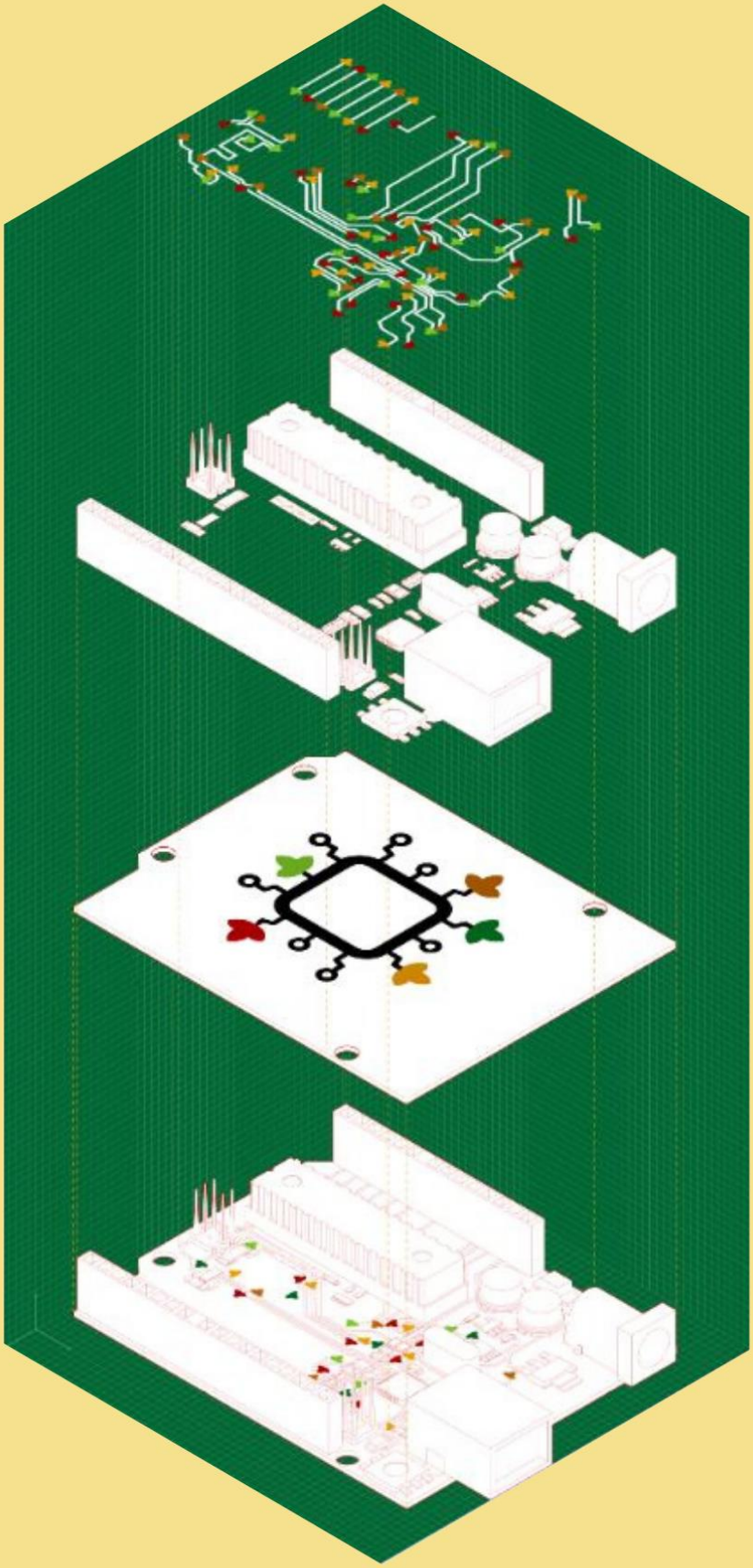
Green STEAM Incubator

The "Green STEAM Incubator" **Trainer Guidelines and Laboratory Principles**



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IO4.6 TRAINER GUIDELINES AND LABORATORY PRINCIPLES

1. Introduction

This part of the handbook provides information on how to organize and facilitate processes in non-formal STEM laboratories, accounting on recent bibliography. Non-formal STEM learning can take place outside the classroom (Giannakos, 2020), whilst formal STEM learning occurs in an organized and structured environment (e.g., in an education or training institution or on the job) and is explicitly designated as learning (in terms of objectives, time, or resources) (CEDEFOP, 2009). In a non-formal setting, learning is embedded in planned activities but not always explicitly designated as learning (in terms of learning objectives, learning time, or learning support). Most of the time, non-formal learning is intentional from the learner's point of view and can take place in museums, science camps/clubs, and through participation in workshops, training sessions etc. The maker movement, including activities such as the ones developed in IO3 and IO4, has also dynamically entered the landscape of innovative education and non-formal and informal learning (Papavlasopoulou et al., 2017). The maker movement refers to instances in which individuals or groups of individuals create artifacts that are recreated and assembled using software and/or physical objects. Typical topics of interest in this context include engineering-oriented pursuits such as electronics, robotics, 3D printing, and computer numerical control tools, as well as more traditional activities such as sewing or arts and crafts (Papavlasopoulou et al., 2017). An interdisciplinary approach, including problem-based and project-based learning, entailing hands-on, often collaborative learning experiences, should be embraced as part of such non-formal, non-formal STEM laboratories. This document provides useful guidelines for trainers when planning and implementing IO3 and IO4 activities in the Green STEAM Incubator project and in non-formal STEM laboratories in general.

2. Trainer guidelines

2.1. Welcoming the participants

The first training session is of great importance: apart from reaching the learning objectives of the STEM laboratory, it is important to establish confidential relations between the trainer and participants, provide the latter with a clear understanding about what will be happening within the following sessions, as well as create favourable environment for the participants to get acquainted with each other and develop a sense of belonging to the group.

After welcoming the participants, introduce yourself and shortly present your experience in the field of STEM. Then, present the overall topic of the session and the type of projects in which they will have the opportunity to engage. It is also necessary to establish the rules everyone has to follow throughout the session – for example, turning off mobile phones

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during the session or putting them on mute, respecting each other, starting with positive things when providing feedback to other participants' work, etc. Let the participants come up with the rules themselves – this way, the probability that they will be sticking to them will be higher. However, if they have any difficulty thinking up the rules, you may provide some hints emphasizing that simple rules will ensure a comfortable atmosphere and effective learning process.

2.2. Training Course Principles

It is essential to first understand the unique learning requirements of our training to ensure that our training interventions are effective. Since our trainings will target youth workers, in other words adult learners, it is essential to keep in mind that we should promote the creation of independent and adaptable individuals. The course principles should consider how to promote a self-directing self-concept; use of experience; a readiness to learn; and a performance-centered orientation to learning (Forrest & Peterson, 2006).

Along these lines, some tips for the trainers are given below:

- There are no right or wrong answers!
- There is not "the" solution for a given problem
- Do not be a "teacher" or the "dispenser of knowledge", but be the coach and the facilitator during the whole process
- Take a step back to allow the participants to take a step forward
- Challenge them!
- The course is not only a tech training – it is about to teaching life skills by using tech stuff, such as microcontrollers and 3D printers
- The challenges and the project work are supposed to give participants the opportunity for practicing life skills:
    - Teamwork
    - Communication & Collaboration
    - Design Thinking & Problem solving
    - Planning and managing
    - Frustration tolerance
    - Self-awareness
- Teaching Failure: They will fail. Let them fail. Make failure a virtue and make them keep going

The courses are following a non-formal learning approach, thus do not target a traditional class format with a teacher lecturing at the front and participants diligently listening or following steps, as mentioned above. It should encourage participants to teach themselves and become independent learners. In order to stay competitive in this changing job market, participants must learn the skill of mastering new concepts on their own. The course aims to show participants the benefits of self-directed learning.

It is advisable to mention that the training is organized based on the non-formal education methodology. There is no need to explain in detail the essence of non-formal education – it

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will suffice to say that there will be no long lectures or tests like in school, and most of the information will be presented in an interactive manner and that the participants will be actively involved in the process during the design and development of their own projects.

2.3. Teaching Failure

"It is better to fail in originality, than to succeed in imitation. He who has never failed somewhere, that man cannot be great. Failure is the true test of greatness." Herman Melville (1819 – 1891)

In non-formal workshops and trainings (such as in fablabs), the learners have a degree of freedom to follow their own learning path (e.g., design and develop their own projects). To this end, the end goal and final product are not addressed explicitly in the setup phase, and this can lead to a total failure (Giannakos, 2020).

You should keep in mind that failure does not hurt. Help participants to fail in a safe environment. Participants in the modern world are rarely given the opportunity to fail. Failure is usually seen as a bad thing, so nobody wants to fail a class. In contrast, in the working world, failure is a key component of everyday life, especially in technology fields.

If you want to make the next great widget, expect to fail many, many times before you succeed. Learning to deal with failure and how you respond to failure is critical for attaining the jobs of the future. Future jobs do not come with teachers who tell you what to do. The learner must learn how to overcome failure through self-taught hands-on learning.

The Green STEAM Incubator lessons are designed in a way that participants quickly run into obstacles they do not know how to overcome and which causes (temporary) failure. They shall learn to cope. This is not a failure of the coach. The technology used provides additional opportunities to fail. A code can include mistakes, wires can be lost, parts can fail, etc. We use this technology intentionally to provide participants with many opportunities in each class to fail in a safe environment with support. While the lessons include guidance on how to find answers, they do not explicitly give "the right" answer. Additional answers are intentionally not included in the trainer handouts so participants have the failure experience and need to work out answers on their own. So, let them fail! Give each participant the opportunity to fail. If participants are frustrated but still making progress, allow them to continue uninterrupted.

Unlike in a traditional STEM course, the trainer should not try to prevent participant failure. On the contrary, the trainer should allow participants to fail as often as they can. As a trainer, you should instead focus on teaching participants how to fail gracefully. (Just like learning to ride a bike, you can't learn to balance till you fall off a few times. And you will never learn to ride a bike if your parent doesn't let go and give you the chance to fail.)

If a participant is frustrated but is still making progress and trying out solutions, allow them to be frustrated. Trainers should only step in when the frustration causes the learner to stop all progress or to grow angry or to be ready to quit. Then the trainer can step in to teach some "techniques for dealing with frustration" (see below).

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Beyond these techniques, you can offer suggestions to stalled participants about what to try next. However, not all these suggestions should be good suggestions. Do not draw a roadmap to success for your participants. Rather than draw a roadmap to more failure, participants must learn to depend on themselves and their resources.

Techniques for dealing with frustration

- Take a breath
- Go for a walk around the room
- Try a different approach
- Check your materials
- Explain the problem to someone
- Ask for help from your peers
- Check your assumptions
- Work on something else for a while
- Look online for guidance
- Put things into perspective
- Remember the reward. Remember why you are in the course and what you hope to learn from it

This is a spectrum of options for a participant to pursue when they are feeling frustrated. There are duplicates in the list, but we want participants to feel like there are many things they can try when they are frustrated. Not all of them will work, but they should keep trying.

Techniques to help participants overcome frustration

- Get them talking
- "What have you tried so far?"
- Give some recognition
- "It looks like you worked really hard on that."
- Encourage them to work with their peers.
- "Have you checked to see if anyone else is having this problem?"
- Encourage them to seek answers online. "What does Google have to say?"
- Suggest a break. "Looks like you could use a break."

Remind participants of the techniques to deal with frustration, but also help them practise those techniques with good questions. Remind them that failure is not something bad. Only a failure will lead to a sustainable learning effect. If the trainer provides the solution, there will not be sustainable learning.

2.4. Trainer Attributes

- Allow your participants to learn by doing
- Do not "help" with their projects (Don't touch)
- Trainers give suggestions from the sidelines
- Encourage your participants to find their own answers
- Trainers don't have all the answers

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- Trainers should give pep talks
- Watch for frustration and jump in before the player leaves the field

Don't be the "teacher"

The IO3 and IO4 modules (i.e., lessons and environmental projects) operate more like a lab than a traditional STEM course. They heavily resemble the project-based learning approach, which is purposefully designed to engage students/ participants in the investigation of authentic problems (Blumenfeld, et al., 1991).

As such, trainers should not give presentations/ lectures longer than 15-30 minutes. Other than simple instructions, participants should be encouraged to pursue the information they need themselves.

Learn by DOING; even if the student does it wrong several times, they will remember more than if you TELL them how to do it.

Not being the "teacher" can be liberating! Let go of the pressure to know all the answers and how to solve all problems. Instead, focus on motivating the participants to find their own answers. Support them and let them know you think they can work through their difficulties. This can often be done by asking probing questions or providing emotional encouragement when they struggle.

It is also good to let the participants see that you struggle and even fail. Show them you are also willing to try to learn new things.

Key attributes of trainers should be:

- Solid interpersonal and life skills, with the ability to:
  - empathize
  - listen actively
  - understand and respond well to others
  - build trusting relationships over time
- Demonstrate and promote positive thinking skills and commitment to a growth mindset with creative problem solving, solutions orientation and persistence
- Some prior level of technical and STEM subject matter expertise is important, with the interest and curiosity to learn enough to support participants in their work
- Ability to identify and call upon technical mentors or experts when needed (recognize that turning to experts is role modeling for participants to persist and find help when needed.)

Trainers shall connect with the participants. To empathize with what they might have going on in their personal lives and recognize not everyone comes to class with a clear head. Additionally, it is beneficial for the trainers to have a network they can utilize in the community or online. Or else feel comfortable seeking out experts. Bring in a guest speaker or encourage your participants to email/tweet / etc., an expert in the field.

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2.5. Inclusive practice

Supporting learners' active participation in maker-centered project-based learning (PBL) can be challenging in inclusive classes (Sormunen, et al., 2020).

Inclusive practice is an approach to teaching that recognizes the diversity of students, enabling all learners to access course content, fully participate in learning activities and demonstrate their knowledge and strengths at assessment. In this context, teacher and trainers play a crucial role in providing quality education (Florian & Rouse, 2009).

The education world has long known that learners have different cognitive abilities and learn differently, but with the traditional methods of teaching available, it was always necessary to set the course for the slower-paced learner. This never gives an ideal outcome as that slower-paced learner can feel uncomfortable while quicker learners become bored. However, with the many ways to differentiate learning in the laboratory, it is easier to provide an interactive, changeable experience for every participant.

Trainers should be responsible for adapting guidance and support to address participants' potential differences. Trainers may also offer such guidelines in different formats or environments to help the participants to continue their projects in ways that best suit their learning style. Important to consider is that trainers should encounter participants' particular interests and needs and help them orient their projects around those.

The trainers are also prompted to focus on group composition when needed and use reflective discussions on the plenary to promote inclusion and support learners' active participation (Sormunen, et al., 2020).

3. Laboratory Principles

This section provides some basic laboratory principles that trainers should consider, i.e., safety rules, tips for facilitating the Design Thinking process.

3.1. Safety rules

In order for participants to fail and learn to deal with their frustration, the course room must be a safe place for participants to try new things. The laboratory/ workshop space should allow the participants to be creative and at the same time safe (physically and emotionally).

The first rule in the laboratory is "Safety First"! Safety rules can be defined as principles or regulation governing actions, procedures or devices intended to lower the occurrence or risk of injury, loss and danger to persons, property, or the environment (GEMET, 2021).

Safety rules while 3D printing and in order to avoid any 3D printer hazards are provided in more detail in the IO4 lessons. Apart from that, use safety to discuss an attitude in the laboratory where we help each other, and we take responsibility. In the laboratory, everyone is responsible for everyone else's safety. Also, the laboratory will not work if only the trainer is responsible for safety.

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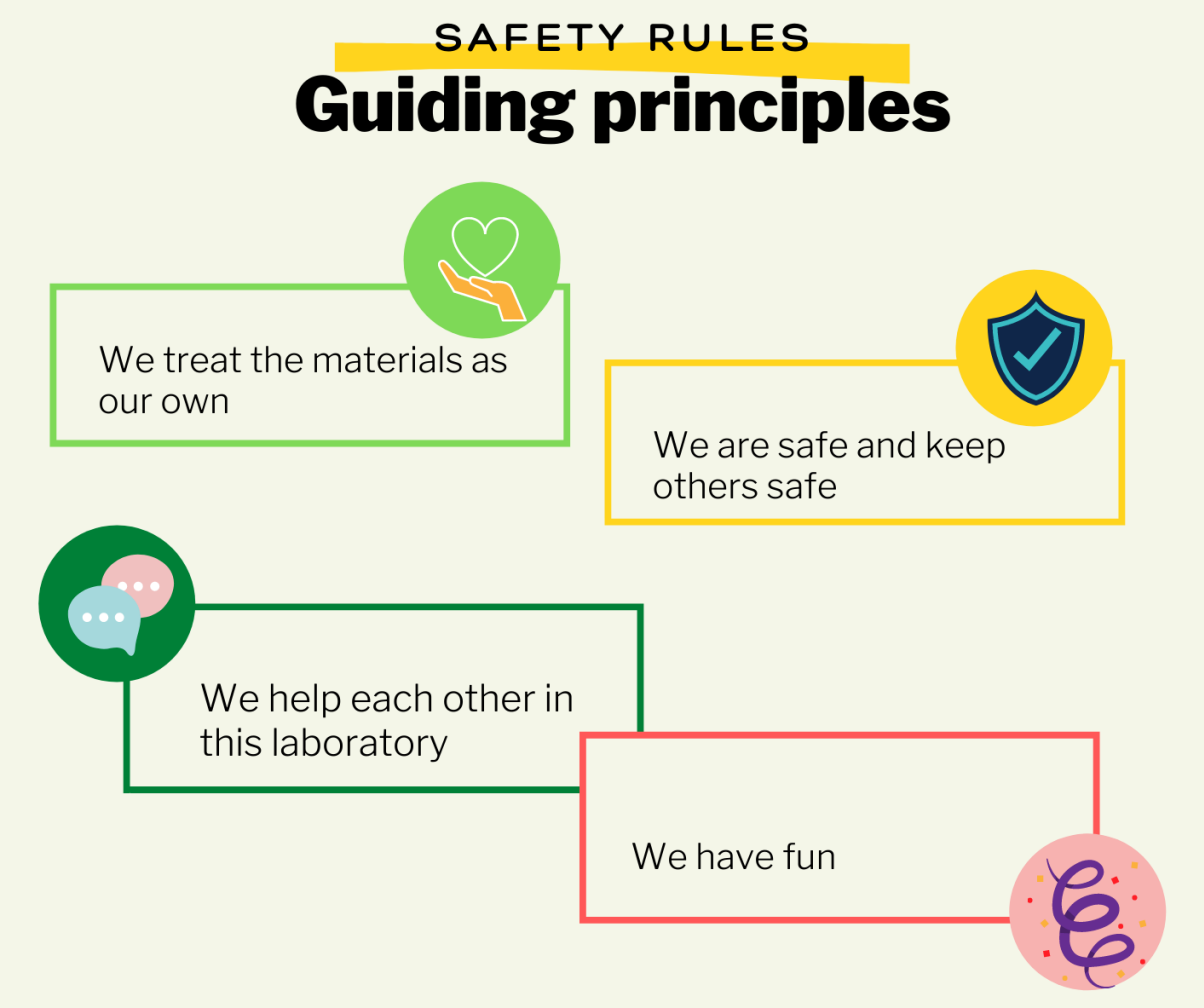
Create your laboratory Rules!!



Each trainer might have different expectations on how things should work in the laboratory. It is important to share these with your participants upfront and allow them to ask clarifying questions. It is suggested that trainers build on the safety discussion with participants to allow them to add additional rules for the whole group.

There is expensive technology in the laboratory (3D printers, microcontrollers, other electronic devices). Like with safety, participants should speak up if they see someone misusing the technology. Not just to the trainer but to the participant misusing the technology. We want participants to feel responsible for their community in the class. All the materials in the laboratory belong to all the participants. They should be encouraged to use what they need once they understand how to use it safely.

In order for open material access to work, all the participants must take ownership. Use these rules of shared things and shared ownership and helping each other, and polite confrontation when needed.

Also, due to the ongoing covid-19 pandemic and the requirement for social distancing practices, trainers and participants should keep in mind to follow the respective measures.

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3.2. Facilitating the Design Thinking Process

In the Green STEAM Incubator project, we embrace the Design Thinking approach (Henriksen, 2017). Design Thinking (DT) is a user-centred and action-oriented approach to innovation that emphasizes interdisciplinary collaboration and problem-solving modes. The aim is to find solutions that are convincing from the user's point of view (user perspective). Design Thinking is based on the assumption that problems can be better solved if people from different disciplines work together in a creativity-promoting environment, jointly develop a research question, consider the needs and motivations of people and then develop concepts that are tested multiple times. The method is based on the work of designers, which is understood as a combination of understanding, observation, brainstorming, refinement, execution and learning.

There is not a single best model, but there are many Design Thinking models which are all equally useful. All models have a common cycle around understanding a problem to solve and the user needs, generating ideas, trial and error (fail fast and try again), making models and prototypes, testing and iterating. More information about those models can be found in the Green STEM Incubator Handbook on Design Thinking Models.

Tips for the trainers when applying DT models in the laboratory are given on the next page.

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TIPS FOR THE TRAINERS WHEN APPLYING DT MODELS IN THE LABORATORY

DTP POSTER

Create a poster of the Design Thinking Process and hang it on the wall of the laboratory

DESIGN THINKING PROCESS

GUIDING QUESTIONS

·Provide guiding questions to help the participants follow the DT cycles, by starting with simple questions, such as, what can you design with duct tape to solve a real problem? It is important that the participants do the entire cycle.

PACE

Require the participants to slow down and do the design thinking process for every challenge. This will help them build the skills of empathy, self-efficacy, perseverance.

CREATIVITY

Important: Note that the participants must create their own projects. They should not just reproduce!

TAKE BREAKS

Advice the participants to take breaks. Get up once in a while. Have a snack.

JOURNAL IT

Participants should use a course journal - like a logbook of thoughts and ideas. This helps them to organize their ideas and to trace their own thinking process.

SPEAK UP & ASK FOR HELP

Advice the participants that when things get tough, they should not just push through it. Tell them to ask your peers, or reach out to you.

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4. Conclusions

We aimed to provide through this handbook essential pieces of information to the trainers on how to organize and facilitate processes in non-formal STEM laboratories, accounting on recent bibliography. Specifically, the handbook offers guidelines and tips to the trainers on how to welcome the participants, then which training course principles should be respected in a non-formal STEM learning environment, how to deal with teaching failure and how to productively use failure in the process, how to encompass inclusive practice, as well as what attributes should the trainer has for securing a successful non-formal STEM laboratory. Then, we provide some basic laboratory principles that trainers should consider, i.e., safety rules and tips for facilitating the Design Thinking process. Trainers can further delve into some topics by searching relevant bibliography, which is provided in the Resources section. We hope that this handbook will offer useful support to the trainers and will contribute towards the successful implementation of non-formal STEM Laboratories.

RESOURCES

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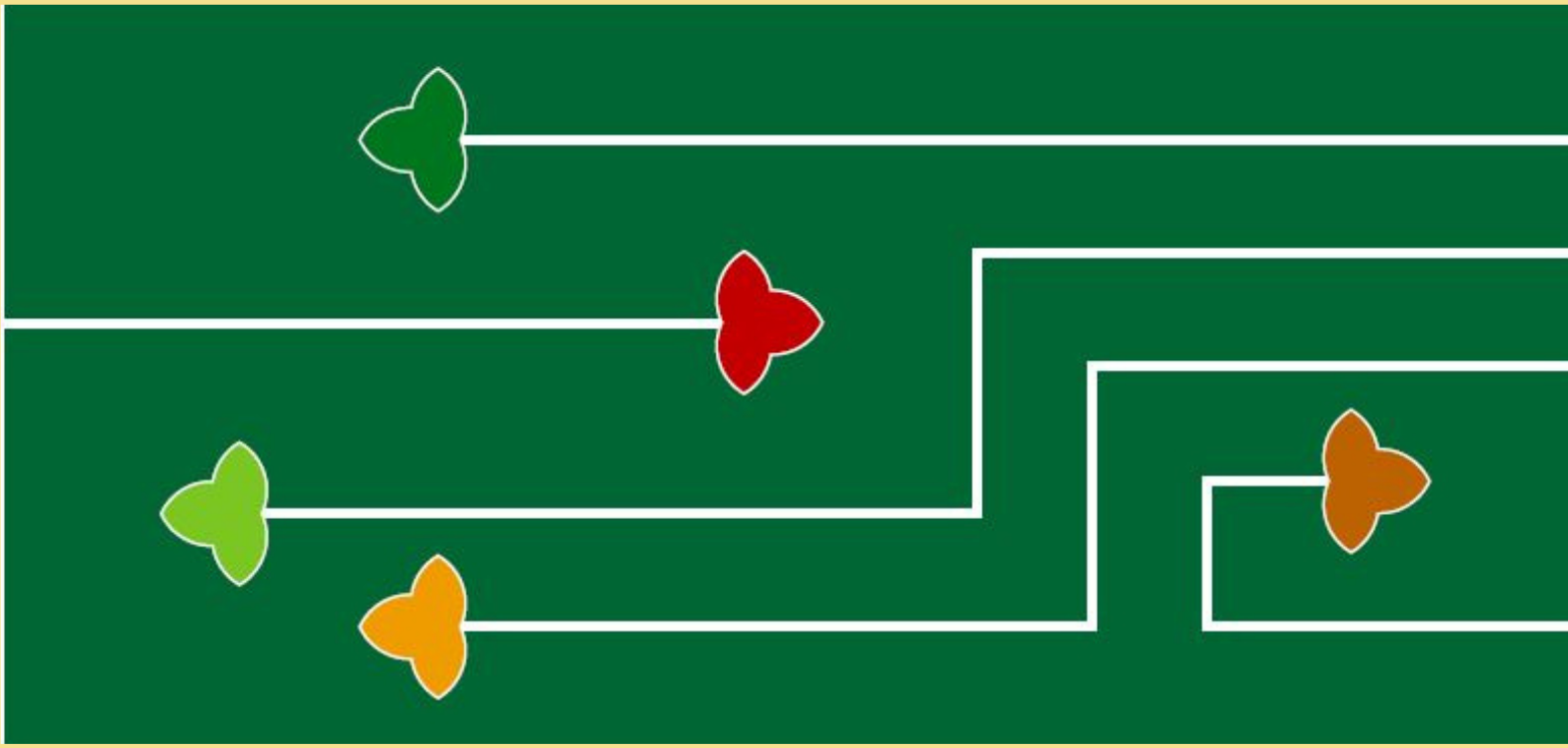

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