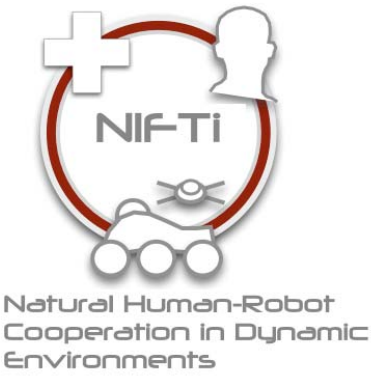

DR 6.1.2: Platform manufacturing and sensor integration

P. Balmer, L. Mayor, N. Tomatis

patrick.balmer@bluebotics.com

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Lead partner:	BLUE
Revision:	SEE Version management
Dissemination level:	public

This document describes the manufacturing of the NIFTi platform.

Appendix

Note: The appendixes are confidential and cannot be published outside of the consortium.

Appendix 1: Compliance matrix.

Appendix 2: API description. Refer to the documentation integrated in the code.

Version management

Revision	Date	Author	Description of changes
0.1	26.01.2011	PB	Initial version
0.2	02.02.11	LM	Minor changes
0.3	02.02.11	NT	Minor changes
1.0	02.02.11	PB	Release for publishing
1.1	15.02.11	PB	Update following GJ's comments
2.0	15.02.11	PB	Release for publishing

1. Introduction

1.1. The NIFTi project

The goal of NIFTi is to improve human-machine interaction in USAR applications.

In order to follow its objectives, the NIFTi project proposes to develop a new robotic platform that accommodates a special sensor suite for remote operations.

1.2. Role of the platform in NIFTi

The platform described in this document will allow each partner of the consortium to integrate each individual work together and evaluate the result in real world situations, during use cases.

1.3. Contribution to the NIFTi scenarios and prototypes

An adequate platform is essential in order to play the scenarios.

1.4. Scope

The goal of NIFTi is to improve human-machine interaction in USAR applications. In order to follow its objectives, the NIFTi project proposes to develop a new robotic platform that accommodates a special sensor suite for remote operations.

The development of the platform is user-centered. End users (firefighters, rescue teams,…) requirements are integrated at an early stage of the design phase, to guarantee that NIFTi obtains the best suited platform and avoid too complex and unusable solutions.

The objective is to find a trade-off between active and passive locomotion. Such an hybrid approach with the two structure types is the best performing structure if we consider all the criteria together (i.e. power, complexity, climbing…).

1.5. Preliminary remark

The sensor integration was taken into account as early as possible in the design phase: during the specification in order to determine the induced constraints and keep them in mind during the platform design.

Thus the sensor integration was already discussed in the deliverable DR 6.1.1 “platform specification and design” and for that reason won’t be discussed anymore in that document.

1.6. Document structure

The objectives of this document are to justify the non compliances to the specification and to develop the assembly sequence.

This document is split in two parts: the compliance matrix and the manufacturing process.

Chapter 2 intends to present the compliance matrix, tool that Bluebotics discovered in the space industry and adapted to its own developments. The non-conformities to the specification are also discussed.

In chapter 3, the manufacturing process is presented. Then the assembly sequence is described. This step is needed in order to optimize time during the assembly phase.

2. Compliance matrix

2.1. Description

The compliance matrix is a document similar to the one used in the space industry to insure that the product respects every specification.

This document is created once the specification has been validated. It takes the form of a table summarizing one specification per line.

The compliance matrix is reviewed twice:

- After the design phase, to avoid producing a non-compliant platform,
- After the production phase to insure that the platform complies to every specification.

When a specification cannot be reached, it is notified in the compliance matrix and the reason of the non-compliance is indicated and actions are taken when needed.

2.2. Compliance matrix

As a compliance matrix is a dynamic document that evolves within the time, the NIFTi platform document has been put in Appendix 1: Compliance matrix, and will be updated accordingly. At the time of writing, the compliance matrix has been filled after the design phase. The platform compliance will be validated at the end of the production phase.

2.3. Non-compliances description

This section is based on version 1.0 of the compliance matrix. The design is not compliant with the following specification:

- **Temperature range of -10..+40°C**

  Some chosen components cannot operate below 0°C:

  - Ladybug omnicam
  - Whistle motion controllers
  - Embedded PC
  - Wifi dongle
  - Unheated SICK laser scanner

  However, self heating due to losses is enough to work until -10° if the system has been stored and is started at room temperature.

- **Manipulation with robot arm.**

  The decision was taken by the consortium during the "NIFTi usecase and platform design meeting in Rome (May 2010) that not arm is to be integrated during Year 1, because:

  - No suitable arm is currently available on the market,
  - The development of an arm is unrealistic both in term of cost and resources.

  Later on, the market will be re-evaluated as well as the possibility to develop an arm.

- **3D sensor and omnicam, mechanical protection removable.**

  No extra protection has been designed because:

  - Both sensors are water protected
  - Both sensors have robust mechanics
  - A metallic mesh would have created too much occlusion.
  - A plastic transparent dome reduces the quality of images (when damaged or dirty).

3. Manufacturing

3.1. BlueBotics manufacturing process

The manufacturing process at BlueBotics is the following:

- **Components ordering**

  Choice of the supplier for non-standard parts (mechanical parts) and purchase of every component. For very long lead time components, the purchase process can also start during the design phase.

- **Delivery and control**

  Delivery date of components is chosen in order to minimize the time before assembly.

  Once received, non-standard parts (e.g. mechanical parts) follow an incoming quality control, in order to detect any manufacturing mistake.

  Critical (or expensive) standard components (e.g. embedded computer), also follow the incoming quality control in order to detect failures.

- **Mechanical assembly**

  The mechanical parts are assembled following the assembly drawings and instructions of the engineering team.

- **Electrical assembly**

  The electrical parts are then assembled and wired following the wire diagrams. Depending on the structure of the platform, the electrical and mechanical assembly phases are mixed, done in parallel or completely separated.

- **Software**

  The software controlling the platform is generally developed in parallel with the mechanical and electrical assemblies. The integration of the software is done directly on the platform.

- **Validation**

  The final phase of the manufacturing process consists in testing and validating the platform. The nature and quantity of tests depend on the complexity, specification and customer requirements. Refer to 3.3 Tests to get an overview of the tests planned for the NIFTi platforms.

3.2. Assembly sequence

The assembly sequence was determined during the design and should be followed. Unfortunately, despite our efforts the delivery of critical components may influence the assembly process.

The assembly process of the NIFTi platform is the following.

3.2.1. Body assembly

The mother board, the power PCB, the 3D sensor PCB and the first mechanical parts are assembled on the aluminum frame of the platform. Cabling is done in parallel.

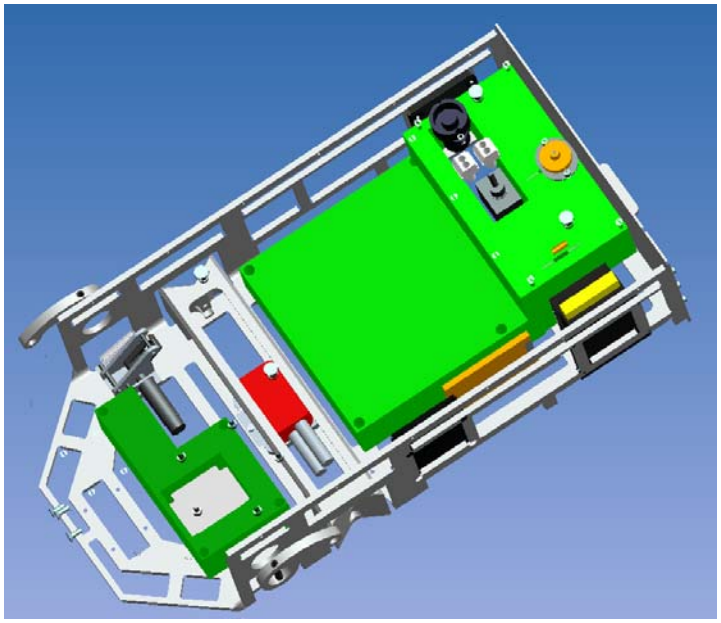

Figure 1. First components assembly on the frame

The differential and the 3D sensor mechanics is assembled on the frame.

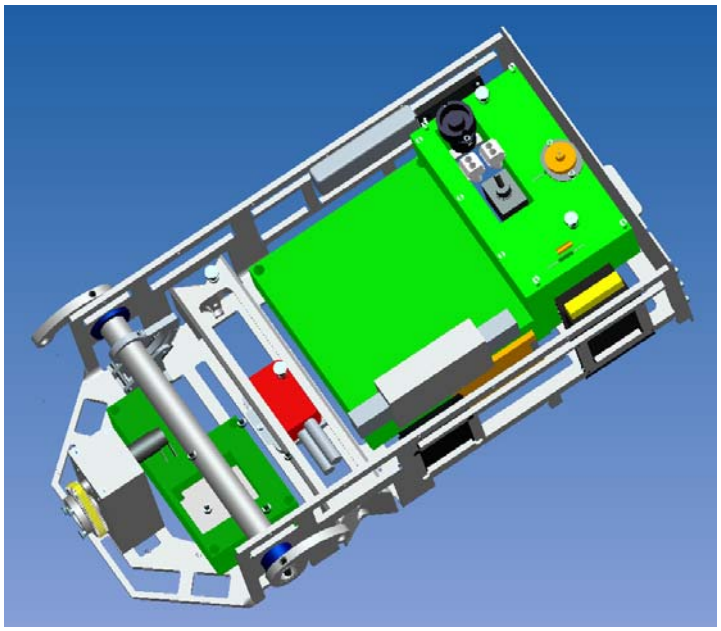

Figure 2. Mechanical sub-assemblies are added

The lower part of the housing is then fixed, as well as the intermediate sheet metal. The laser scanner is mounted.

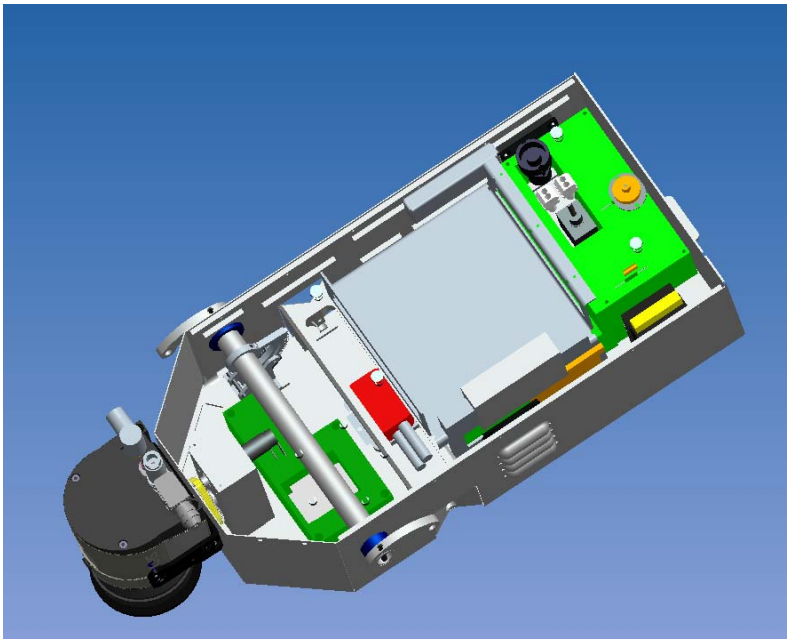

Figure 3. First Lower part of housing is added

The upper part of the housing is installed. The omnicam and the GPS antenna are fixed on it.

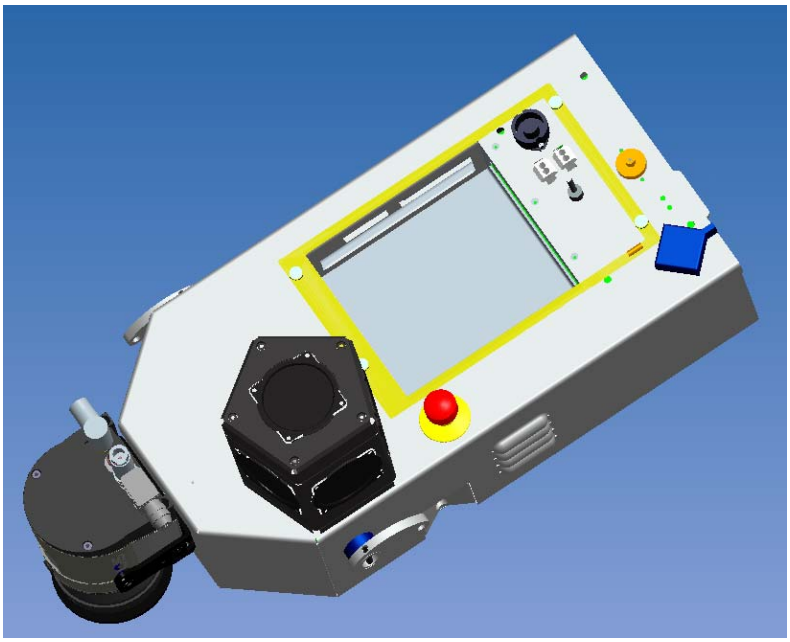

Figure 4. Upper part of housing is assembled

Finally the battery and its cover are installed on the body.

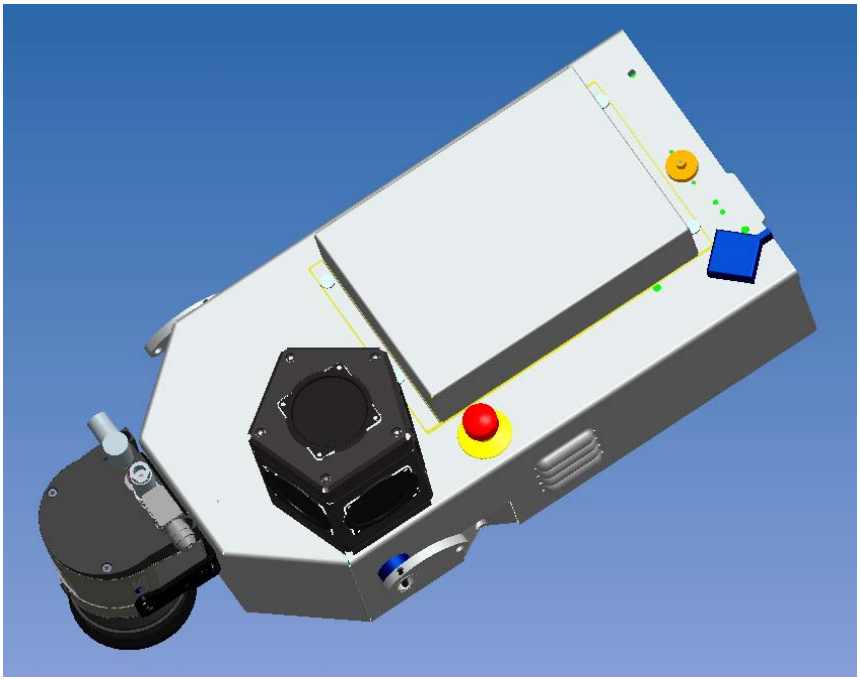

Figure 5. The battery and its cover are assembled

3.2.2. Bogies assembly

The mechanical base of the bogie is assembled. The motor modules are integrated. The bogie PCB is installed and cabled.

The motor modules have been designed by BlueBotics for the NIFTi platform. The mechanical assembly has been subcontracted in order to optimize the use of our resources and to take benefit from the expertise of our partner.

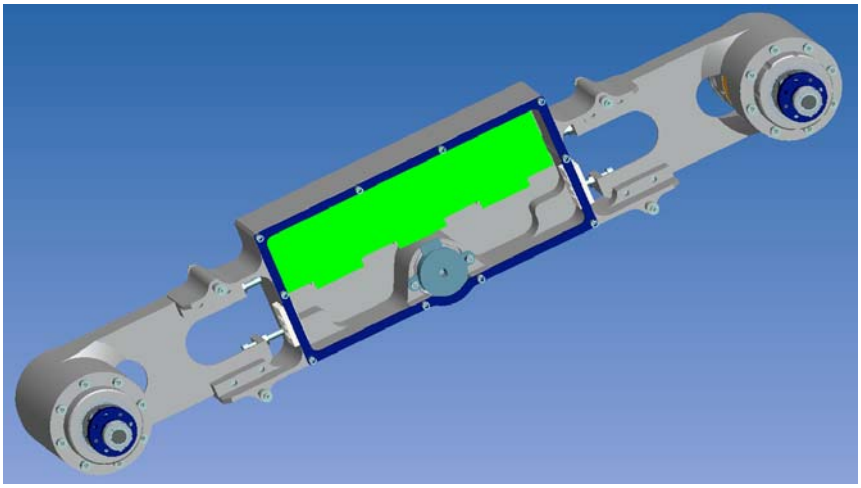

Figure 6. Mechanical base of the bogie

The traction wheels are then installed on the base assembly.

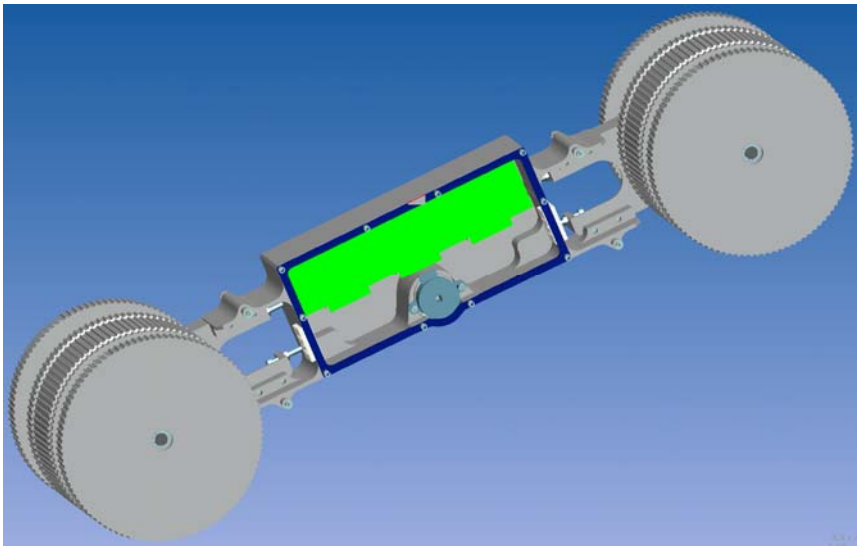

Figure 7. Wheels are installed

The flipper structure is added and the electronic compartment closed.

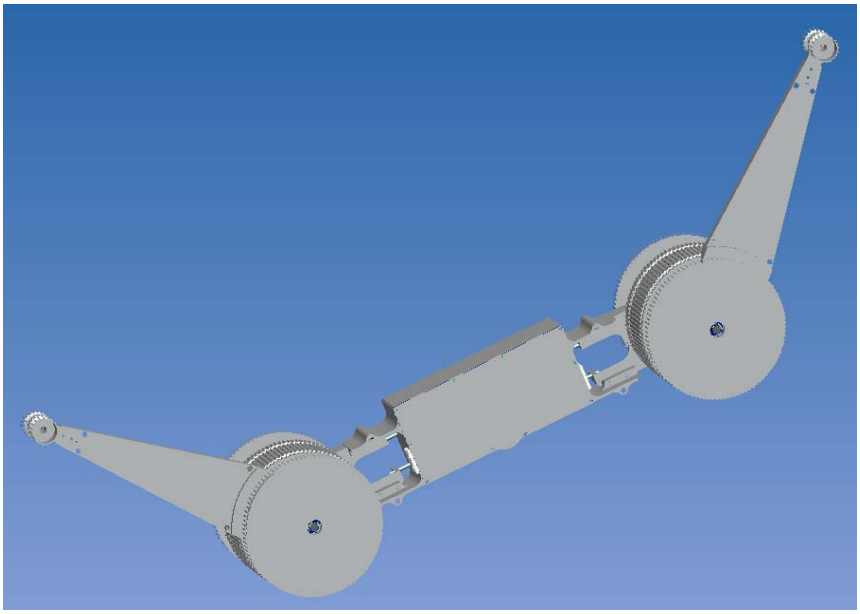

Figure 8. The flippers structure is added

The tracks are mounted and adjusted. The adjustment is done using long holes.

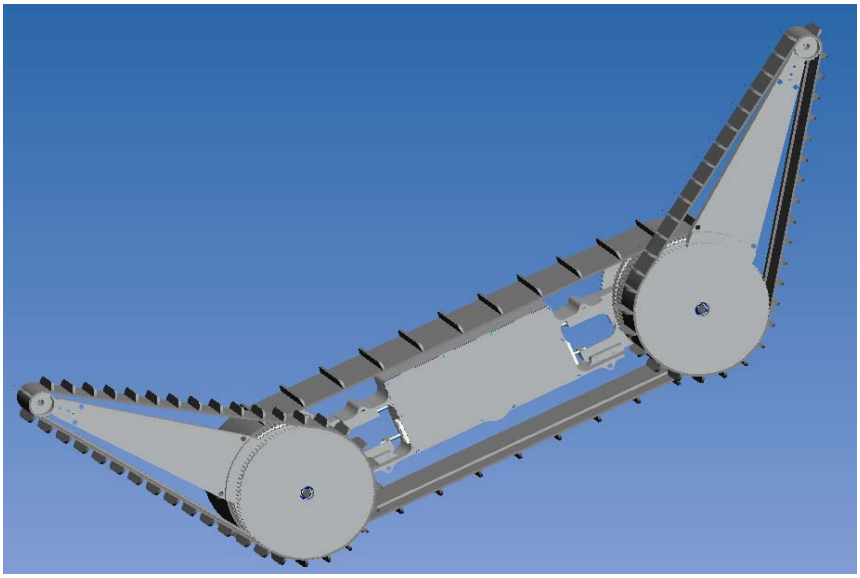

Figure 9. The tracks are mounted

The mechanical protections are installed. Plastic has been used in order to lower the total weight of the robot.

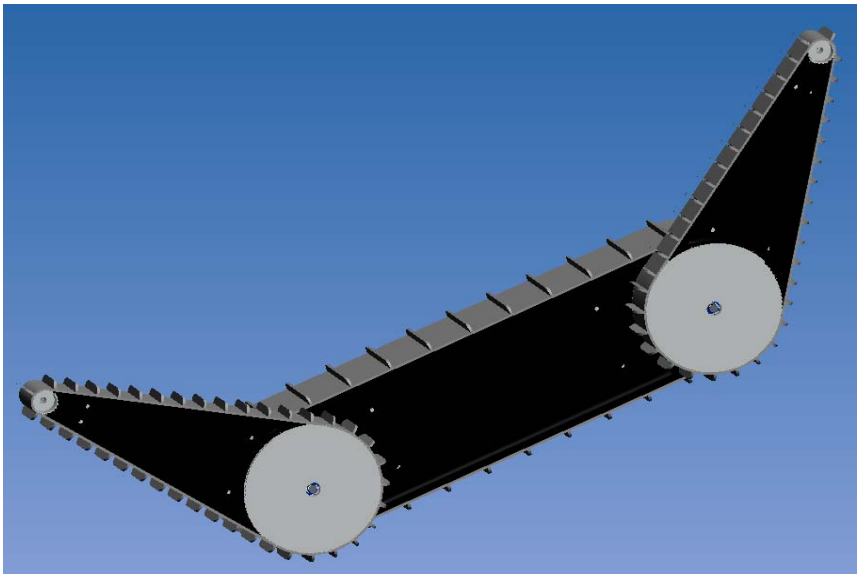

Figure 10. The protections are installed

Finally the body attachment sub-assembly is installed.

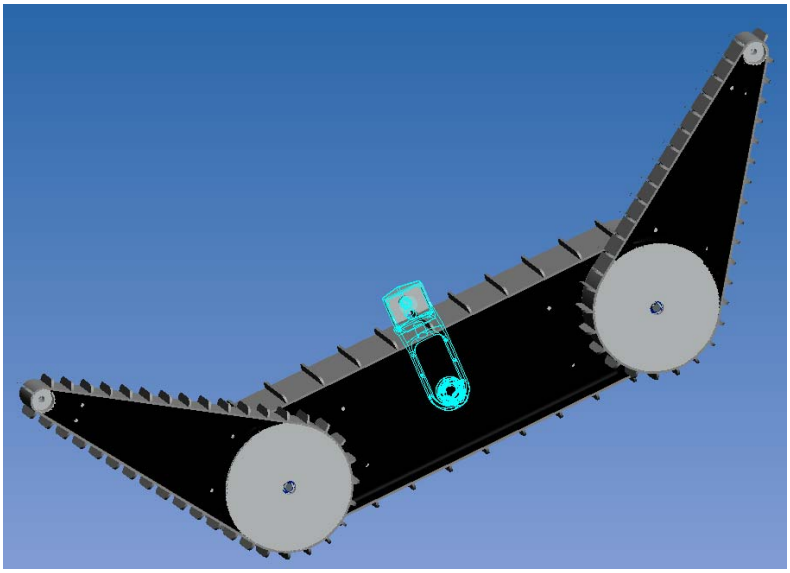

Figure 11. The body attachment is installed

This job is of course done for both bogies.

3.2.3. Final assembly

The last step consists in assembling the bogies on the body. This is done using fast unscrewing screws, as the bogies should be unassembled during transportation. The differential is also connected to the bogies.

The electrical connections are made.

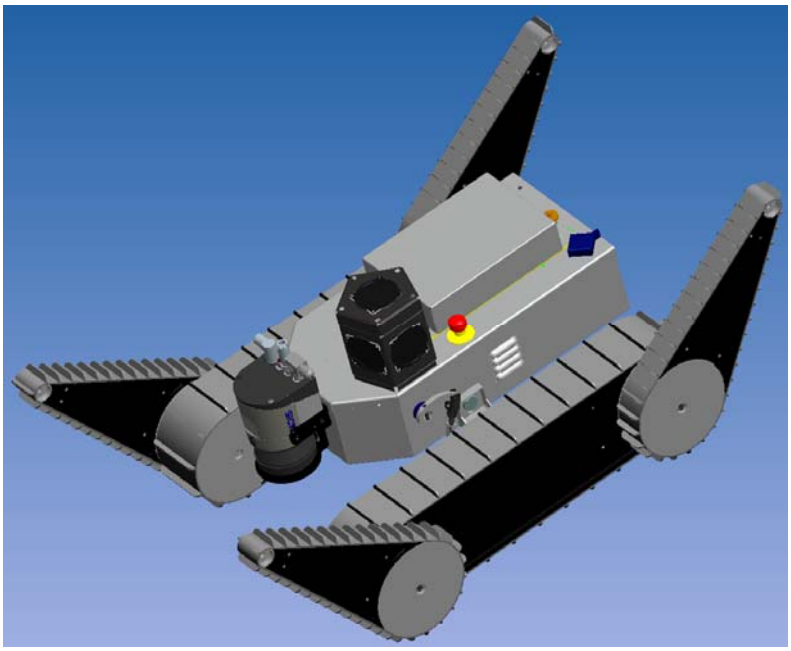

Figure 12. Assembly of the bogies on the body

3.3. Tests

Preliminary tests on sub-assemblies are performed during the assembly process in order to detect as early as possible the failure of a sub-assembly or component. The PCBs have been assembled at BlueBotics and have been fully tested before their integration on the platform.

After assembly, 2 types of tests will be performed. Firstly, tests on every platform to control that every feature is functional on all the platforms. Then specific tests will be conducted on one platform only, in order to validate that we are compliant with each specification.

3.3.1. Test on every platform

- Basic tests are performed in order to validate the good functionality of:
  - Every sensor,
  - Every actuator.
- The global functionality of each platform is also tested to validate that it can be setup in every configuration.
- The different inputs/outputs are tested.
- The communication is tested:
  - To the embedded computer,
  - Between the embedded computer and the sensors.

3.3.2. Specific tests

Specific tests will be performed on one platform only, in order to validate:

- The behavior of the platform in every configuration.
- The correct movement of the platform on different types of ground.
- The passage over the specified obstacles.

These tests will allow us to fill the compliance matrix.

4. Conclusion

This document described the manufacturing process as well as the method BlueBotics uses to control the compliance of its designs to the specification: the compliance matrix.

At the time of writing, most of the components have been delivered and the production of the six platforms is about to start.