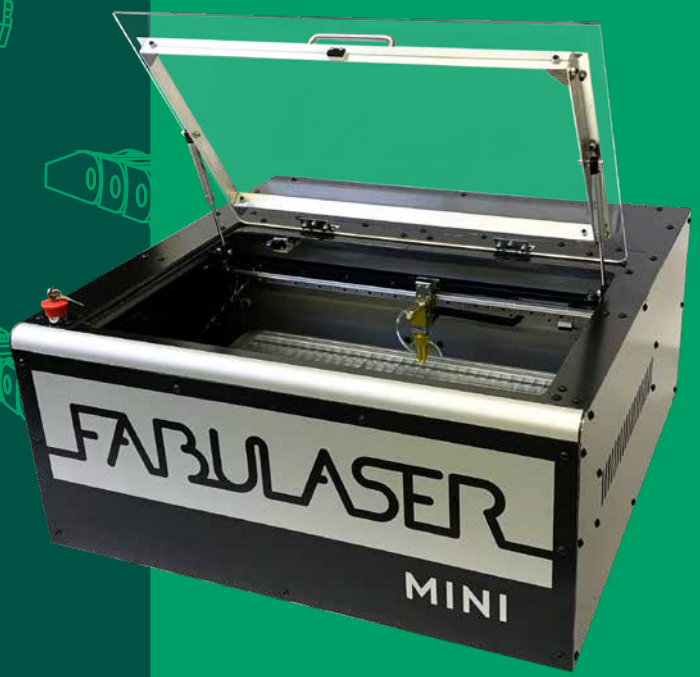
OPEN LAB STARTER KIT:

Empowering Makers Anywhere

The development of the Open Lab Starter Kit is part of the Fab City project at the New Production Institute at Helmut Schmidt University in Hamburg. It equips makerspaces with affordable and reproducible Open Source Machine Tools, tackling challenges like high initial investments, vendor lock-ins, and maintenance issues. It ensures accessibility even in regions with limited availability of machines or spare parts.

FABULASER MINI

Fabulaser Mini is a compact, open-source laser cutter for Fab Labs and classrooms. With a 40W CO_2 laser, it cuts up to 8mm of acrylic or plywood and offers a spacious 600x400mm cutting area. Compact size of 1161 x 812 x 390 mm fits small rooms. More info online: ***fabulaser.net***



BUILDING UP AND SCALING LOCAL PRODUCTION

Fab Labs and makerspaces require a certain set of technical capabilities to benefit their users. With commercial machine tools, the initial investment is very high (easily more than 250k USD) and lab managers are stuck with vendor lock-ins or lack of documentation for maintenance and repair. Not to mention that some regions in the world might not even be able to access machines or spare parts. This is where the concept of Open Labs comes into play: The idea is to equip and run Fab Labs with affordable, accessible, and reproducible open source machine tools in order to address the previously mentioned challenges.

The Open Lab concept has further evolved into the so-called Open Lab Start Kit comprising a set of open source machine tools tailored for Fab Labs and maker-spaces. The development process focuses on increasing replicability, striving for the quality of commercial machines, transferring knowledge, empowering individuals to utilize the machines effectively, and ultimately fostering distributed production and a circular economy. The goal is to create a fully open source ecosystem akin to a "Wikipedia for Machine Tools."

At present, eight types of machines are being developed through the Fab City research project at the New Production Institute in collaboration with InMachines GmbH, including laser cutters, CNC routers, 3D printers, a vinyl cutter and a 3D scanner. These machines not only meet high safety standards but also function effectively and possess an aesthetically pleasing design. Furthermore, their open source nature allows individuals to choose from various options: building the machine from scratch using the provided Bill of Materials (BOM), purchasing a ready-to-use machine from a distributor, or acquiring a prepared kit and assembling it following detailed instructions.

The Fabulaser, which is part of the Open Lab Starter Kit, was designed to be a DIY Assembly Kit, and brings an affordable quality laser cutter to schools that want to teach digital fabrication. It includes an easy to follow step-by-step instructions manual. The Fabulaser is one example of the open source machines that each Tolocar is equipped with. Tolocar teams have hosted several machine build workshops in Ukraine to help makers build and use open source machines.

THE OPEN LAB STARTER KIT GOALS ARE:

- **Develop Open Source Digital Fabrication Machines**
- **Document the reproduction process**
- **Fill the gap between commercial and Open Source machines**
- **Lower the barriers in accessing digital fabrication technologies**
- **Transfer the knowledge behind the machines**
- **Include and enable anyone in the process**
- **Create fully Open Source Fab Labs (Open Labs)**
- **Boost the Fab Cities' local production and circular economy**

ENABLING OPEN INNOVATION IN KONOTOP

Fabulaser Replication Workshop

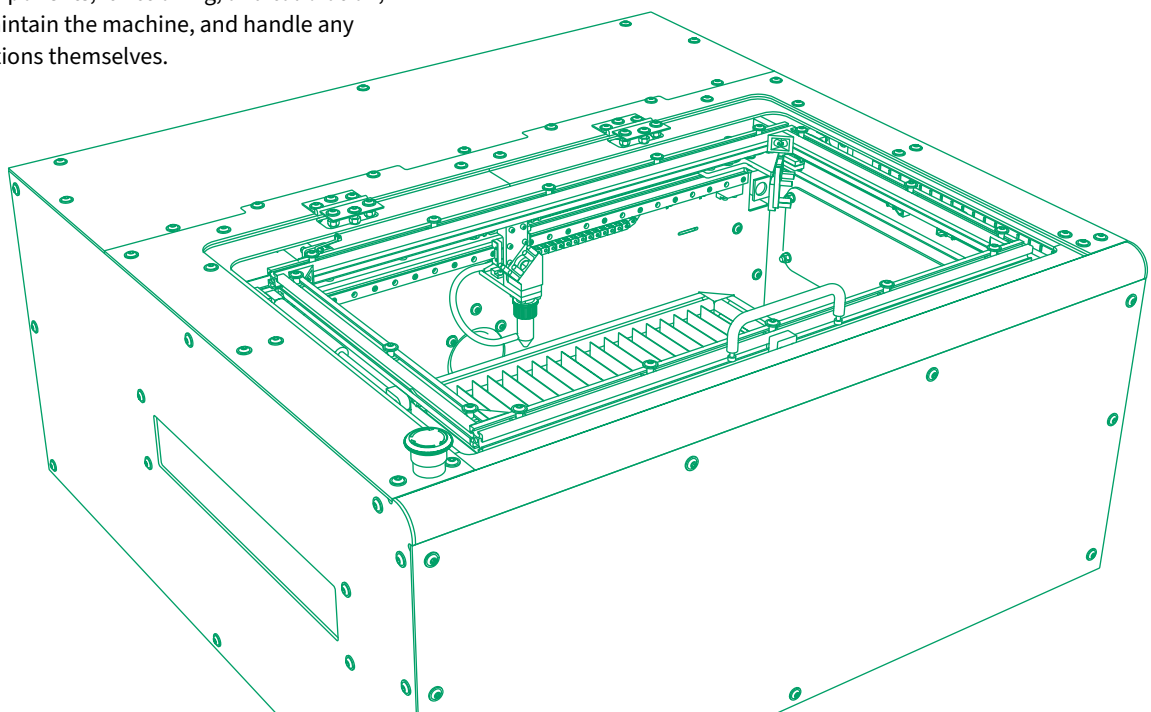
Konotop, located in northeastern Ukraine about 180 km from the Russian border and home to over 85,000 people, was occupied during the full-scale Russian invasion and liberated in April 2022. As a previous railroad hub renowned for its mechanical engineering sector, Konotop now faces significant challenges in rebuilding its industries.

The Tolocar project supports the establishment and development of a makerspace at the Classical Professional College of Sumy State University. This project has long been in the works and planned by the College in collaboration with Robogenius Kon, a civil society organization which offers Coding, Robotics & Artificial Intelligence courses for kids and is part of the local IT Cluster.

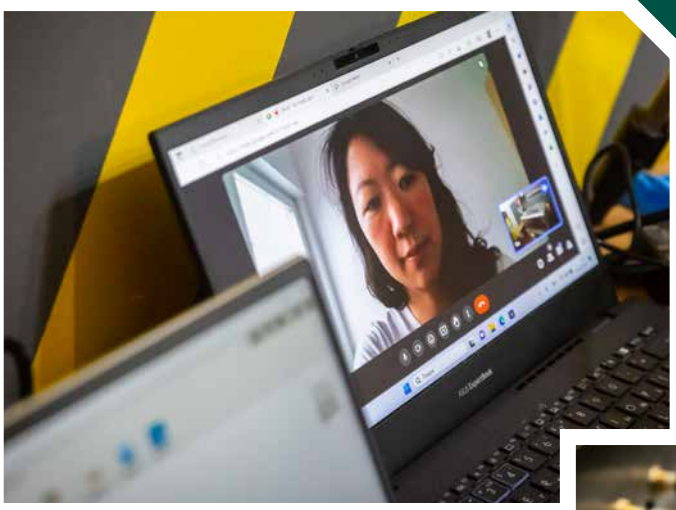
After an initial visit to replicate two 3D printers and to train teachers and students on their usage, the Tolocar team returned for a week-long visit, during which they replicated a Fabulaser Mini. They facilitated the assembly of a Fabulaser Mini with teachers and students on site, while Liane Honda of the InMachines team guided them through the whole assembly process using online video calls.
The laser was built from scratch, with each step from the Fabulaser Mini Workbook being taken deliberately and explained thoroughly by Liane. Following this approach takes several days, but ensures that those who use the laser understand its components, functioning, and calibration, and are able to maintain the machine, and handle any potential malfunctions themselves.

In addition to facilitating the assembly process, the Tolocar team conducted workshops to enhance the makerspace's functionality. They used open designs from Hacklab in Kyiv to make pegboards in the soldering lab, allowing for easy replication and adaptation as the tools used in the makerspace change. Teachers at the Polytechnic College participated in a training of trainers focused on laser basics, safety, software usage, material preparation, drawing creation, and access to ready-made designs. Following this, the Tolocar team trained college students on how to operate the laser for their projects while providing an opportunity for teachers to observe the training facilitation.

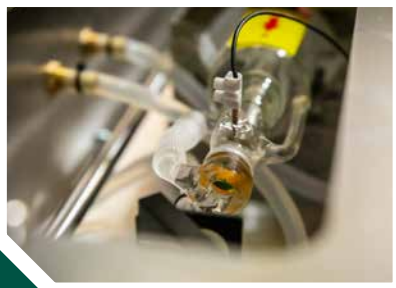
The machines will be used in a newly established maker-space in Konotop, which will serve various purposes, and is intended to provide access to students from the school of robotics, technical college students, and city residents. College teachers will also utilize the Open Source Machines for educational practices, production projects, as well as supporting the further development of the makerspace. The establishment of the makerspace and the integration of the Fabulaser Mini and 3D printers are significant steps towards fostering innovation, entrepreneurship, and educational development in Konotop.



Fabulaser Replication
Completing all of the steps in the assembly process together took several days.



Team Work
Tolocar operators Olha Ivanchenko and Volodomyr Babii with teachers from the College in Konotop.



Hybrid Facilitation
Liane Honda from InMachines guided the safe assembly of all parts via online video calls.

"Tolocar should be the starting point for a broader conversation about the needs that maker solutions can cover, for example road reinforcements made from recycled plastic, water filters and pumps."

Ivan Nesterenko, Tolocar Operator

Ivan Nesterenko (left) and Denys Kvasov with their Tolocar.

WINDOWS OF HOPE

Tolocar operator Ivan Nesterenko assessing a building.

The Insulate Ukraine project brings warmth and hope to war-torn Ukraine through the production and installation of temporary windows. The Tolocar team installed 39 such windows in 5 days in addition to training 3 teams of communal services workers in this remarkably simple but effective technique that transforms lives in the cold winter.

"When we came to Okhtyrka, the most important thing for the people we worked with were not the windows we fixed, but that there was somebody there to listen to them, to hear their stories, and know that we care, even if we were complete strangers. They did not expect us to change anything, some of them did not even need the solution that we had to offer – but we could give them some of our consumables, which would take 10 seconds, and we could give them attention, which would take 15 minutes. And that was what they needed, and that is what I mean when I say that we don't help Ukraine in an abstract way, but help real Ukrainians." Denys Kvasov, Tolocar Operator

Insulate Ukraine

The Bill of Materials (BOM) is short and adds up to only around 15–20 €

- PVC piping
- 4 layers of stabilized polyethylene film which doesn't degrade under sunlight
- Insulating noodle – if this material is not available, it can be replaced with newsprint pages, bubble wrap or any other component that is soft at the edges.
- Duct tape

During winter average temperatures in Ukraine drop to –8 degrees Celsius. The shattering of an estimated 50,000 windows due to shelling leaves homes vulnerable to the elements. When people are freezing, it does not only make them sick, but also undermines their resolve to defend themselves and stay in their homes which are under the constant threat of invasion. Standard replacement windows are expensive, hard to get, and may be shattered again. Easily accessible solutions, such as using hemp or wood for insulation, fall short in several respects: they do not insulate well, do not let light through, or can be difficult to install.

The Insulate Ukraine project, initiated by British researcher and activist Harry Blakiston Houston, set out to come up with an easily accessible solution which addresses these common shortcomings in the winter of 2022/23. The solution is ingenious in its simplicity: triple-glazed polyethene windows.

To build the frame, PVC pipes are cut to size and joined using pipe connectors or duct tape. Then the first air chamber is created by wrapping the frame in polyethylene and fixing it with tape. The insulating noodles are placed around it and the frame with the noodles is wrapped in film once again. Four spaced layers of cellophane create three air chambers which make it a very effective insulator. The windows insulate like double glazing, let light through, cost around 10 € per square meter, can be built at home in 15 minutes from basic materials, and last for several months or years (depending on conditions)

The Tolocar Team building a *plivkopaket*. (see box on following page).

> *"By teaching others, we empower Ukrainians to fix the problem themselves. What takes 6 people 100 days takes 60 people only 10 days."*
>
> Insulate Izyum project

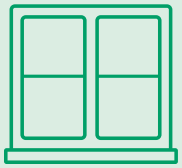
without the risk of shattering again from continued shelling.

When Harry reached out to the Tolocar project in October 2022, we were impressed by the simple yet effective design, the collaborative approach of Insulate Ukraine, and the results achieved in their pilot projects in the city of Izium. We then tested the solution, and teamed up with BUR (Building Ukraine Together), the Okhtyrka Youth Centre, the Velyka Pysarivka Village Council, and several municipalities in the Sumy region in Northeastern Ukraine, who all provided us with lists of people who needed windows. Together, the teams were able to install 39 windows across 12 locations in just 5 days. The windows were installed in a variety of buildings, including municipal buildings like the Okhtyrka House of Culture, apartments and private houses in Trostyanets, Okhtyrka and Velyka Pysarivka.

With a solution so simple, cheap and effective – it's the knowledge transfer through workshops that delivers one of the biggest impacts. After repeated shelling in Velyka Pysaryvka in May of 2023, communal workers replaced all of the broken windows with Insulate Ukraine ones within a couple of days. In doing so, they noted how much safer this solution is compared to permanent glass windows in that they do not shatter. Glass shards are reported as being the most trauma-inducing consequence of shelling and air raids.

It is to these teams that we owe the term *"plivkopaket"* – a camera made of polyethylene – which is an apt adaptation of the Ukrainian term *"steklopaket"* to describe a double-glazed window made of plastic film.

This inspiring project is a testament to the power of community-driven initiatives and knowledge exchange: Through workshops and collaboration, it brings warmth and relief to many families in one of the regions most affected by the war. With each window installed, Insulate Ukraine empowers communities to take charge of their living conditions, offering hope and a brighter future in challenging times. We are proud to be their partner!



Key Information

- Glass shards are reported as being the most trauma-inducing consequence of shelling and air raids.
- Insulate Ukraine (IU) windows are triple-glazed polyethene windows designed to protect against the cold.
- IU windows insulate like double glazing, let light through, cost around 10 € per square meter, and can be built at home in 15 minutes from basic materials.
- The concept was developed by Harry Blakiston Houston, a PhD Student from Cambridge university.
- 39 windows were built by the Tolocar project for the most vulnerable dwellers of the identified communities.
- 3 workshops were held for the municipal workers who fix the houses after shellings.
- Municipal workers nicknamed the windows "plivkopaket": a camera made of polyethylene.

THEORY OF CHANGE

INPUTS

- Tolocar Team & Partners
- Global Maker Networks
- Open Source Designs Repositories
- Financial Ressources
- Mobile Makerspaces: Vehicles + Machines + Tools + Equipment

ACTIVITIES

Strengthen Capacities of Ukrainian makers and makerspaces

- Support Existing Makerspaces
- Support New Makerspaces
- Provide Trainings & Workshops

Support projects of local partners with Tolocars

- (Re)construction / Renovation / Repair
- Machine Replication Workshops
- Prototype Development

Connect Communities

- Distributed Design and Manufacturing
- Awareness Raising Events
- Cultural Relief Activities, Storytelling, Documenting, Sharing

OUTPUTS

Ukrainian makers co-create and prototype solutions with their local and global peers through (virtual) collaborative projects.

(Re)construction, repair and renovation projects are supported with digital tools and technologies.

Technical capacities of Ukrainian makers and organizational capacities of Ukrainian makerspaces are strengthened through trainings and workshops.

The self-efficacy of participants is strengthened through making, as engaging in creative activities has a positive psychological impact on individuals who are experiencing stress and trauma due to war.

OUTCOMES

Ukrainian makers are well-connected with each other and their global peers.

Systems for distributed manufacturing in Ukraine are prototyped.

Ukrainian makers support the socio-economic recovery of the country.

IMPACT

A strengthened Ukrainian innovation ecosystem contributes to the participatory recovery of Ukraine.

KEY STRATEGIES

To make things that make sense anywhere

- **Enabling Local Communities through Collaborative Partnerships**
- **Skill Development and Capacity Building**
- **Innovation and Resilient Rebuilding**
- **Knowledge Sharing and Collaboration**

PARTNERS

The Tolocar project aims to support both emergency relief activities and the development of a participatory innovation ecosystem for the socio-economic recovery of Ukraine. To achieve this, the project connects communities within Ukraine and globally, so that they can engage in distributed design and manufacturing activities. These connections are only made possible through collaboration among various partners who support the project.

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH is a federal enterprise with worldwide operations. It supports the German Government in the field of international cooperation for sustainable development. GIZ is also engaged in international education activities around the globe. It assists people and societies in shaping their own future and improving living conditions. ***giz.de***

HIWW is a leading consulting firm for value creation increasingly focused on openness, decentralization and sustainability. HIWW supports and accompanies organizations in breaking new ground in the areas of innovation, production and knowledge management. HIWW managed the second phase of the Tolocar project. ***hiww.de***

MitOst has been connecting active citizens in an open and diverse network in Europe and its neighboring regions for years, and was managing administration, communication and networking during the first phase of the Tolocar project. ***mitost.org***

CADUS is a non-profit and independent aid organization with headquarters in Berlin which provides medical and technical emergency response in crisis-affected areas. In every aspect of their work, CADUS prioritizes local collaboration and capacity-building to provide effective aid, and openly shares solutions and innovations with the public. CADUS managed the first Tolocar during the initial project phase. ***cadus.org***

Global Innovation Gathering (GIG) is a vibrant, diverse community of innovation hubs, makerspaces, hackerspaces and other grassroots innovation communities. In the Tolocar project, GIG facilitates collaboration between Ukrainian and international makers. Together, they're co-designing essential open-hardware products, workshops, and service kits aimed at addressing local needs. The outcomes will be shared on Appropedia, a widely recognized platform for accessible solutions, which allows individuals to access, replicate, and utilize projects and training kits worldwide. ***globalinnovationgathering.org***

Insha Osvita is a non-governmental organization that works with culture and art as forms of collective learning and exchange, and creates and uses spaces for this. This aspect is also very important in the Tolocar project: through diverse, holistic and living learning from each other, people develop more trust in themselves and others, and join together to strengthen themselves and their communities. ***insha-osvita.org***

MakerHub has been convening the Ukrainian maker movement through offline meetings and events, as well as online community calls for a decade. They are the Ukrainian organizers of internationally acclaimed maker conferences and festivals such as Maker Faires and RepRap Festival. MakerHub to date has supported the Tolocar project with extensive research into the Ukrainian maker movement, including stakeholder mapping as well as capacity and needs assessments. ***makerhub.org***

MetaLab is a laboratory for urban development in Ivano-Frankivsk. Since the beginning of the Russian full-scale invasion, they not only provide a safe space for their colleagues from Kyiv and the east of the country to work, but also develop new projects. One of them is CO-HATY, in the course of which a total of six abandoned apartment buildings and hotels are being renovated and transformed into shelters for internally displaced persons. What's special: The renovations are carried out by local organizations and many volunteers together with the IDPs themselves, which also creates new friendship. ***metalab.space***

Ostriv Platform, a community makerspace in Kyiv, has been helping diverse communities in Ukraine build spaces for exchange – and grow together as communities – for years. They are now developing new construction projects like shelters in Kyiv, as well as scalable project ideas such as the development of ecological sanitation solutions for host communities in rural regions in western Ukraine. ***ostrivplatform.com***

May – August 2022 | **June – November 2022**

Cadus

Technical Emergency Response

Equipment: Manual power tools

Illustrative Interventions:

Ivano-Frankivsk / May 18 – June 13, 2022:
CADUS supported the renovation of Hotel Olya as part of MetaLab's CO-HATY project. Throughout the intervention, 40% of the renovation project was completed. It also provided an opportunity for community building among the individuals involved in the renovation project, some of whom later made Hotel Olya their home. An additional 4–6 weeks of work were required to bring the project to completion.

Makariv, Kyiv region / July 07 – 15, 2022: CADUS utilized the Tolocar as a mobile workshop to support partner organization Building Ukraine Together (BUR) and the State Emergency Service (DSNS). The objective was to reconstruct the heavily damaged DSNS building, which had suffered from shelling. The Tolocar project provided the necessary equipment and human resources/skills to facilitate the reconstruction efforts, enabling the project to progress successfully.

"A mobile makerspace also creates space for shared learning, community engagement, connection and discourse."

Sebastian Jünemann, CADUS

MitOst

Rebuilding, Reconstruction & Cultural Relief Activities

Equipment: Manual power + some digital tools

Illustrative Interventions:

Bila Tserkva, Kyiv region / September 04 – 10, 2022:
A Tolocar was deployed in Bila Tserkva to improve the public space near the Youth Center. The intervention focused on creating furniture and games equipment, aiming to enhance the city park infrastructure and foster cooperation, trust, and cohesion among local young people and internally displaced youth. The initiative also sought to promote the social integration of internally displaced people (IDP) within the host community.

Kyiv and Ivano-Frankivsk / September 2022:
Ostriv Platform organized three maker training workshops in Kyiv and Ivano-Frankivsk, using a Tolocar. These workshops introduced participants to the mobile maker-space, its tools, equipment, and potential applications. Specialized inductions were provided in digital fabrication (CNC milling), woodwork, and metalwork, offering valuable skills and knowledge to the attendees.

Motyzhyn, Makariv community, Kyiv region / October 01, 2022:
In Motyzhyn, a one-day art therapy program was conducted by Insha Osvita and ArtPole agency. The aim of this intervention was to facilitate sharing and discussing memories of traumatic events which transpired during the village's occupation amongst members of the local community. Participants, including students and teachers from the local school, engaged in physical work by creating flower beds and planting flowers in the school courtyard. The combination of physical and artistic activities fostered strong bonds among the participants, encouraging them to share personal stories and communicate with sincerity.

Since October 2022

HIWW

Distributed Manufacturing

Equipment: Digital + some manual power tools

Illustrative Interventions:

Truskavets / November 28, 2022 – May 30, 2023: The team conducted a 3D design workshop in Truskavets, bringing together veterans and school children in a local school. The success of this workshop led to the establishment of a Fab Lab within the school, supported by the Tolocar project through replication workshops and trainings during seven subsequent visits over the next six months. This initiative aimed to empower and inspire creativity among the participants, while also promoting collaboration and knowledge exchange.

Kyiv / Winter 2022–23: The truck provided support to Hacklab in Kyiv, the capital's oldest hackerspace, during the winter season. Through several workshops, the team helped improve the heating system, and provided the ability to switch to the emergency power system more quickly. Collaborating with residents, the Tolocar team created heat mats, an emergency power system, and emergency lights. The designs of these items were then shared and used in train-the-trainer formats, benefiting several shelters where they were replicated.

Global / Summer 2023 / Maker Academy team: In response to the breakage of the Nova Kakhovka Dam, the Tolocar teams, together with all partners and networks, swiftly took action. They received and curated 41 potential solutions, ranging from speculative ideas to research papers and off-the-shelf commercial products. These solutions are currently undergoing testing in collaboration with multiple laboratories across Ukraine. Additionally, local teams in Ukraine began constructing OpenFlexure microscopes, an open-source design for 3D-printable, low-cost, digitally-controlled microscopes. This initiative enables Tolocar teams to conduct bacterial water tests independently, enhancing their capabilities and facilitating accurate and cost-effective testing.

Tolocars: VERSATILE MOBILE MAKERSPACES

The Tolocar project is the first of its kind. Although there is a growing number of various types of mobile makerspaces serving different needs, the scale and scope of the project are without precedent: A fleet of three vans and a truck are being used to both support emergency relief and reconstruction efforts, and help to establish a well-connected innovation ecosystem in the country, which will be instrumental to the development of a more decentralized, inclusive and equitable systems of production and value creation after the war. Notably, while the project led by HIWW offers capabilities that could be valuable in military contexts, Tolocar maintains a steadfast commitment to the humanitarian principle of "no dual use".

CADUS were the first to send a fully equipped van loaded with professional tools to Ukraine. This van served as a valuable resource for the CADUS team and volunteers, working closely with Ukrainian organizations for a duration of four months. The final intervention of the CADUS van was the transformation of a travel bus into a Mobile Intensive Care Unit in Ivano-Frankivsk, where digital designs were made and turned into stretcher brackets by Pavlo Marchenko, a local welder (see Tolocar Stories: Converting a Bus into a Mobile Intensive Care Unit (MICU).

MitOst, on the other hand, outfitted one van with professional workshop tools and a 3D printer. This van was utilized by the local organization MetaLab to support rebuilding and reconstruction efforts across various regions of Ukraine. Subsequently, it was handed over to HIWW and is currently predominantly used in and around Okhtyrka. A second van was transferred to Ostriv Platform, a prominent maker community in Kyiv. They have used it in activities such as the renovation of a community space in Derevnya, and the restoration of a dormitory for internally displaced people in Kamianets-Podilskyi. In addition, MitOst rented a Tolocar Support Car from Kolya Kravchenko to transport volunteers and materials inside Ukraine.

Serving different purposes with one goal

All across Ukraine, projects by different Tolocar teams have successfully implemented a series of interventions aimed at fostering community development, resilience, and social integration. These interventions have brought together local residents, organizations, and volunteers to address specific needs, empower Ukrainian makers, and support the sustainable, inclusive and participatory recovery of the country.

Watch MakerHub's Yuri Vlasyuk in conversation with Tolocar team members (YouTube).

> *"The dialogue started by Tolocar was as necessary as air. It gave a reason to activate the communication capacities of the community and its players."*
>
> Anonymised quote from the MakerHub Research Report [4]

Crafting Resilience:
The Ukrainian Maker Movement in the past and now

With input from Yuri Vlasyuk, MakerHub

Making is deeply rooted in Ukrainian culture throughout history, encompassing traditional practices such as fixing, repairing, combining broken pieces, planting, and naturally exchanging goods.

The spirit of making has thrived in this resilient nation, providing a powerful counterbalance to consumerism. The Ukrainian maker movement has gained attention from community leaders, civil servants, businesses, educational institutions, medical establishments, international foundations, and even the government and armed forces. The resourcefulness of makers in fixing and repairing became vital during the war and is expected to play a crucial role in post-war reconstruction.

The maker movement in Ukraine has flourished in the last decade, with public makerspaces sprouting across the country since 2012, serving as centers of DIY culture, product innovation, and micro-production. Izolyatsia, one of the first makerspaces in Donetsk, emerged from a project supported by Terre des Hommes. Despite the destruction of Izolyatsia's building during the 2014 secession of Russia-supported militia, the makers adapted and continued their activities in Kyiv as Isolab. In 2022, the maker movement in Ukraine transformed into a tight-knit and supportive community. Collaborations between makers within this community, such Maker Faires, "Book Arsenal" participation and the RepRapUA festival, have garnered international recognition and support from organizations like the Fab Foundation and Make magazine.

Insights from MakerHub Research

MakerHub, the producer of 15 Maker Faires in Ukraine, conducted research on the recent state of the maker scene in Ukraine as part of the Tolocar project [4]. As part of the research, 312 Ukrainian makers took part in a survey – most were men under 45 with higher technical education, engaged in making for three or more years. Many of them work alone from home, while some have established organizations where they work together with others. The study revealed key needs among makers, including training, idea generation, sourcing materials, improving efficiency, networking, and funding. The maker movement in Ukraine is embracing community engagement: 68% of the study participants expressed interest in joining community activities, with informal gatherings, workshops, and maker fairs being the preferred formats for interaction. Makers are increasingly willing to take on community leadership roles, as many of them are not hobbyists anymore, but support the socio-economic recovery of Ukraine. The Ukrainian maker movement gives testimony to the creativity and ingenuity of its people. Through resilience and collaboration, makers have demonstrated the transformative power of creation. Guided by the spirit of community and innovation, the movement forges a path towards a vibrant and empowered nation.

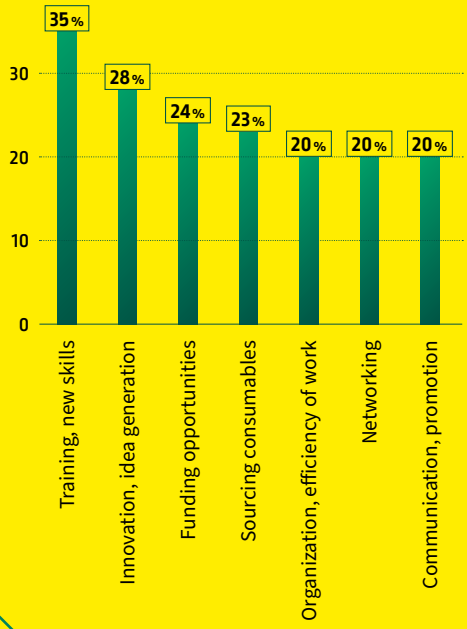
"It's the story, not the stuff."

Konstantin Leonenko

Konstantin Leonenko is the Team Lead of the Tolocar Operators.

He built IZOLAB, the first Makerspace in Ukraine in 2012, and is one of the Co-Founders of Fab Foundation Europe.

WHAT WERE THE NEEDS IN 2022?



1. Fab Lab Brody ▸ *Brody*
2. Peremoha ▸ *Chernihiv*
3. Engineers Coworking* ▸ *Chernivtsi*
4. Ksi Prostir ▸ *Dnipro*
5. Yane Lab* ▸ *Dnipro*
6. IZOLAB* ▸ *Donetsk*
7. MetaLab ▸ *Ivano-Frankivsk*
8. Garage Hub* ▸ *Kharkiv*
9. Makerspace Kharkiv ▸ *Kharkiv*
10. Makerspace at College ▸ *Konotop*
11. DrevoDim ▸ *Kramatorsk*
12. KNUBA ▸ *Kyiv*
13. Platform Ostriv ▸ *Kyiv*
14. Hacklab ▸ *Kyiv*
15. Fabricator ▸ *Kyiv*
16. Lampa ▸ *Kyiv*
17. MachineRoom ▸ *Kyiv*
18. America House Makerspace* ▸ *Kyiv*
19. Makerspace Lviv* ▸ *Lviv*
20. Lem Station ▸ *Lviv*
21. 1991* ▸ *Mariupol*
22. Lyceum* ▸ *Novoaidar*
23. Hub Lab* ▸ *Odesa*
24. MiRONAFT* ▸ *Odesa*
25. America House Makerspace* ▸ *Odesa*
26. SiniY Crab Art Space ▸ *Odesa*
27. BUR Okhtyrka Makerspace ▸ *Okhtyrka*
28. Technolab ▸ *Poltava*
29. Lyceum* ▸ *Popasna*
30. V. Dahl University* ▸ *Severodonetsk*
31. Bobry ▸ *Sumy*
32. Fab Lab TNTU ▸ *Ternopil*
33. Fab Lab Truskavets ▸ *Truskavets*
34. Creative Rural Hub ▸ *Verhniy Verbizh*
35. Makerspace at Vinnytsya Technical Vocational Collegeb ▸ *Vinnytsya*
36. Youth Centre* ▸ *Volnovakha*
37. Lyceum* ▸ *Zolote*

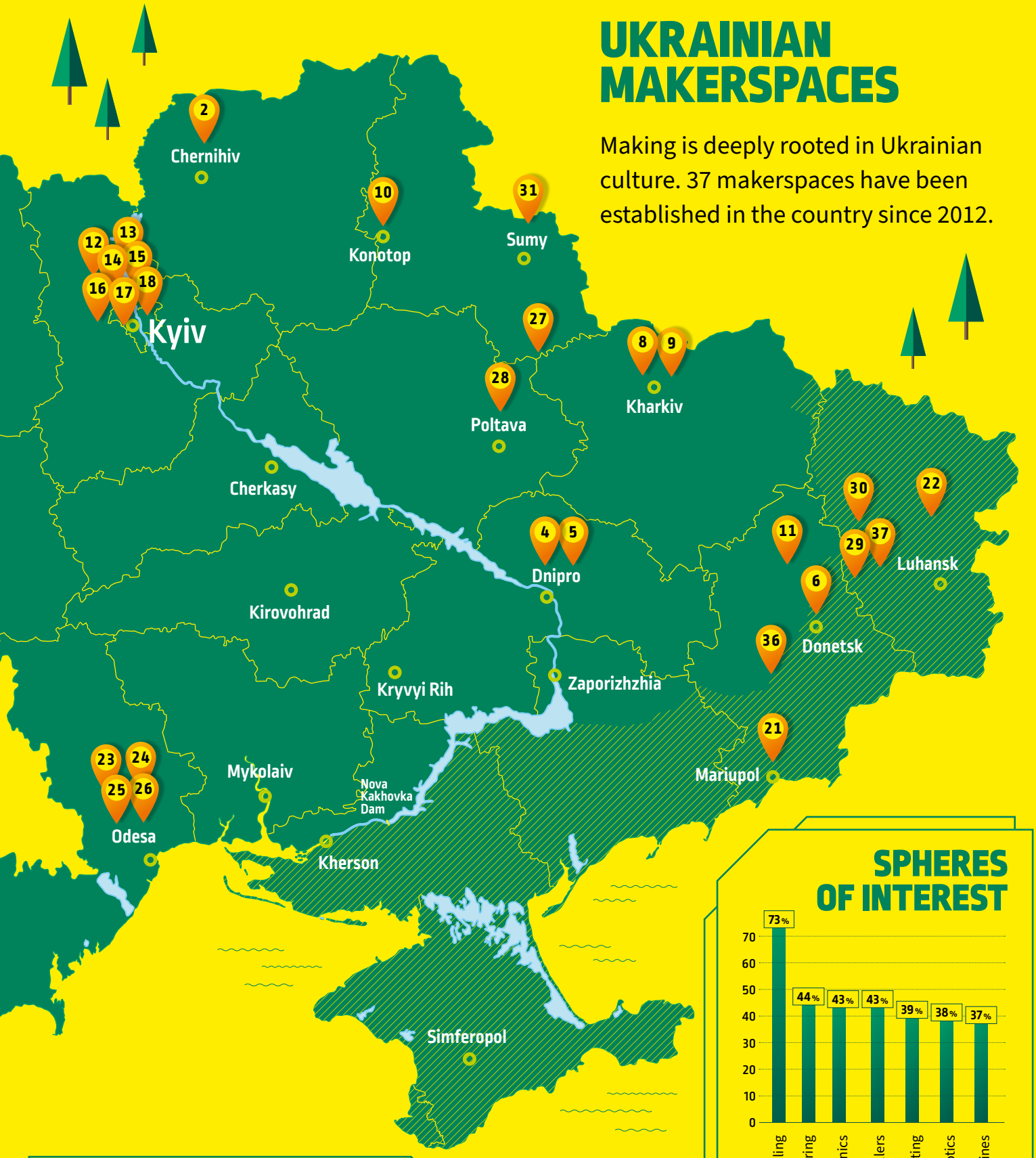
All data as of August 06, 2023

* These makerspaces are either temporarily displaced, defunct, or destroyed.

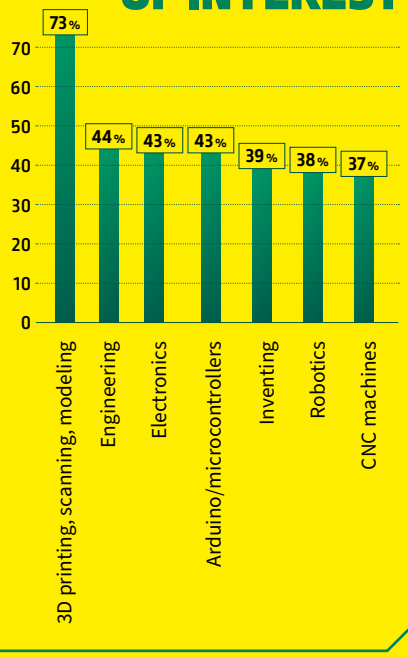
City · Makerspace · Ukraine · Occupied Territories

UKRAINIAN MAKERSPACES

Making is deeply rooted in Ukrainian culture. 37 makerspaces have been established in the country since 2012.



SPHERES OF INTEREST



"What does making mean to you? – Life. If I have not crafted anything for a long time, this means I am very likely to be diagnosed with depression during this period."

Anonymised quote from the MakerHub Research Report [4]

Source: Masiyenko, Y., & Zagryvenko, K. (2022). Study of the Current Needs of the Ukrainian Maker Community. MakerHub and MitOst for the Tolocar project [4].

Part 02

HOW TO TOLOCAR

Tolocar on Instagram

In this chapter, we share our insights from the Tolocar project, and the diverse possibilities and applications of mobile makerspaces in Ukraine since May 2022. We showcase different interpretations of what mobile makerspaces are, share use cases and equipment lists, and introduce the different qualities of our team which have been essential to the successful implementation of the project. Drawing from our experience, we also share practical insights and key learnings, as imparted from our team of operators.

Everything that the Tolocar project does serves to empower Ukrainian makers and thereby support the sustainable, inclusive and participatory socio-economic recovery of the country. In order to achieve this, we combine tried and tested approaches and methodologies from different fields, incorporating a unique new element: a fleet of mobile makerspaces.

Make Things that Make Sense. Anywhere.

This is the core of what the Tolocar project actually does. The phrasing was first introduced in the Critical Making project [1]. Just like the Tolocar project, critical making aims for impact, is characterized by open collaboration, connects local and global contexts, addresses social dimensions and ethical concerns, while critically reflecting on established norms, and infusing joy and purpose into the act of making. Diversity and inclusion are prerequisites for ensuring that solutions make sense to as many people as possible and leave no one behind.

The first step in making things that make sense is to ask local stakeholders what they need. The Tolocar project focuses on local and communally situated making, ensuring that the solutions created are deeply rooted in the communities we serve. Our stakeholders in Ukraine include various actors, from civil society organizations to small and medium enterprises (SMEs), educational institutions and public administrations.

Contact between local communities and the Tolocar project is usually established by mobile makerspace operators, who introduce themselves, the capabilities of their respective Tolocar, and the project as a whole with a Meet&Greet. This introduction is accompanied by a quick, low-key demo workshop, where small trinkets like key-chains are 3D printed. Another point of connection to local communities is through the vibrant network of makers in Ukraine. Although Ukrainian maker communities are not all formally organized, they have long been connected through various events and interest-based groups, many of them facilitated by MakerHub.

Once we have established what the local needs are, we set out to find solutions. This is either done through consultations within the Tolocar project teams, with Ukrainian makers and organizations, or through outreach to various global maker networks, such as Tolocar project partner GIG, Fab Foundation, the Gathering for Open Science Hardware (GOSH), Maker Faires, and Make: Magazine. In connecting communities in Ukraine and internationally, it is always important to consider differences in culture and circumstance and to develop customized activities based on local stakeholders needs and ideas. These activities encompass needs-based projects such as renovations and repair, the development, adaptation or replication of machines, and capacity development workshops.

Throughout the implementation of our activities, we prioritize safety above all else. We have established safety protocols and provide training to safeguard the physical and psychological well-being of our team and the communities we serve, creating a secure environment for collaboration and innovation. To foster transparency and knowledge sharing, we document all of our work in open source repositories, such as Appropedia and GitHub, and share updates through the Tolocar website, social media, and publications like this Playbook. Across all of our communication mediums, the utmost care is being taken to protect personal data.

Iryna Kolotylo on top of the Tolocar Support Car in summer 2022.

THE TOLOCAR APPROACH

The Tolocar project is situated at the intersection of emergency relief and development cooperation, combining local and global activities, and requires an approach in which values matter as much as methodology. Mobile makerspaces and globally distributed collaboration only make sense when embraced by people coming together for a short period of time. The ephemeral and co-creative nature of Tolocar project activities blurs the line between users and producers, and necessitates a strong connection between the Tolocar team and stakeholders on the ground, enabling bi-directional learning. We want to understand their problems and the solutions they may already have – and they want to understand how digital technologies can amplify what they do.

KEY STRATEGIES

Enabling Local Communities through Collaborative Partnerships

The Tolocar project thrives on partnerships with local maker communities, educational institutions, and innovation hubs, creating a robust ecosystem of shared knowledge and expertise. We equip communities with the necessary tools, skills, and resources to address their own needs, fostering self-reliance and community-driven solutions – sometimes in dedicated, newly established makerspaces or repair workshops, sometimes supporting existing makerspaces, and sometimes with no dedicated makerspace beyond the Tolocars.

Skill Development and Capacity Building

We conduct training sessions and workshops to enhance technological literacy and digital production skills, creating employment prospects and enabling individuals in emerging fields. Collaborations with schools and youth centers have been particularly impactful, equipping the younger generation with future-oriented skills through STEAM (Science, Technology, Engineering, Arts, and Maths) education. The virtual Maker Academy extends our impact beyond in-person workshops which require physical access to a mobile makerspace.

Innovation and Resilient Rebuilding

Mobile makerspaces have become catalysts for innovation, propelling Ukraine's rebuilding efforts. Despite or maybe because of the ongoing war, we have witnessed impressive manifestations of a culture of creative problem-solving, driven by the determination of local communities to overcome challenges.

Knowledge Sharing and Collaboration

Our team both in Ukraine and abroad, especially project partner GIG, facilitate extensive knowledge exchange among stakeholders, also connecting Ukrainian communities with the global maker community. This interconnected network of innovators has fostered collaboration and opened up new opportunities for learning and growth.

THE 7 STAGES OF A NEEDS-BASED PROJECT

The Tolocar project offers many resources/interventions such as machine replication and capacity development workshops, however, this section will focus on needs-based projects. These projects are realized by our oporators in collaboration with local communities in Ukraine.While the Tolocar project also encompasses machine replication and capacity development workshops, in this description, we focus on the needs-based projects which the operators realize together with local communities in Ukraine. HIWW, the project's main partner when it comes to implementing needs-based solutions , has been studying the phenomenon of open production for more than ten years. Operating within the Laboratory of Production Engineering at Helmut Schmidt University they have also implemented various projects within this research area.

The Tolocar project drew upon this experience and adapted the 6-stage Innovation Process developed by elrha and HIF in their Humanitarian Innovation Guide [2] to describe our approach in a concise manner. For more methods and tools, we highly recommend the Humanitarian Innovation Guide, which uses a lot of tools from other toolkits that we also use in our work, such as Nesta's DIY Toolkit and Strategyzer.

1 Connect

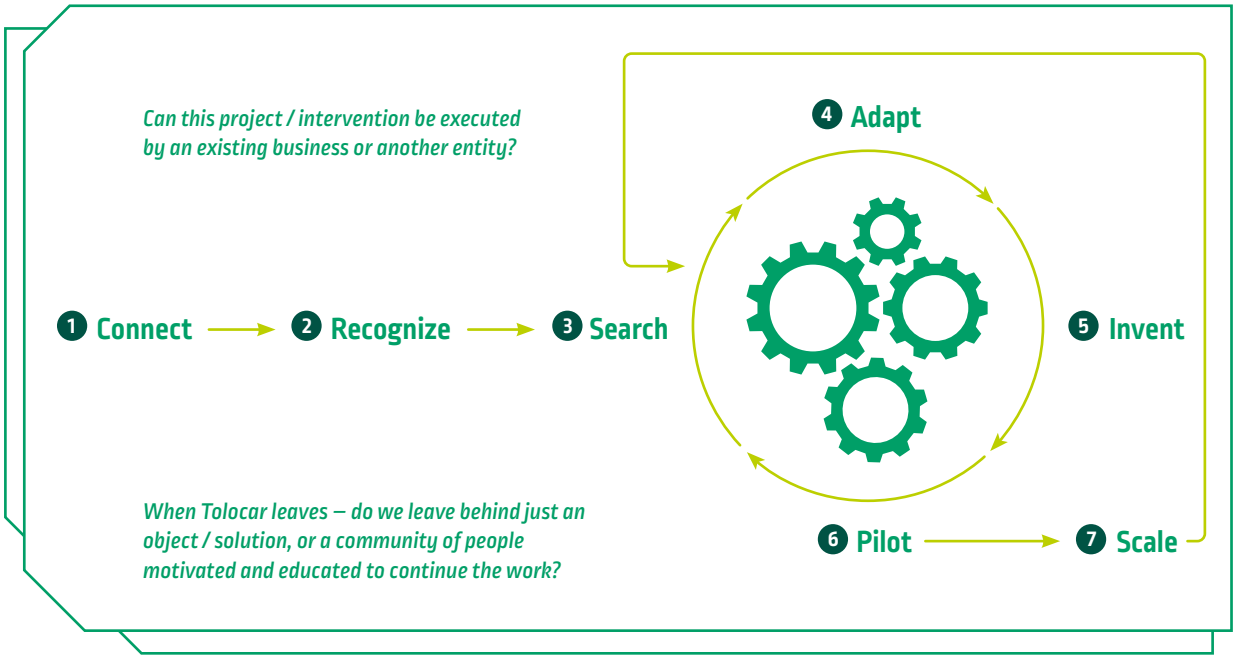
This stage emphasizes the crucial first step of building strong relationships. We connect with local partner communities through personal and professional networks, incoming partnership requests, or by searching databases such as the Platform for the Reconstruction in Ukraine and the internet. Establishing mutual trust is a significant focus at this stage.

Example: The organization Eco Misto in Chernihiv contacted the Tolocar Team with the idea to create an innovation hub for the local community.

2 Recognize

Here we work to recognize specific problems, opportunities and needs by gathering and accessing relevant knowledge, diagnosing root causes and framing the challenge appropriately. We support local stakeholders by leveraging our expertise in design thinking and approaching the problem from an outsider's perspective, encouraging them to think differently. As the Tolocar project progresses, we increasingly encounter issues related to digital fabrication, makerspace development, and distributed production.

Example: A Tolocar team visited Chernihiv, and operators met with representatives of the local community: Eco Misto, the Polytech, and the IT Cluster. The former cinema "Peremoha" was identified as a location, and the required renovations were identified.



3 Search

In this stage, we actively search for existing solutions within the local context, the global maker community, and relevant sectors or industries. We explore specific product designs, intervention planning, and makerspace development projects.

Example: Architects from the Ostriv Platform community designed potential solutions to turn three rooms in the building into a makerspace, community space, and event space.

4 Adapt

Sometimes, we adapt solutions from elsewhere, which may require significant rethinking of certain elements, to fit the local context. This stage involves identifying the necessary changes to adapt an existing solution to a new context. We carefully consider the specific requirements and make modifications accordingly.

Example: Beyond the designs by Ostriv, other open-source designs for furniture were adapted to fit the needs of the community, and additional (donated) machines were set up in the makerspace, including a plastics sheet press.

5 Invent

This stage involves inventing specific products, hardware and technology to solve problems or address opportunities. Our approach differs from the process described in the Humanitarian Innovation Guide in terms of user involvement. We work with users and primary beneficiaries from the beginning, instead of only engaging them at this stage. Collaborating closely, we co-create solutions and develop prototypes.

Example: As part of the makerspace activities, several tests are being run to find solutions for recycled building materials, using, for example, the plastics sheet press.

6 Pilot

At this stage, we pilot and test potential solutions in complex real-world environments to assess their effectiveness and implementation. This stage encompasses three workstreams: implementing the innovation, generating learning and evidence, and providing support and logistics.

Example: Peremoha Lab is running as a community and innovation space with a fully functional makerspace. The Tolocar team is supporting the local community in documenting the status quo and finding more partners for scaling.

7 Scale

This stage involves scaling the impact of the innovation to address the magnitude of the social problem it aims to solve. We focus on building the necessary complexity for sustainability and distilling this complexity to ensure replicability or adaptability – in addition, scaling requires good documentation.

Example: To transform Peremoha Lab into a fully functional community and innovation space, significant renovations are required. For instance, the community aims to incorporate the basement, which served as a shelter for over 300 people in the spring of 2022, into the community space. While these necessary activities currently fall outside the scope of the Tolocar project, a clear roadmap for scaling is in place.

The Connect, Recognize and Pilot phases require the physical presence of a team of Tolocar operators to ensure realistic partner expectations, mutual trust, and sustainability of our interventions, while the Search, Adapt and Invent phases can be done with or by domain experts anywhere in the world.

Throughout the process, we dedicate time to reflect on the value of our collaboration with our partners at each stage. Our guiding questions are:

Can this project / intervention be executed by an existing business or another entity?
Does our team possess specific expertise, technical capacity, mobility, or any other qualities that make Tolocar uniquely suited to address this challenge? If the answer is yes, we proceed. If not, we explore other options and ensure we do not take paid work away from local businesses.

What is the scaling and growth potential of each project / intervention?
When Tolocar leaves – do we leave behind just an object / solution, or a community of people motivated and educated to continue the work? Our goal is to deliver efficient solutions that maximize the use of our tools and minimize reliance on off-the-shelf components - not to showcase our capabilities as makers, but to enable others to create what they need themselves.

GETTING PROJECT MANAGEMENT RIGHT

In a distributed project, tooling for project management is crucial, including considerations for efficiency. The Tolocar team uses a comprehensive tool to streamline work and foster efficient communication across four countries. This helps the team track everything and ensures smooth coordination, so the team can effectively serve communities.

The first key aspect is the use of a purpose-built (or better yet: "purpose-grown") relational database. This database covers various aspects of the Tolocar project, including a content management system for solutions and social media management; customer relationship management; procurement; financial administration; asset management; and of course project and task management. Each part of the database serves a unique purpose, allowing team members to access and update relevant information easily. Having all data interlinked and in one database allows us to navigate the project in different ways depending on the questions asked, stories willing to be told and circumstances that constantly change.

Through this data-driven approach, we have developed new and adapted existing taxonomies that allow us to manage the ambitious and complex task of mobile and distributed making. Consolidating all the data allows us to prioritise interventions and come up with solutions that not only align with the goal of "making anything anywhere" but are truly about making things that make sense.

Another vital aspect is the implementation of status fields for longer-term projects, as well as one-off events and interventions. This helps the team track progress and maintain a clear understanding of their current states. These status fields are broken down into several steps which can be viewed as a kanban board, providing a structured approach to project management.

Lastly, the team emphasizes a well-defined "Definition of Done" for each project or intervention. This set of criteria ensures that all necessary administrative tasks are completed after the project's execution, facilitating proper documentation and reporting.

DATA ENTRY FORM

Our template for creating new projects in the database includes the following fields:

Project Name
(Parent Project, if applicable)

Short Description

Status
- KPIs met
- Project Lead
- Tolocar(s) + Operators

Location
- Start Date
- End Date
- Hosting Organization(s)
- Partner Organization(s)
- Potential Partner Organization(s)
- Target Group

Tasks
- Tools uses
- Material / Supplies used
- Purchases

Type of project
- Complexity
- Solutions
- Needs

Attendees
- Number of people impacted
- Documentation (external links)
- Notes
- Public Photos

Final Report done?

Where applicable, the fields are connected to various interlinked databases, such as purchases, reporting, as well as the To Do Lists of individual team members, and repositories of solutions.

Some Tolocar operators:

Vitalik Tereschenko, Oleksandr Holenko, Ivan Nesterenko, Denys Kvasov, Radion Dubrovka, Oleksandr Buhaenko, Artem Dyachenko, Konstantin Leonenko (from left to right)

DRIVING SUCCESS THROUGH COLLABORATION

The Tolocar Team

Our team – all people from all partner organizations working on Tolocar together – is the driving force behind the success of the Tolocar project. Together, we faced a multitude of challenges, first and foremost of course the ongoing war which started with Russia's full-scale invasion of Ukraine, and all its implications, from logistics to the mental health of our team members.

Some of the challenges our team faced were language barriers, remote work beyond the usual home office, and not having a blueprint for deploying a fleet of mobile makerspaces – it had simply never been done before on this scale. To overcome these obstacles, team members pooled their diverse skills, nurtured a culture of continuous learning, and fostered a collaborative spirit, all of which contributed to our project's accomplishments.

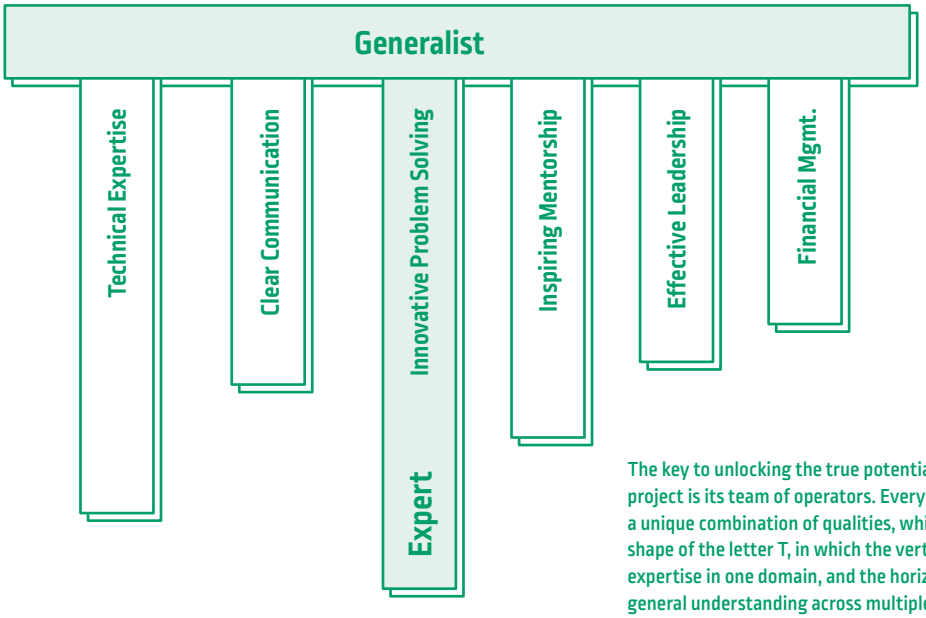
The consortium of partners is represented by a balance of engineers, social scientists, architects, economists, urban planners, and artists. This diversity of expertise is further complemented by a variety of genders and cultural backgrounds, where partners are united by their commitment to openness, creativity, and problem-solving. Embracing difference ensures our team can effectively tackle challenges and drive successful outcomes.

When it came to recruiting our team of operators, several key factors needed to be considered. First and foremost, it was important to seek individuals who are open-minded and willing to take risks. These qualities enable our operators to approach challenges with a constructive attitude, focusing on finding solutions rather than dwelling on problems. Second was finding people who are effective learners, recognizing that technical skills can be developed more easily than a robust aptitude for learning. By prioritizing the recruitment of individuals who possess a combination of open-mindedness, willingness to take risks, a solution-oriented mindset, and the ability to learn effectively, you can build a team that is well-equipped to embrace new ideas, overcome obstacles, and ultimately reshape community engagement.

QUALITIES OF A TOLOCAR OPERATOR

We think it is important for practitioners who want to start mobile makerspace projects themselves to take a closer look at the qualities that make our operators stand out within the Tolocar team. Instead of assigning specific roles, we value a range of qualities that not only contribute to our project's success but also serve as valuable traits for operators in other mobile makerspaces. These qualities include innovative technological skills, effective leadership, inspiring mentorship, sound financial management, technical expertise, and clear communication. Each of these attributes plays a vital role in achieving Tolocar's goals and ensuring the project runs smoothly.

T-SHAPED QUALITITES OF A TOLOCAR OPERATOR (Example)



The key to unlocking the true potential of a mobile makerspace project is its team of operators. Every Tolocar operator embodies a unique combination of qualities, which can be illustrated by the shape of the letter T, in which the vertical stem of the T represents expertise in one domain, and the horizontal bar of the T represents general understanding across multiple areas.

Innovative Problem Solving

Tolocar team members possess deep knowledge of software and hardware. With their ingenuity, they develop innovative solutions, repurpose technology creatively, and push boundaries in order to achieve project goals. The combination of expertise and collaboration with the whole team, as well as with partners and users, drives technological integration, and fosters a culture of innovation.

Effective Leadership for Successful Project Delivery

A culture of effective leadership permeates the team, as members skillfully plan, organize, and coordinate tasks, adeptly manage resources, and communicate with stakeholders. Their collective adaptability to changing circumstances and decisive decision-making drive projects to successful completion.

Inspiring Mentorship for Growth

Throughout the various workshops and trainings, Tolocar operators also act as mentors. They guide and facilitate learning for workshop participants, create engaging lessons, provide feedback, and nurture a positive learning environment. They inspire and motivate, impart knowledge, develop critical thinking skills, and foster personal and academic growth, shaping the future of individuals and society.

Sound Financial Management

A financial administrator oversees and manages financial operations within Tolocar, including budgeting, financial reporting, cash flow management, and financial analysis. They ensure compliance with regulations, and provide guidance, but the operators on the ground manage the intervention-specific budgets.

Technical Expertise for Maintenance and Troubleshooting

The team relies on the technical expertise of its members to maintain equipment and systems, ensuring their reliable operation. They troubleshoot issues, perform regular maintenance, in order to uphold a safe working environment. Their resourceful problem-solving and collaborative nature contribute to the smooth functioning and reliability of equipment and infrastructure.

Clear Communication

The team acknowledges the importance of communication, with each member playing a pivotal role in facilitating communication that is clear and productive. They collectively ensure a seamless flow of information, manage public relations, and enhance brand reputation. Dedicated experts implement communication plans, manage PR, and enhance brand reputation in collaboration with partners and based on input from operators.

Volodomyr Babii and Olha Ivanchenko took over the truck in October 2022.

Artem Dyachenko, Oleksandr Buhaenko, and Radion Dybrovka (from left to right) gave the van their own personal note.

INSIGHTS AND LEARNINGS

Put yourself out there in professional networks.
In the years prior to the Tolocar project, all partners have been actively engaging with local, regional and international (maker) networks, openly sharing their work and contributing to others' projects, and attending relevant events and conferences. These connections and the relationships we built are not a prerequisite to designing a mobile makerspace project, but they allowed us to quickly identify potential new team members who possess the specific skills and passion necessary to contribute to the Tolocar project's success.

One person, different skills and roles.
Our team members all have T-shaped skill sets. This metaphorical representation signifies a combination of deep expertise in a specific domain (vertical stem of the T) and a broader understanding across multiple areas (horizontal bar of the T). Everybody in Tolocar is a communicator, and has some technical expertise on at least one of our core topics.

Knowledge Sharing and Mutual Learning.
Encouraging knowledge sharing among all project partners and within their teams promotes a dynamic learning environment. We take time to reflect on different activities together. Regular opportunities to exchange insights, best practices, and lessons learned help us elevate our collective expertise and fosters a culture of continuous learning and improvement.

Have a Clear Goal.
Establishing a shared understanding of the project's purpose and each partner's and team member's responsibilities helps us align our efforts and increases a sense of shared ownership and accountability.

Trust and Psychological Safety.
Especially in Ukraine during the ongoing war, it is important to build trust among partners and team members by promoting a psychologically safe work environment. We rely on respectful dialogue, active listening, and constructive feedback. When team members feel safe to express their opinions and take calculated risks, it enhances collaboration and innovation.

Diversity and Inclusion.
We strongly value and embrace diversity, recognizing the importance of incorporating varied perspectives, cultural and personal backgrounds, and areas of expertise to stimulate more creative solutions and enhance our decision-making processes. Our team on the ground in Ukraine currently lacks diversity in terms of gender and ethnicity, but it includes individuals with diverse cultural backgrounds, ages, and professional experiences.

Recognition.
We recognize and respect each other, as well as the ever-changing circumstances we find ourselves in – again, this is particularly important during the war when things may not go as planned because of air strikes and other threats, but we believe it is always relevant. We acknowledge and appreciate everybody's efforts and achievements, and celebrate milestones together.

Converting a Bus into a Mobile Intensive Care Unit (MICU)

In August 2022, CADUS and Metalab embarked on an ambitious mission: converting an old passenger bus into a Mobile Intensive Care Unit (MICU) that could transport four critically injured patients and up to six patients with minor injuries at once in a secure ambulance. MICU has transported hundreds of patients requiring intensive care in the Dnipro region as of July 2023.

Stretcher Attachment Bracket

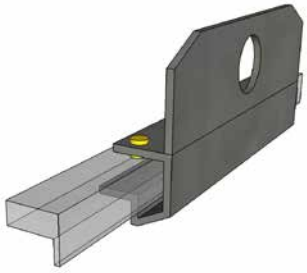
The design of the Stretcher Attachment Bracket is critical, as it has to securely hold the stretchers during transportation, ensuring the patients' safety throughout the journey. The team fabricated precise brackets in Metalab's Makerspace, and shared the designs via open-source repository Appropedia.

Volunteers work on the bus transformation at Promprylad in Ivano-Frankivsk.

A MOBILE INTENSIVE CARE UNIT FOR MEDICAL EVACUATIONS

Since the beginning of the Russian war on Ukraine on February 24th 2022, the safety of medical patients and their necessary care in hospitals cannot be guaranteed, especially near the frontlines. Intensive care patients are particularly affected by the situation, as they must be monitored around the clock. Medical evacuation (MedEvac) missions transport patients to safe hospitals in Ukraine or in the European Union. Each MedEvac mission is usually carried out by an ambulance with a crew consisting of a driver and at least one paramedic. Transportation of several patients from the same place would thus require several ambulances and crews. In a huge country like Ukraine, this ties up a lot of the workforce, and stresses the vehicles, which tend to be not built for long distances. To make MedEvac missions more effective, CADUS and Metalab converted a bus into a Mobile Intensive Care Unit (MICU). The advantage: more patients are transported with fewer staff, using a vehicle that is designed for long-distance travel. The Tolocar team supported the design and planning of the bus, which was later built with financial support of the German Ministry for Foreign Affairs

MICU could not have been realized without the support of dedicated volunteers from both Ukraine and Germany. The volunteers helped strip the bus of its unnecessary elements while ensuring the preservation of its structural integrity. Over the course of three weeks, they worked tirelessly to install essential components such as electrics, oxygen and water supplies, as well as to integrate the much-needed medical equipment. Amidst the limited space available, they also managed to create practical storage areas and set up a functional nurses station. This endeavor



The design by Ukrainian maker Pavlo Marchenko is shared open source on Appropedia.

Volunteers strip the original travel coach in Berlin.

The design of MICU was part of the Tolocar project, while procurement and operations are part of a project supported by the German Federal Foreign Office.

demanded meticulous planning and precise execution, making it a real challenge – but it was also a tremendous success! AS of July 2023, hundreds of patients have been transported with MICU, most of them wounded soldiers. MICU has become a symbol of resilience through solidarity and open innovation.

The CADUS Crisis Response Mobile Makerspace (CRMMS)

CADUS is a non-profit and independent aid organization based in Berlin. Their projects focus on innovation, sustainability, and developing local capacities based on the needs of the communities they serve. They operate in areas where few other aid organizations are active or from which they have withdrawn. In every aspect of their work, CADUS emphasizes cooperation with local partners, and openly shares solutions and innovations with the public.

The CADUS Crisis Response Mobile Makerspace (CRMMS) is a mobile workshop vehicle that can be used in various situations. CADUS lent this vehicle to the Tolocar project, where it was mainly used for Crisis and Emergency Response – supporting housing and infrastructure (i.e. construction projects), providing rapid assistance after minor damage to buildings. This mobile workshop vehicle could also be used as a mobile production facility for 3D printing and CNC milling to produce (medical) components and solutions on site, although CADUS is yet to explore this use.

Some of the learnings, which CADUS generated through internal reflection sessions, are:

- Specialized vehicles should be used instead of “catch-all” versions.
- A physical workshop (“base”) from which the vehicles can operate is beneficial.
- Close collaboration with local partner organizations and specialized businesses is essential to support the local economy and better understand needs.
- Established systems should be handed over to local partner organizations to build a solidarity network that can provide assistance in various crisis areas.
- A network to exchange knowledge and experiences should be set up and maintained. In the long term, structures from old crisis areas can offer assistance to new crisis areas in a spirit of solidarity and pass on materials that are no longer needed. This deconstructs the hierarchy of donors and recipients, and creates an understanding of a solidarity network that works in different directions.

Solidary, differentiated and humane: CADUS Activities in Ukraine

Responding to the crisis in Ukraine, CADUS established a base in Lviv just one month after the full-scale Russian invasion. Since then, they have been coordinating and executing patient transports throughout the country, with a particular focus on Eastern Ukraine since mid-2022. Additionally, they have conducted vital medical and safety trainings and supported local rescue organizations by delivering essential materials, and providing 22 ambulances to bolster rescue efforts.

CADUS's commitment goes beyond immediate aid: they are also focused on strengthening local rescue structures in Ukraine, which mirrors the Tolocar project's objective of supporting rebuilding efforts and fostering the Ukrainian innovation ecosystem in the long run. This is why CADUS collaborated with Tolocar from May to August 2023 by deploying their CRMMS vehicle.

Inspired by the success of MICU, CADUS transformed a truck into a mobile Primary Health Care Unit (PHC), which was handed over to their partner organization BASE UA in February 2023 and has since been deployed near the frontlines. At the time of writing, CADUS is preparing the CRMMS for a mission to provide support to the people affected by the Nova Kakhovka dam break.

> *"If anybody will build a Tolocar for any country, any region, any task: They should not try to build the perfect Tolocar, but build a baseline Tolocar, and leave some budget for the operators to get exactly the tools that they need for what they will do."*
>
> Denys Kvasov

CHECKLIST

We want to share our learnings and good practices with other teams that (plan to) operate mobile makerspaces. We have developed a checklist for ourselves, which is a continuous work in progress and does not claim to be exhaustive or applicable to each and any mobile makerspace project. But we wish we had had something like it when the Tolocar project started! Therefore, we share our checklist here and also online as a living open-source document, so anyone can easily adapt it to their needs, add to it, and join the discussion.

TEAM

Recruiting

- ☐ Prepare a job description for recruiting, including necessary driver's licenses and technical skills.
- ☐ Explicitly offer specific skills training on the job.
- ☐ Prioritize soft and communication skills, an open and solution-oriented mindset over technical expertise.
- ☐ Consciously reflect on the diversity of your team – which groups are represented, which are not? Is that intentional, and if not: what can you do to become a more diverse team, and thus develop more inclusive solutions? [1]

Onboarding

- ☐ Draft contracts for different roles, in accordance with all applicable laws.
- ☐ Prepare an onboarding package:
  - ▸ Project Description, including objectives, indicators, and limits
  - ▸ Introduction to all tooling, e.g., database, team communication channels
  - ▸ Reporting Guidelines: internal reporting vs. reporting to partners vs. reporting to the funder vs. reporting to the public via (social) media and events
  - ▸ Templates of all paperwork in all necessary languages (in our case: Ukrainian, German, and English), e.g., Time Sheets, Handover Protocols, Participation Sheets, Transfer Agreements for photo, video, and audio material
- ☐ Conduct internal onboarding sessions, pair experienced team members with new ones.

Locally Distributed Operations

- ☐ Create a connection between the back office and operator teams through informal "All Hands" meetings, in addition to internal sessions for operational planning, knowledge exchange, and process improvements.
- ☐ Have a Code of Conduct.
- ☐ Community Engagement and Collaboration: Co-create and constantly iterate your team's strategies for building relationships with local communities and partners, fostering collaborations, and effectively sharing knowledge and skills.

Working with communities

- ☐ Understand the context of the respective community.
- ☐ Learn about the innovation ecosystem and get in touch with local hubs, makerspaces and innovators.
- ☐ Build on local resources and cultural strengths.

Learn and Share

- ☐ Reserve ample time for learning and sharing within the team, as well as with users and partners (e.g. feedback rounds at the end of an activity, regular retrospective meetings).

- ☐ Contact others to share your experiences and learn from theirs.
- ☐ Re-use open resources and designs.
- ☐ Contribute and upload your own solutions to open source repositories (e.g. Appropedia, GitHub).

Safety and Security

- ☐ Always prioritize the safety of your team and partners! If you are required to work with external service providers to ensure any of the points below, budget for it.
- ☐ Develop a system to ensure safety.
- ☐ Create emergency procedures, e.g., for fire, natural disasters, and in our case: war.
- ☐ Create safety protocols for machine usage.
- ☐ Facilitate internal trainings to ensure everyone knows how to act in cases of emergency, administer first aid, and handle tools and machinery safely.
- ☐ Remember that psychological safety is as important as physical safety! Create space and time for mental health, if necessary: budget for external support. In Ukraine to date, burnout and post-traumatic stress disorder (PTSD) are the biggest threats to mental health among civil society actors.

Reporting, Monitoring and Evaluation

- ☐ Monitoring and evaluation informs management decisions on all levels: within operator teams, partner organizations, and the overall Tolocar project.
- ☐ Define the frequency and format of internal monitoring and evaluation. Determine who will be responsible for compiling and distributing these reports. Use these reports as a basis for collaborative learning and sharing.
- ☐ Outline reporting requirements for partners or collaborating organizations.
- ☐ Specify reporting obligations for project funders.
- ☐ Plan to share updates with the wider public through media channels, social media, or events. Public reporting can help raise awareness about the project and its impact.
- ☐ Feedback and Learning: Encourage a learning-oriented approach to reporting, where insights and feedback from reports are used to improve project strategies and outcomes.
- ☐ Address data privacy concerns and obtain consent from participants if data or media which feature them will be used in the reports.
- ☐ Co-create and iterate a plan to track project progress and measure its impact. Define the data collection methods and metrics for evaluating the project's success. Establish clear indicators.

Administration

- ☐ Familiarize yourself with all procedures (in our case: customs, temporary import of vehicles, tools and machines, visa for foreign nationals).
- ☐ Prepare all necessary paperwork and make sure copies or originals are in the vehicle. In our case, this includes:
  - ▸ Vehicle registration documents
  - ▸ Insurance
  - ▸ Equipment warranty documents
  - ▸ For passing checkpoints: A letter from HIWW and GIZ that explains why Ukrainian operators (stating the names of the team members) are driving a vehicle with German number plates
  - ▸ Prepare handover documents.

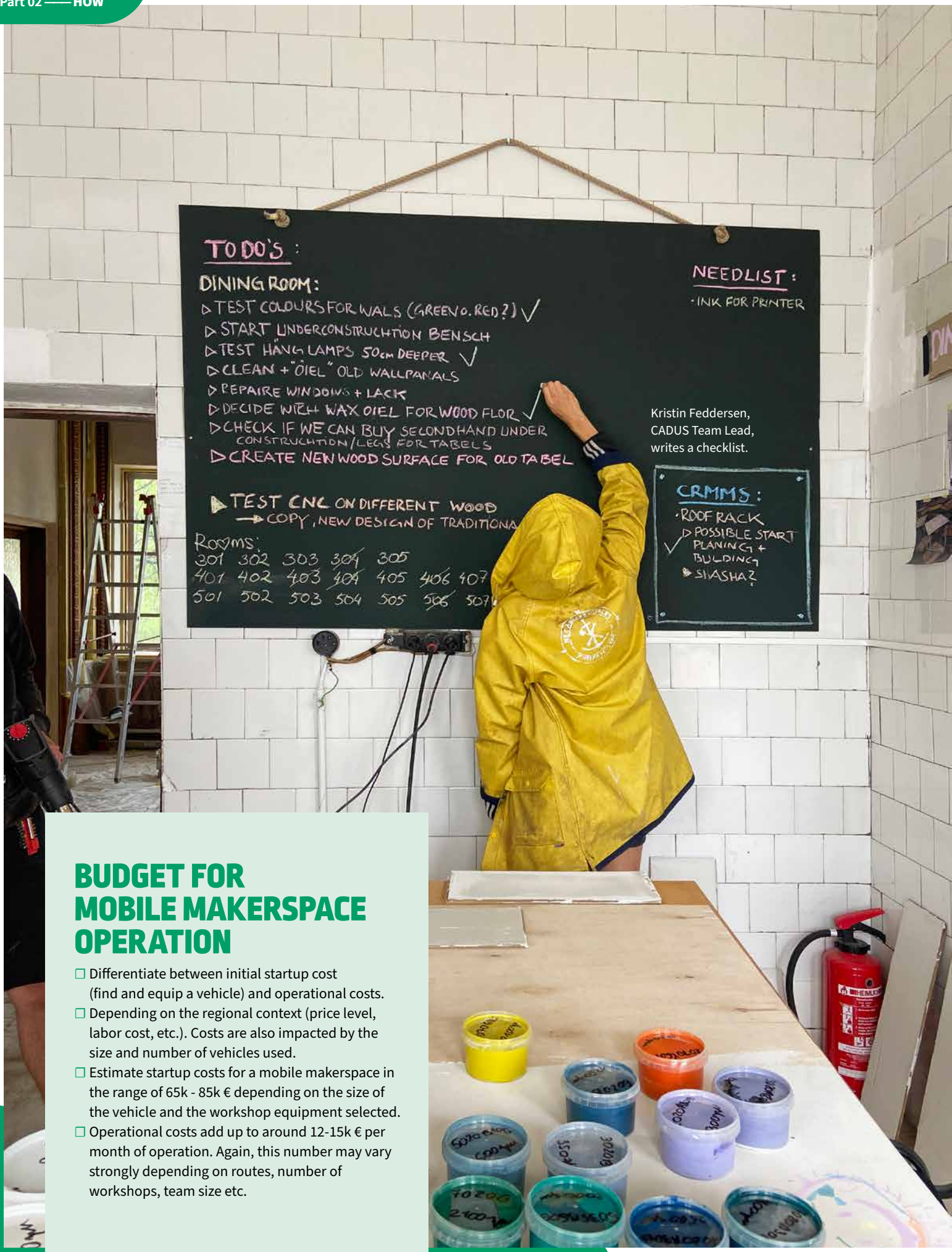
VEHICLES

Designing the vehicles

- ☐ Choose the machines and tools for your vehicles based on the needs of your partners and your project goals.
- ☐ Choose open source machines whenever you can. They are easier to maintain by yourself, and can be replicated in workshops with partners.
- ☐ Aim to keep the center of gravity as centered and low as possible – this will significantly improve stability of the vehicle.
- ☐ Ensure internet connectivity and self-sufficient power supply.
- ☐ Consider climate conditions: Use appropriate materials, insulate the vehicle before you outfit the mobile workshop, and if you operate in cold/hot climates: add a diesel-powered heater and/or air conditioning.
- ☐ Make sure that the software you need to run the machines is installed, updated, and running on dedicated appropriately-specced computers.
- ☐ Install an alarm and remote monitoring system of the vehicle as it is a high-value target for thieves.

Using the vehicles

- ☐ Always maintain the vehicle and all machines, tools and equipment so they stay in top condition.
- ☐ Consider external conditions when planning interventions, e.g. road conditions, safety concerns, availability of fuel.
- ☐ Have at least two keys per vehicle, and never store them in the same place.
- ☐ Store your vehicle toolkit separately from other tools for easy access when needed.
- ☐ Have all machine manuals with you in print, in case you have no internet connection when you have to fix something.



Kristin Feddersen, CADUS Team Lead, writes a checklist.

BUDGET FOR MOBILE MAKERSPACE OPERATION

- ☐ Differentiate between initial startup cost (find and equip a vehicle) and operational costs.
- ☐ Depending on the regional context (price level, labor cost, etc.). Costs are also impacted by the size and number of vehicles used.
- ☐ Estimate startup costs for a mobile makerspace in the range of 65k - 85k € depending on the size of the vehicle and the workshop equipment selected.
- ☐ Operational costs add up to around 12-15k € per month of operation. Again, this number may vary strongly depending on routes, number of workshops, team size etc.

I. Planning & Preparation Phase (approx. 3 months)

	Estimated Costs
Materials & Equipment*	
Vehicle purchase	20–30,000 €
Machines, tools & equipment purchase	15–25,000 €
Furniture/wood	1,500€
Electrical components	1,000€
Mechanical parts	1,500€
Paint	1,500€
Other	1,000€
	Services/Personnel
Sourcing of vehicles, machines etc.	2,500€
Registration	100€
Initial Check-up	1,500€
Maintenance & repairs	1,500€
Installations (furniture, machines, electrics etc.)	9,000€
Exterior design / branding	1,000€
Documentation / Tutorials	7,500€
Initial Invest:	**65,000 € (Van) – 85,000 € (Truck)**

II. Operations Phase

	Cost per month
Personnel**	
2-3 Operators (Full time equivalent)	3,000 – 4,500 €
Travel expenses	3,000 €
Materials***	
Vehicle maintenance & repair (10 % p.a. of purchase price)	200 €
Machines / tools maintenance & repair (5 % p.a. of purchase price)	75 €
Operational machine cost (energy, consumables etc.)	500 €
Operational vehicle cost (fuel, tires, parking, tolls etc.)	3.000 €
Consumables for workshops	1.5000 €
Administrative	
Vehicle tax & insurance (5 % p.a. of purchase price)	100,00 €
Depreciation (assuming linear depreciation over 10 years)	200,00 €
Operational costs per month:	**12,000 – 13,500 € per month**

* Depending on vehicle type, state and location. We searched for used vehicles in good condition in Germany.
** Depending on local labor costs and region of operation.
*** Depending on location, content and number of workshops

OUR FLEET – THE TRUCK

Video of the truck's departure © Sat1 Regional

The Truck is a versatile, self-sufficient, fully functional standalone FabLab on wheels. It is designed to be deployed virtually anywhere, allowing the team to work in remote locations with ease. It is equipped with a range of machines and tools, and with furniture and computers to host workshops with up to 6 participants inside.

Make and Model	**MAN TGL**
Weight	**7.5 tons**
Nominal power	**132 kW / 178 PS**
Dimensions	**7.95 m x 2.55 m x 4.00 m**
Home Base	**Kyiv**

EQUIPMENT

Power & Heating

Working voltage of 230V, maximum combined output current of 40A.
Power station with rechargeable battery and 3 solar panels.

- ☑ 1x Power station: Bluetti AC200P
- ☑ 1x Power station: Bluetti B230
- ☑ 3x Solar panels
- ☑ 1x Diesel heater

Computer

- ☑ 1x 3D Scanner: Revopoint Pop 2
- ☑ 6x Laptops
- ☑ 1x Documentation Server
- ☑ 1x Starlink receiver

Machines

- ☑ 3x 3D Printers: FLSUN Super Racer – Delta 3D Printer
- ☑ 1x Small PCB CNC: Sain Smart Genmitsu
- ☑ 1x Laser cutter: Fabulaser Mini
- ☑ 1x CNC milling machine: CNC6040
- ☑ 2x Vinyl cutters: Silhouette Portrait 3 (with extra accessories)
- ☑ 1x Manual plasma cutter machine, 40 amps

Electronics Lab equipment

- ☑ 1x Baku 603D soldering station
- ☑ 1x Oscilloscope
- ☑ 1x Heat gun

Workshop equipment and tools

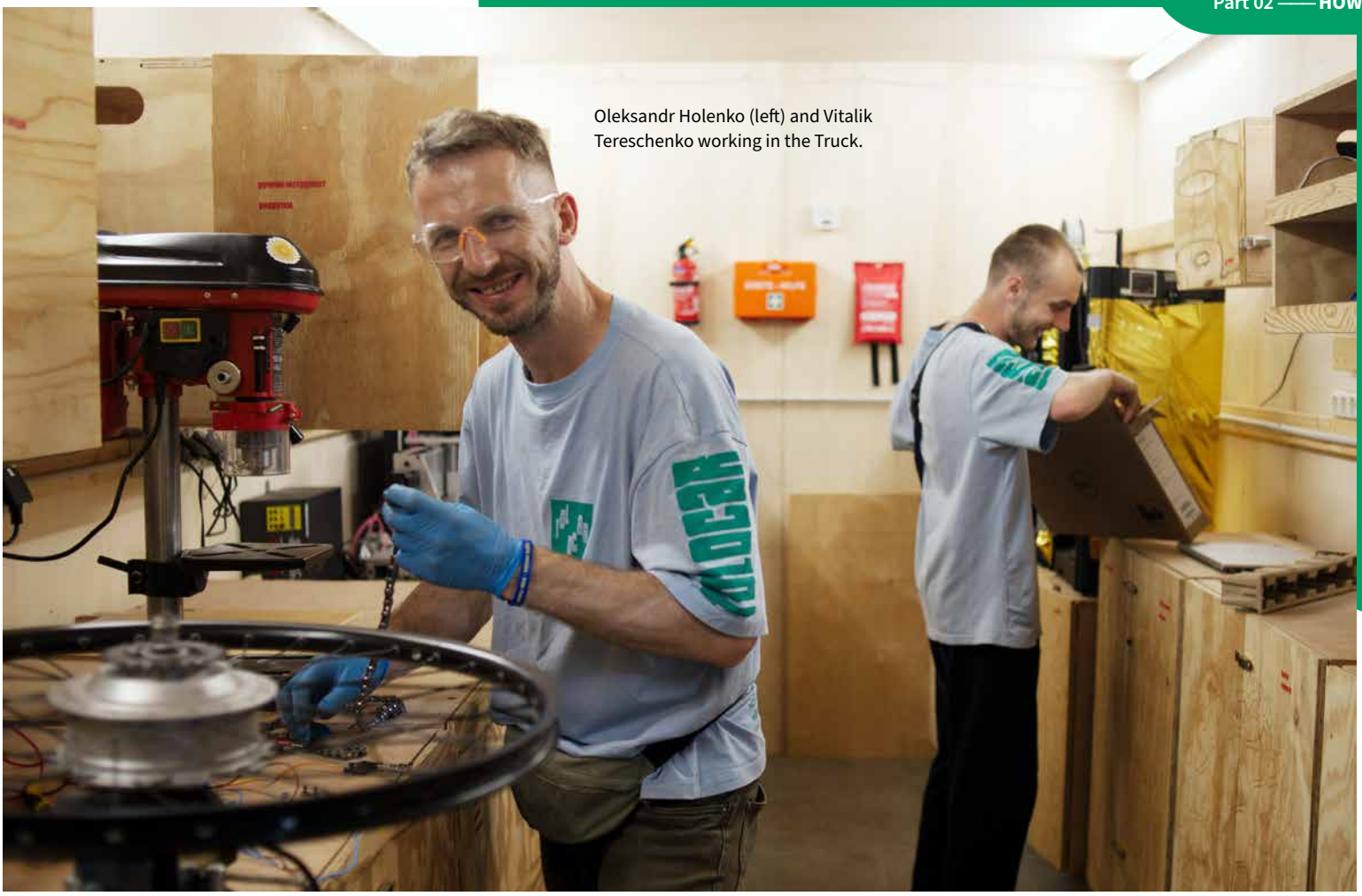
- ☑ 2x Grinders
- ☑ 2x Sanders
- ☑ 2x Extra rechargeable batteries
- ☑ 1x Drill press
- ☑ 1x Welding machine: GYS Smartmig
- ☑ 1x Compressor

Other Tolocars as well as a full list of all machines, tools, consumables, safety & security equipment, and accessories can be found **online**.

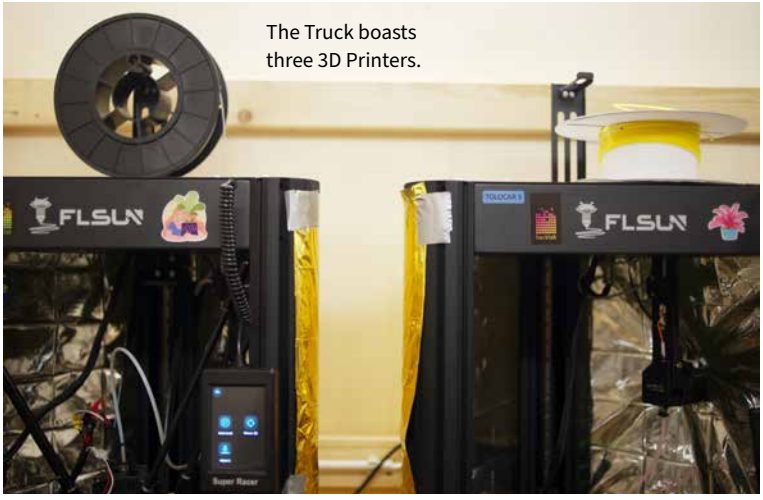
3D printer replication workshop at Klub Dobrodiiv.

Making emergency lights for shelters in Kyiv during blackouts in 2022.

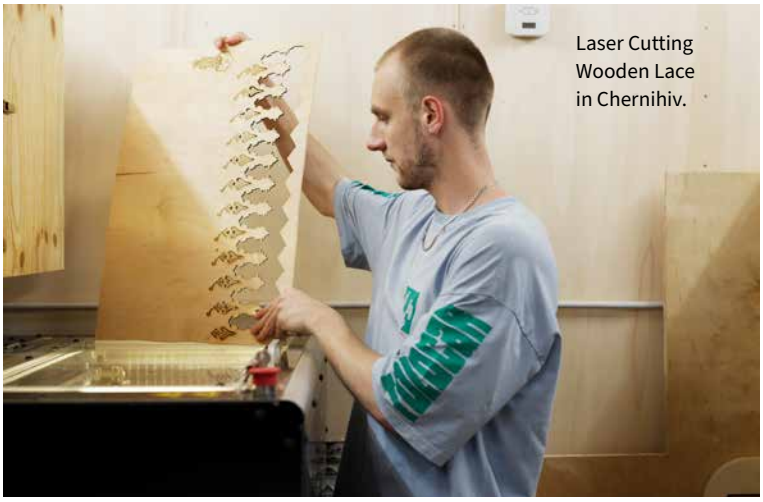
Replication workshop at a school in Kyiv.



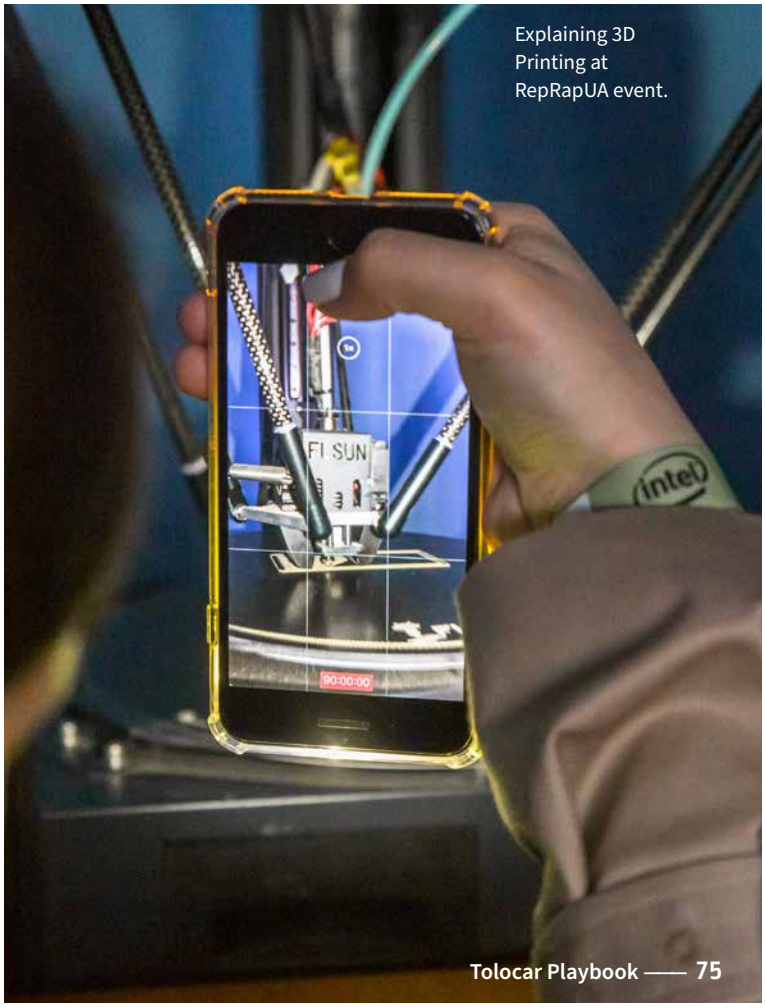
Oleksandr Holenko (left) and Vitalik Tereschenko working in the Truck.



The Truck boasts three 3D Printers.



Laser Cutting Wooden Lace in Chernihiv.



Explaining 3D Printing at RepRapUA event.

EQUIPMENT

Power & Heating

Working voltage of 230V, maximum combined output current of 40A.
Power station with rechargeable battery and 3 solar panels.

- ☑ 1x Power station: Bluetti AC200P
- ☑ 1x Power station: Bluetti B230
- ☑ 3x Solar panels 36V 100 W
- ☑ 1x Diesel heater

Computer

- ☑ 1x 3D Scanner: Revopoint Pop 2
- ☑ 6x Laptops
- ☑ 1x Documentation Server
- ☑ 1x Starlink receiver

Machines

- ☑ 3x 3D Printers: Flsun Super Racer
- ☑ 1x Small CNC mill
- ☑ 1x Laser Cutter: Fabulaser mini

Electronics Lab equipment

- ☑ 1x Soldering station: Baku 603D
- ☑ 1x Oscilloscope

Workshop equipment and tools

- ☑ 2x Angle Grinders
- ☑ 2x Vibration Sanders
- ☑ 1x Circular Saw
- ☑ 1x Band Saw
- ☑ 1x Welding machine: GYS Smartmig
- ☑ 1x Compressor

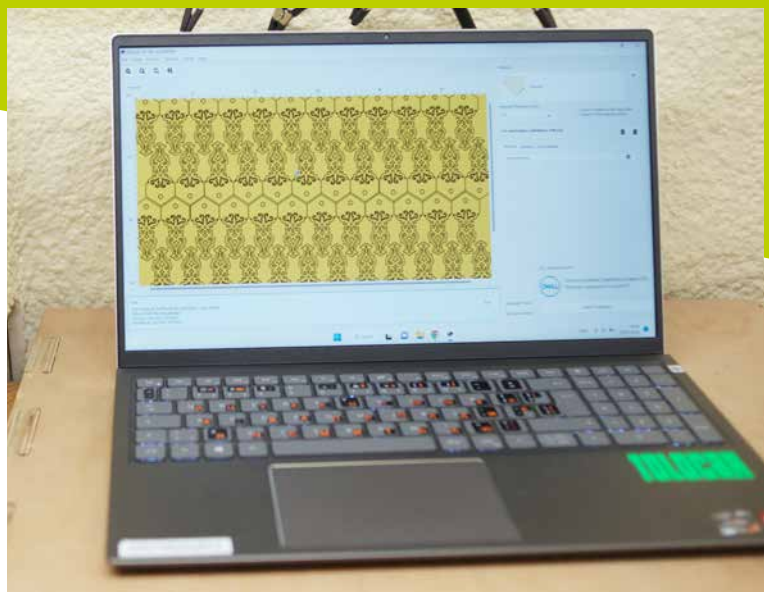
Other Tolocars as well as a full list of all machines, tools, consumables, safety & security equipment, and accessories can be found **online**.

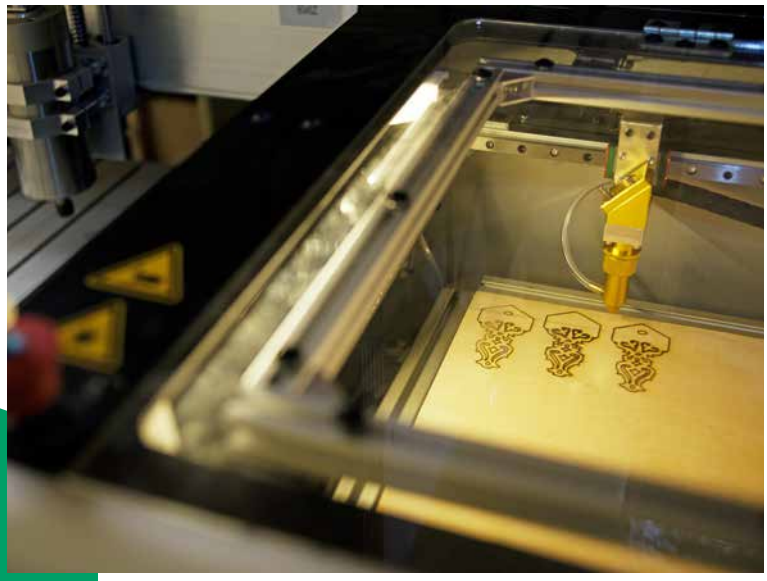
OUR FLEET – THE VAN

The Van which was equipped by InMachines and launched in October 2022 is a compact yet powerful hub of innovation on wheels. The van is small enough to be used with ease in cities, powerful enough to drive long distances faster and more comfortably than the truck, and robust enough to manage any road condition in any weather. Its self-sufficient power supply offers the flexibility to operate anywhere, even in remote locations. The van comes outfitted with an array of cutting-edge machinery, electronic laboratory tools, and a comprehensively equipped workshop.

Make and Model	**Iveco 35–160**
Weight	**3.5 tons**
Nominal power	**115 kW / 156 PS**
Dimensions	**7.13 m x 2.01 m x 2.66 m**
Home Base	**Ivano-Frankivsk**

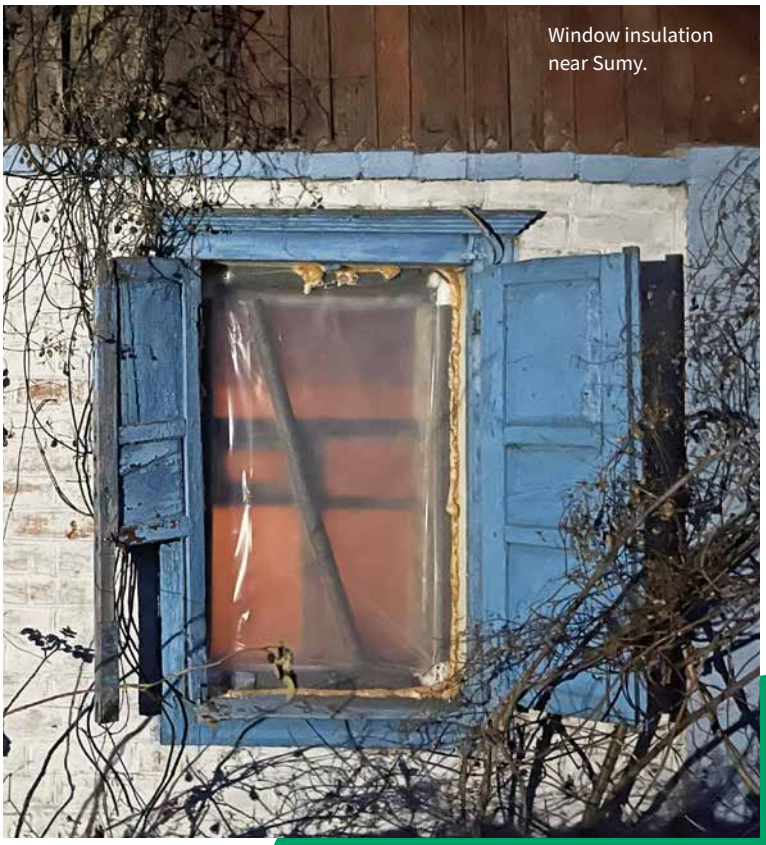
Making furniture with kids at a summer camp in Truskavets.





Visitor to Peremoha Lab in Chernihiv.

Ivan Nesterenko
operating the Fabulaser.



Window insulation
near Sumy.

Making emergency lights
in Ivano-Frankivsk.

> *"The workshop is a different space, and the kids are so normal and straightforward that I forgot about my medical routine and all those procedures for a while."*
>
> Serhiy, veteran workshop participant

Transforming Truskavets Together

Truskavets in Lviv Oblast is a renowned spa and rehabilitation town in the Carpathian mountains, which has become a place of healing and support for veterans seeking treatment for their physical and psychological traumas. The Tolocar Project conducted a transformative workshop here in November 2022 that brought together veterans and school children, setting a chain of activities in motion.

Through innovative solutions, international partnerships, and the establishment of a Fab Lab at School No. 3, the Tolocar project has left a profound mark on the lives of the participants and the spirit of Truskavets.

Many veterans who are facing limb loss and psychological trauma after fighting at the frontlines in the war, come to Truskavets to heal and recover. Being cognisant of the transformative power of making for people with disabilities and the advances in open source designs for assistive technologies, which projects like Careables have brought about in the last decade, the Tolocar team organized a workshop for veterans and school children. They did this in consultation with international partners Saad Chinoy from Salvage Garden in Singapore and Enrico Bassi from Opendot Milan and Fabcare, the Tolocar team organized a workshop for veterans and school children. The children, equipped with basic 3D design skills learned as part of their curriculum, were guided to embrace a user-centric design approach, understanding the needs and challenges faced by the veterans. While the tangible outcome of the workshop was just a personalized phone holder to assist veterans using crutches, the interaction between the children and veterans proved to be a powerful therapeutic tool, facilitating healing through empathy and understanding.

The resounding success of the initial workshop and the potential of the Fab Lab concept resonated with the teachers of School No.3. This workshop was made possible through the efforts of Denis Shilenkko, a local activist and IDP, and school principal Igor Letsiuk who joined forces to campaign for a Fab Lab to be added to the school. Letsiuk had previously spent a long time advocating for the establishment of a Fab Lab in Truskavets, building up a local network of supporters and raising financial and material support (including laptops through USAID). Their efforts and vision became a reality when the Tolocar project provided the crucial equipment for the Fab Lab in addition to assisting with several building interventions, running a

Before and after the transformation of a room into the FabLab at School No.3

Learn more about the WeArm O

replication workshop for 3D printers, holding strategic consulting sessions, and providing hands on tips for equipping and running a Fab Lab.

On February 22, 2023, the Fab Lab at School No. 3 was officially inaugurated, a testament to the collaborative effort between Tolocar, the local authorities, and the business community in Truskavets. Equipped with cutting-edge technology, including two 3D printers, a laser cutter, a plotter, and three desktop computers, the Fab Lab now serves as a hub of creativity and exploration for the school and the entire community.

While all of these activities are happening on the ground, Aziz Wadi from the GIG Support Project is working on developing a Maker Academy course to teach the assembly and creation of such low-cost prosthetic limbs, which the Tolocars will be able to implement all over Ukraine. Aziz' work has only been made possible through the potential of distributed design, which has allowed access to WeArm O, the open source version of the WeArm invented by Nigerian-American student Okezue Bell. Aziz is currently diligently working on testing and updating the innovative WeArm design with the goal of verifying its effectiveness with an up-to-date bill of materials (BOM) to ensure optimal functionality and accessibility, and designing a workshop format for its replication. A comprehensive and easily replicable open source workshop for a prosthetic which costs less than 1,000 € holds the promise of transforming the lives of people with disabilities everywhere, in Ukraine and beyond.

In Truskavets, we experienced the transformative power of a single workshop. The bringing together of veterans and school children, fostered healing, empathy, and learning – qualities which are now embodied in the Fab Lab at School No. 3. By providing tools and training, it will nurture a generation of compassionate innovators. Empowered with knowledge and inspired by their experiences, these young minds have the potential to drive further advancements in (assistive) technology and engineering in the future. We are really proud to be a part of the efforts that will continue to transform lives and uplift communities, embracing a future where no one is left behind.

MAKER ACADEMY

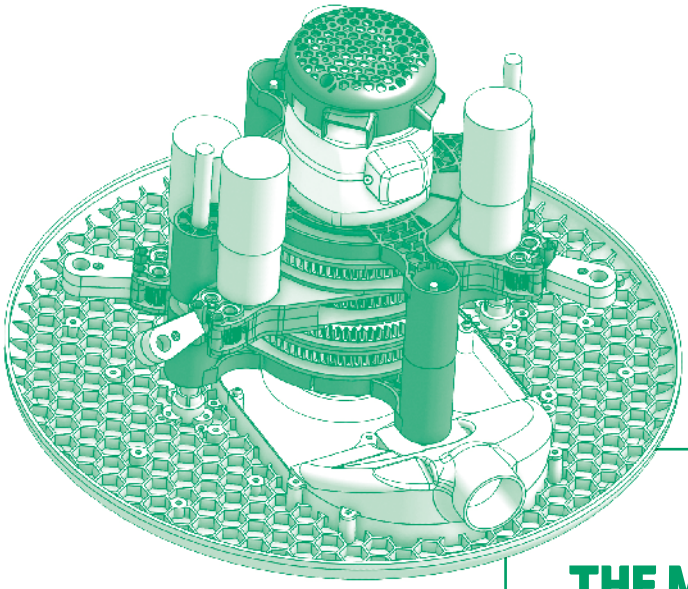
One of the key features of both stationary and mobile makerspaces is the availability of a catalog of project-based learning formats rooted in open source hardware documentation, which can be implemented locally. While access to tools, technologies, and materials is part of enabling people to realize their creative ideas, knowledge and skills are equally indispensable.

Beyond hosting hands-on capacity development workshops ourselves, we want to strengthen local makerspaces by training trainers, so that they are able to enhance their workshop curricula focused on engineering, design, electronics, programming, and other STEAM-related subjects. A curriculum of learning workshops facilitated by local makers can increase the visibility and attractiveness of the makerspaces and also provide new approaches to local value creation for makerspaces and freelancing trainers, e.g. in collaboration with vocational schools and training centers.

Learning in open source hardware is based on open source repositories of project documentations, including source files of designs and instructions. The documentations can be remixed and adapted to meet specific needs. Progress in the field of making is created through these adaptations. Despite numerous projects being documented across various platforms and repositories, only a handful of them have been adapted to cater to local needs in Ukraine – considering language, entry level, and adaptability to diverse skill levels. As we conceptualized the Tolocar project, our primary goal was to establish an online learning platform for future making focusing on self-hosted learning.

However, in the initial months of the project, it became evident that deficiencies in digital and technical skills were a significant obstacle to the effective implementation of the Tolocar program on the ground. We then decided to pivot and adopt a more introductory approach to the development of technological literacy.

To address this introductory approach, we are crafting a project-based curriculum centered around the construction of open source computer-controlled machines, ranging in complexity and capabilities. These are low-cost projects that are aimed at building the audience's confidence with digital fabrication toolchains. Additionally, they foster skills such as basic machine troubleshooting, familiarization with microcontroller programming, digital communication protocols, data formats, and similar competencies.



A Maslow CNC is being built as part of the virtual *Toloka* facilitated by GIG, and documented for the Maker Academy.

CURRENT DRAFT CURRICULUM

Level 0
Introduction to 3D printing:
Creating keychains in TinkerCAD

Level 1
CAD modeling and 3D printing

Level 2
3D printing and basic electronics:
EggBot-style build

Level 3
Basic Microcontroller programming, basic robotics and precision mechanics:
AxiDraw-style pen plotter build

Level 4
Extending microcontroller programming and advancing path planning:
Drawbot wall-mounted plotter build

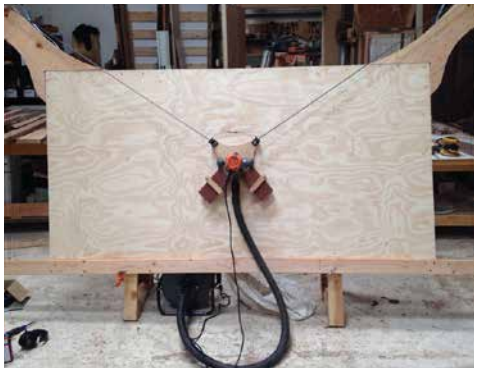
Level 5
Advanced robotics and CNC control:
MaslowCNC build

These are all projects that have been extensively documented in western English-speaking maker communities, but can be challenging to implement in the Ukrainian context due to the shortage of specific electronic or electro-mechanical components and the lack of well-structured documentation in the Ukrainian language.

We proceed with our iterative approach in developing and delivering such workshops by building a network of partners that is already established.

THE MASLOW CNC MILLING MACHINE

A special case in the area of Fab Lab and Maker communities is the Maslow CNC milling machine. The Maslow CNC is a project based on open source hardware and software. Its special feature is its structure: The plate to be machined does not lie flat and horizontal, but almost vertical, slightly angled. This makes the machine particularly space-saving. A hand-operated router is used as the centerpiece. This sits in a housing that hangs from two chains that are lengthened and shortened under motor control so that the router can move left, right, up and down over the panel. In addition, the Z-direction of the router is controlled, i.e. the vertical plunge into the slab.



The Maslow CNC machine stands at a slight angle, almost vertically, which makes it extremely space-saving. A router that can be used for manual operation hanging from two chains that are lengthened and shortened by motors – controlling the movement of the router.

*As of 25 May 2023, the International Organization for Migration (IOM) estimates that 5.1 million people are still internally displaced within Ukraine. [5]

"There are so many amazing people here that we worked with on this project. I think that was a very encouraging experience for all of us."

Kristin Feddersen, Team Lead CADUS

CO♥HATY

BUILDING FUTURES WITH LOVE

The full-scale Russian invasion of Ukraine forced around 12 million Ukrainians to leave their homes. Of those, 6.5 million people moved to the Western part of the country.* In Ivano-Frankivsk, the remarkable CO-HATY project emerged as a ray of hope for those who had lost their homes due to war.

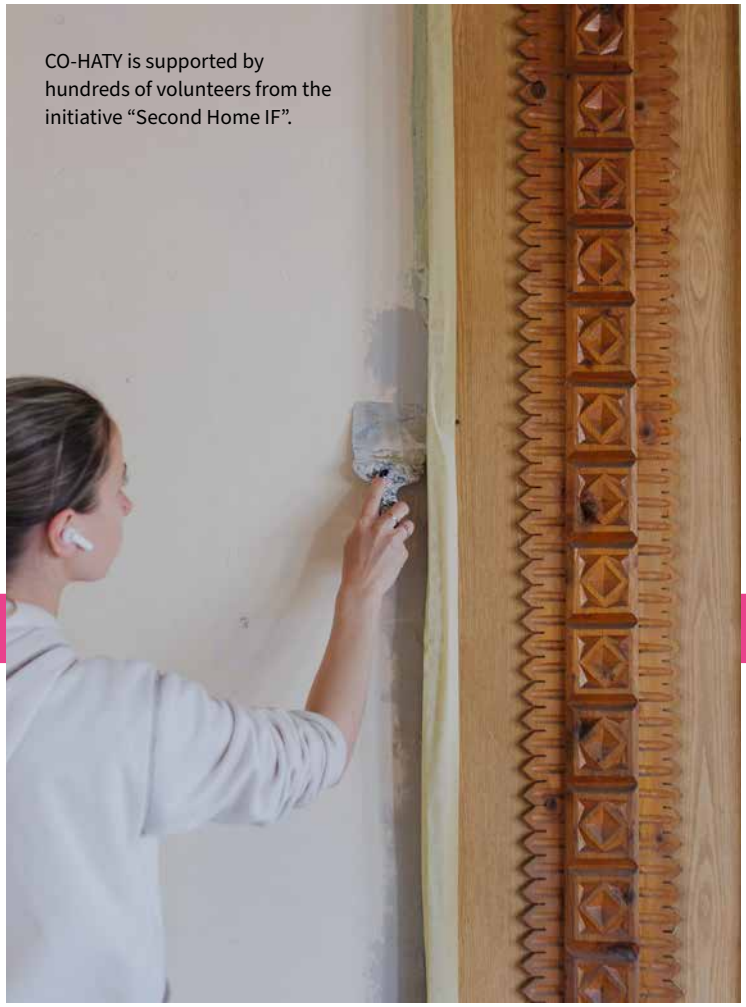
CO-HATY is a co-housing project for people who became internally displaced during the conflict. The name "CO-HATY" is a combination of the Ukrainian word "HATY" meaning "houses," and "CO" as in co-creation and co-working. Taken together, the Ukrainian word "COHATY" actually means "love" – a fitting name for an initiative that focuses on creating co-housing solutions with care and compassion. The project was launched in March 2022 and is a collaboration between METALAB, an urban laboratory in Ivano-Frankivsk, and members of the independent agency Urban Curators, who relocated from Kyiv. With the support of partners and a dedicated community of volunteers, they set out to renovate buildings and create homes that would provide shelter and dignity for the displaced individuals.

Tolocar ♥ CO-HATY

The first Tolocar intervention in May 2022 was a collaboration with Metalab and CO-HATY. Together with Tolocar, they embarked on a journey to transform the former Hotel Olga, one of the six buildings of the CO-HATY project.

Hotel Olga had been abandoned for about a decade, and extensive work was needed to transform it into suitable homes for mid/long-term living for internally displaced people. The Tolocar team's contribution was invaluable, as they undertook various tasks such as planning, preparation of drawings, task and workflow management, procurement and transportation of materials, and construction of a woodwork station. As part of their collaboration with CO-HATY, the Tolocar team played a vital role in constructing new furniture, dismantling old plumbing and heating systems, bringing water supply to the dining hall, assessing the state of utility systems, and restoring parquet floors and existing wooden windows. Basic hand tools and woodworking equipment proved to be essential for the successful completion of the renovation.

What made this collaboration truly special was the involvement of 30 internally displaced persons (IDPs) who would eventually have the opportunity to live in Hotel Olga once the project was completed. The entire undertaking served as a community-building activity, fostering a sense of camaraderie among the people involved in the renovation project.



CO-HATY is supported by hundreds of volunteers from the initiative “Second Home IF”.

CO-HATY creates spaces where people can live in dignity.

The CO-HATY Bed
Tania Pashynska designed this multifunctional bed.

By the end of the four-week Tolocar intervention, the collaborative efforts had resulted in completing 40% of the renovation project. Though further work was needed to bring the project to its full completion, the foundations were laid for a brighter future for those who had been displaced by war.

Beyond the physical renovations, the project's impact reached far beyond the walls of Hotel Olga. The designs of the furniture created during this collaboration could be replicated in similar projects, spreading the idea of sustainable and community-oriented housing solutions for the displaced.

Distributed Design and Manufacturing of Furniture

An essential aspect of CO-HATY is the distributed design and manufacturing of furniture, which aligns well with a similar project in Hamburg called “Production Next Door.” The idea is to design products whose plans are shared with carpenters and can thus be locally produced anywhere in the world. It's about creating supply chains of ideas, rather than supply chains of products. A notable example of this vision is the CO-HATY bed, designed by Tania Pashynska. The bed was created with the specific needs of people living in compact spaces in mind. It is easy to assemble and transport, multifunctional, provides ample storage space, and is accessible for older individuals. The bed is locally produced from regionally sourced materials, making the process sustainable and supporting the local economy.

Outlook

The collaboration between CO-HATY and Tolocar exemplifies the power of unity and the shared vision of building a better world. They show that when organizations and individuals come together with love and determination, they can make a tangible difference in the lives of those affected by conflict.

Metalab is a resident of Promprylad.Renovation, an innovation center on the premises of an old plant, which focuses on four areas of regional development: new economy, urban design, contemporary art, and education. Embracing the impact investing model, Promprylad and its residents, including Metalab, contribute to social changes in the region while receiving dividends as a return on investment. The center is a hub of diverse projects and programs, such as a capacity development initiative for entrepreneurs. The combination of Promprylad’s, MetaLab’s, and Tolocar’s visions sets the stage for a brighter future – one that transcends mere utopian dreams and lays a concrete and practical foundation for their realization.

Support CO-HATY

You can support CO-HATY financially, provide tools and materials, or become a volunteer yourself!

metalab.space/co-haty

SUPER LAB

Tolocar's vision includes the crucial role of Fab Labs and Fab Cities, in which “Super Labs” are established: large Fab Labs that serve as hubs for creativity, innovation, and community empowerment. One goal of the Tolocar project in 2024 is the creation of such a Super Lab in Ivano-Frankivsk where people can collaborate, share ideas, and designs openly, and then locally implement them. Fab Labs and Fab Cities are part of a movement that seeks to put production tools and knowledge in the hands of people, promoting decentralized production possibilities. This way, communities can act autonomously and sustainably, without relying on complex global supply chains.

MetaLab’s CO-HATY project already embodies these values in the present. It shows that remarkable change is possible through compassion, collaboration, and an open exchange of ideas. With projects like CO-HATY and Tolocar on the rise, a future may be within reach where the world is characterized by supply chains of ideas, and a sense of community and unity that transcends borders.

Outlook

Exploring New Horizons with Tolocars in Ukraine and Beyond

Producing this Playbook provided us with a chance to reflect on the past, present and future of the Tolocar project – in Ukraine and beyond.

For over a year, we have been operating in a country at war, with unforeseen, seemingly random attacks not only on military targets but also on civilians and public infrastructure. Daily air raid alarms via smartphone apps serve as a reminder to the team in Germany of the harsh reality their colleagues face in Ukraine: constant threats of war.

With our interventions, we are contributing to the rebuilding of Ukraine, helping to rebuild not only its architecture but also its social fabric. Our vehicles, machines and teams bring inspiration, knowledge and connections, and thereby contribute to the development of a participatory innovation ecosystem for the socio-economic recovery of Ukraine.
The Tolocar project serves as an example of the concept of Critical Making.

In the future, we aim to explore new and exciting fields of application for mobile makerspaces in Ukraine, such as supporting specialized labs for prosthetics, bio applications, and recycling, which could bring cutting-edge technology to underserved people and industries. In the next phases of our project, we plan to raise even more awareness about the vast potential of digital fabrication, distributed design, and open-source hardware in various sectors, including small and medium enterprises (SMEs) and startups. By showcasing the benefits of these technologies, the project aspires to drive innovation and progress in the industrial landscape of Ukraine.


ERSTE - HILFE
МОБІЛЬНИЙ
МЕЙКЕРСЬКИЙ
ПРОСТІР
50KG

MAKERS INNOVATION AWARD

Makers are essential actors in the Ukrainian innovation ecosystem and can thus make great contributions to the socio-economic recovery of the country. The next step of the Tolocar project therefore is the Makers Innovation Award: a program that not only funds but also mentors makers who drive social innovation and community cohesion. By fostering collaboration and ideation among makers and civil society organizations, the program aims to catalyze impactful projects. At the center is an incubation program that aligns technological innovation with societal well-being, emphasizing the importance of localized production, knowledge sharing, and decentralized solutions.

Just as Tolocar envisions Super Labs as creative and innovation hubs, the Makers Innovation Award aspires to create an environment where makers can collaboratively address pressing issues and forge connections, ultimately contributing to a future of borderless unity through the supply chains of innovative ideas. Partnering with betterplace lab and Future Challenges will enable the Tolocar project to begin implementing this program in 2024.

We also envision advancing decentralized physical infrastructure by facilitating large-scale open-source machine tool workshops. The aspiration is that providing access to these workshops will enable individuals and businesses to harness the power of these tools to transform their ideas into reality. To further professionalize its offerings, the project aims to explore additional services beyond mobile solutions. This includes exploring concepts like Manufacturing-as-a-Service, Hardware Co-working, and Incubation programs in designated Super Labs or Micro factories. Such ideas would nurture talent and innovation, ensuring sustainable growth in the maker community.

Digital infrastructure plays a crucial role in enabling decentralized processes, from collaborative product development and knowledge sharing to local production. The aim is to enable even more local communities, fostering self-reliance and supporting economic development. We also want to strengthen the connections between Ukrainian makers and makers from the rest of the world by leveraging digital infrastructure. The idea is to tap into a vast network of knowledge and expertise, potentially benefiting from advancements made worldwide, and set up and test ad-hoc distributed production networks via digital infrastructure. By exploring such possibilities, the project aims to enhance efficiency and coordination, leading to a more robust and interconnected maker ecosystem.

The long-term dream is of course to create a Tolocar that can reproduce a Tolocar. While an exciting idea to some, it is essential to recognize that this is still in the realm of aspirations, and considerable research and development would be required.

The Potential of Mobile Makerspaces for Scaling Distributed Manufacturing and Global Collaboration

The Tolocar project demonstrates that mobile makerspaces are powerful and versatile tools to serve various socio-economic development purposes on the ground. By integrating local actors and making use of local resources, they ensure that any potential solutions are tailored to the specific needs of each community. They also enable individuals by equipping them with open-source machines, knowledge, and a community of supporters, so that they are in the driver's seat on their journey to greater self-reliance and sustainable growth.

The focus of any mobile makerspace depends on its context. It may be used for education and training, nurturing the next generation of innovators and problem solvers, as a hub for innovation, prototyping, and providing solutions to local challenges, or as a support vehicle for production activities, such as repair, re/upcycling, and small-scale manufacturing, promoting circular economy principles and reducing waste. Community building is the purpose that all mobile makerspaces serve, with joint workshops fostering collaboration and knowledge exchange, and strengthening social cohesion.

Embracing the concept of open-source hardware could allow machine tools and equipment to be adapted to different types of vehicles around the globe with reasonable investments, potentially increasing accessibility and scalability. As such, we would like to contribute to the establishment of a global network of mobile makerspaces which collaborate, share best practices, provide valuable solutions, and troubleshoot challenges collectively.

Conclusion

Beyond crisis situations, distributed manufacturing offers broader benefits, including positive environmental impacts, economic advantages, and contributions to community resilience. As the Tolocar project progresses, its success in Ukraine could potentially serve as a model for other regions and contribute to the global movement towards sustainable and decentralized production systems. Critical Making – putting critical thinking into making – is at the core of the change we would like to see in the global maker movement, so it can unfold its full potential for tackling the multiple crises humanity faces in the Anthropocene.

The Tolocar project remains committed to Ukraine, to enabling communities and driving innovation through collaborative partnerships, mobile infrastructure, and global connections. As a team, we dream of the day when our monthly All Together meeting will bring us all together physically – be that in Kyiv, Hamburg or somewhere completely different!

EPILOGUE

Dr. Tobias Redlich is one of the founders and the Managing Director of HIWW (Hamburger Institut für Wertschöpfungssystemik und Wissensmanagement) which supports and accompanies organizations in breaking new ground in the areas of value creation and knowledge management focused on openness, decentralization and sustainability. They managed the second phase of the Tolocar project.

Dr. Tobias Redlich

Tolocar: A Journey of Tech, Togetherness, and Impact

Dear readers

As we close the Tolocar Playbook, I reflect on our journey with a sense of profound accomplishment, gratitude, and optimism. This project represents not just a successful co-creative initiative but a pivotal chapter in the evolving narrative of open source hardware and the global maker community.

When we embarked on this venture, our goal was clear: to leverage the power of distributed manufacturing and community solidarity to support the socio-economic recovery in Ukraine. Our fleet of mobile makerspaces, each a hub of innovation and creativity, has traveled to different parts of Ukraine, bringing hope and empowerment to communities. We have witnessed firsthand the transformative power of open technologies and shared knowledge.

From facilitating critical repairs to fostering local innovation, the Tolocars have become symbols of resilience and ingenuity.

At the heart of the Tolocar project is the community. The spirit of *Toloka* – communal work – has been our guiding force. This project has shown us the immense potential that lies in collaborative efforts, uniting people across borders and backgrounds in a shared mission.

The journey, while rewarding, has not been without its challenges – first and foremost Russia‘s war of aggression, which continues to cause loss, grief and trauma. Logistical hurdles, adapting to evolving needs, and learning valuable lessons in real-time collaboration and problem-solving seem small in comparison. Our experiences have enriched our understanding and will undoubtedly shape our future endeavors.

As we look to the future, our commitment to empowering communities through technology remains unwavering. The foundations laid by the Tolocar project will serve as a springboard for further initiatives. We envision a world where innovation and collaboration are not just ideals but the norm, where every community has the tools and knowledge to shape their destiny.

I extend my heartfelt thanks to our dedicated team, partners, supporters, and, most importantly, the communities we serve. Your determination, resilience, and ingenuity have been the true driving forces behind Tolocar‘s success.

I hope that you, dear readers, will let this book ignite your imagination and inspire you to embrace the potential of open source hardware and makerspaces.

Together, let’s harness these tools to make a real difference, not just in Ukraine but across the world!

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Tolocar Partner Organizations in Ukraine

May – November 2022 (Phase 1 led by MitOst)
Bakota Hub / Territory NGO
Bila Tserkva Youth Center
Caritas Ivano-Frankivsk
Center of Technical Education in Kamianets-Podilskiy
Creative Rural Hub
Kamianets-Podilskyi city council
Krasnodvir Castle Club
Makariv Fire Department
Makariv Village Council
NGO BUR (Building Ukraine Together)
NGO Music Saves
NGO Svitovyd Art Center
Nizhniy Verbizh village council
School of Motyzhyn
State Emergency Service of Ukraine office in Makariv
Stryi Professional Art School
Stryi Youth Center
Verhniy Verbizh Public Library
Vulyk zmistiv
Youth Center Paragraph
Youth of Vasylkivshchyna
Youth Space "Khata Chytalna"

Since October 2023 (Phase 2 led by HIWW)
A safe space for women
Bobry
Boryslav liceum
BUR Okhtyrka
BUR Uhryniv site
Chernihiv bicycle workshop
Chernihiv IT cluster
Chernihiv Merezhevo
Chernihiv wooden lace NGO
Classical professional college of Sumy State University
Dmytro Bakhmatyuk Kalush Lyceum
Drohobych Liceum #16
Drohobycz lyceum #10
Eco Misto NGO
FabLab Brody
FabLab Halych
FabLab Horodenka
FabLab Kamyanets-Podilsky
FabLab Kolomiya
FabLab Kosiv
FabLab Truskavets
FabLab Yaremche
Gay Alliance Ukraine
GO "Zakhody"
Hacklab
Hryshka National Botanical Garden
Hub 93
Inzhenerny
Ivan Trush Brody Gymnasium
Ivano-Frankivsk City Youth Science and Technology Centre
k10street workshop
Kaizen Al private school
Kalush Lyceum #2
Klub Dobrodiiv
KNUBA
KNUCA Hub
Kosiv town administration
Ksi Prostir
Kudos
Kvadrat
Kyzemyn art residencies

Kyiv Library 115
Misto Dobra
MMR Terebovlya
Molodizhniy Prostir
NGO “Pryluchchyna Robotics Federation”
NGO Divchata Hostomel
NGO Podolianochka
Okhtyrka city council
Okhtyrka House of Culture
Okhtyrka museum
Okhtyrka secondary school of grades I-III No. 1 of the Okhtyr City Council
Okhtyrka Youth Centre
Onuka
Parasolka
PDU Sumy
Peremoha
Pixlab
Ponikovytsya level I-III school
RED CROSS SOCIETY in Okhtyrka
Repair Together CAMP
Rezidenzia molodi
Roboclub
Robogenius Kon
School #2 Brody
School #251 Kyiv
School #315 Kyiv
School in Buzova
Shelter Ukraine
Sonyakhensky educational complex
Spilno Camp
State Scientific-Technical Library of Ukraine
Stebnyk Gimnasium #6
Stem is fem Rivne
STEM is fem Vinnytsya
SuperHumans
Terre des Hommes UA
Tepla Hora
Trostyanets PTO
Trostyanets Public Library
Trostyanets Town Council
Truskavets school #3
Urban Library
Velyka Pysarivka Village Council
Velyka Pysaryvka Lyceum
Velyki Mosty school
Vinnytsia Technical Vocational College
Vyshgorod city library
Zeleni Kruchi
Zherebny School
Zhytomyrska miska pada

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