



Circular machine building: digital solutions for machine maintenance

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Digital support helps machine builders work on a circular basis and create added value

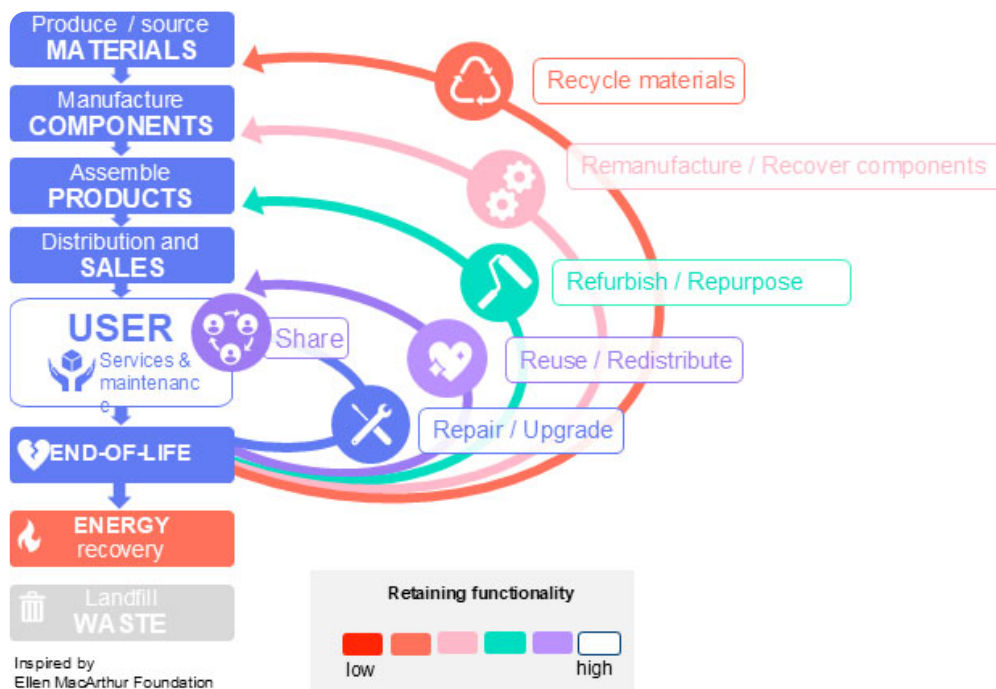
Machine builders want to contribute to a circular economy, too. One strategy is to extend the life of products through maintenance and repairs. Using a concrete example, this article explains what role digital solutions can play in this and what you as a machine builder should definitely bear in mind.

Circular strategies in mechanical building

More and more companies are working on the circularity of their products. Machine builders, too, are taking steps to reduce the environmental impact of their products. In the Living Lab project 'circular machine building', three companies set out to find suitable circular strategies for their product, business and market.

Machines are technical products with a great deal of added value owing, for example, to assembly, programming and testing. That value is obviously lost when the product is reduced to its base materials. The greatest potential for machines therefore lies in preserving and maximising their technical and functional value. This can be done in several ways (see figure):

1. **Increased machine utilisation:** more output with the same machine
2. Longer machine life at customers: **through maintenance and repair**
3. Longer machine rotation via **remanufacturing**: revaluing and re-marketing discarded products



Circular strategies for machines: the inner circles retain the most added value.

How do machine builders make a difference in maintenance?

The Eliet case

Eliet, a manufacturer of garden machinery based in West Flanders, explored the route of extending the life of machines through **maintenance and repair** within the Living Lab project.

Like most machine builders, Eliet already takes into account design choices that affect the life of their machines and the impact these choices have on the cost and attractiveness of their product. However, maintenance and repairs are often carried out by customers and distributors. This sometimes leads to premature product failure, dissatisfied customers or reputational damage.

Gains through digital support

As a manufacturer, how do you ensure that machines are maintained correctly, problems are fixed faster and you earn something from them, as well?

By supporting maintenance and repairs directly, you create a **win-win-win** for the machine builder and the customer as well as contributing to the reduction of the environmental impact through **improved circularity**:

- **Less unexpected machine downtime**: fast problem resolution saves customers time and money and reduces risks.
- **Longer machine life**: customers postpone investment in new machines and avoid unnecessary repairs.
- **Direct insights from customers and machines**: this **saves time** for **machine builders** in dealing with customer issues and helps improve product design.
- **Additional income**: you generate revenue through paid product options and services, and indirectly through product sales and spare parts sales.

Specifically, how can you support customers during maintenance and machine breakdowns?

By carefully examining the customer's needs and the machine builder's role, you gain a better idea of which functional requirements a solution has to meet.

Below are examples of possible subtasks as regards 'maintenance' and 'troubleshooting'.

Maintenance support	Troubleshooting support
1. Identify the right maintenance action at the right time. 2. Inform the maintenance technician of the required action. 3. Provide the maintenance technician with clear instructions for efficient, safe and quality maintenance. 4. Provide customers with a way of quickly and easily ordering the correct spare parts. 5. Give the customer and the maintenance technician access to the maintenance history.	1. Automatically detect and diagnose problems. 2. Inform the operator of the required repair method. 3. Give the operator clear instructions on how to resolve breakdowns efficiently, safely and qualitatively. 4. If the problem is not solved, send relevant machine data to the manufacturer. 5. Analysis of the problem by the manufacturer using data such as product status and history. 6. The manufacturer guides the operator through the repair procedure in real time.

Examples of possible subtasks of the machine builder as regards 'maintenance' and 'troubleshooting'.

Digital solutions for machine maintenance

Digital technology makes it possible to partially or fully support the above subtasks in maintenance and troubleshooting. This is done in a scalable and potentially cost-effective way.

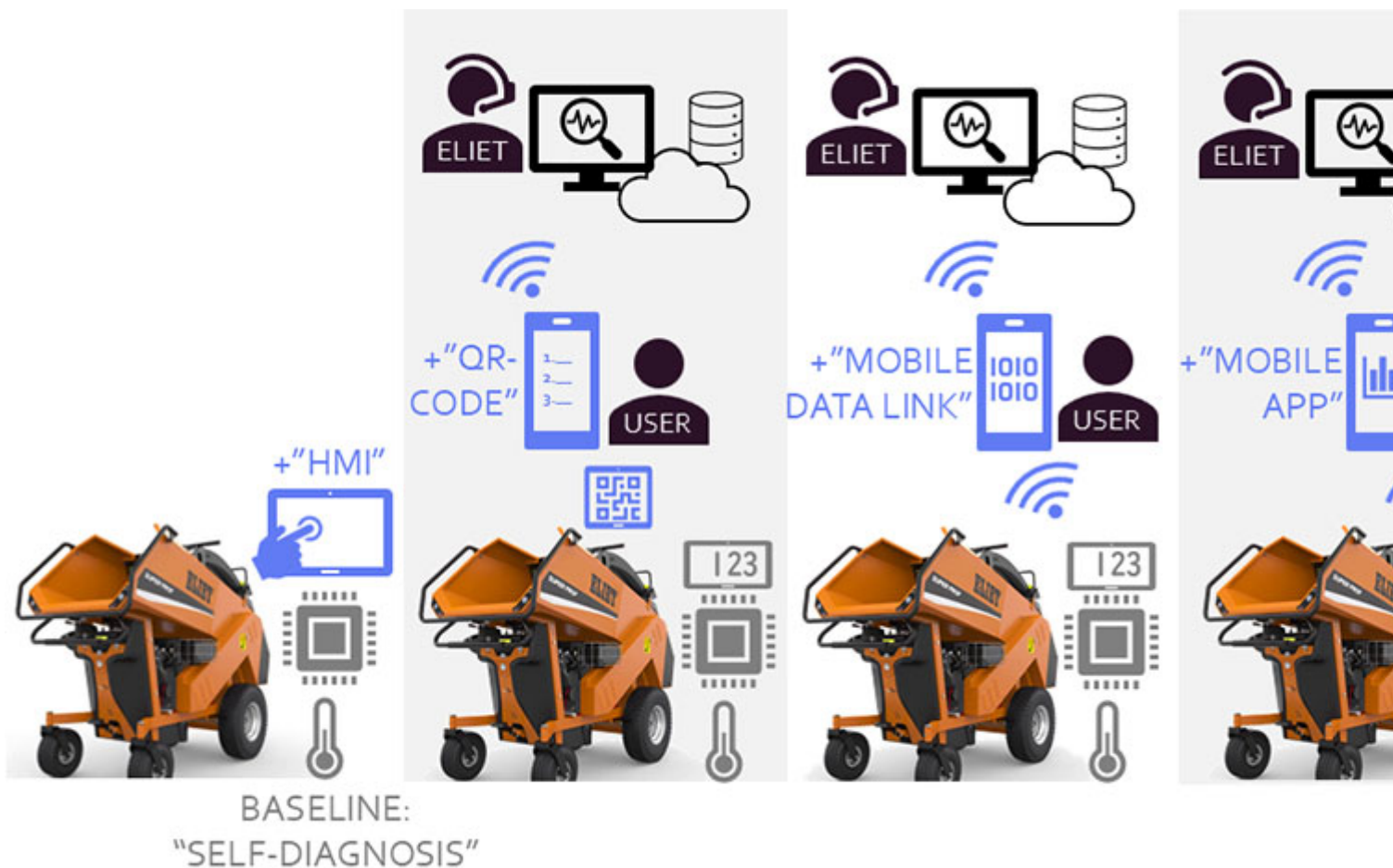
For both maintenance and breakdowns, everything starts with **self-diagnosis** in the machine. This ensures that you know what maintenance action is needed or what technical defect you are dealing with. This can be done with an **embedded system** that collects and processes (measurement) data to decide on the most appropriate action.

Key questions here are:

- What **sensors** are needed in the machine to reliably identify defects and/or maintenance statuses?
- What **data analysis** is needed in the machine to make an initial diagnosis and decide on a follow-up action?

The machine then has to exchange the necessary data with the operator, the customer and the machine builder. This can be done through different interfaces, each with its own **connected solution concept**. Applied to a wood chipper, this is what it looks like (see figure):

- **User interface** (display) integrated in the machine.
- **QR code** on a machine display, to be scanned with a smartphone that establishes a link to the appropriate web application.
- **Mobile data link** that exclusively uploads data via Bluetooth/Wi-Fi from the machine and via the smartphone to a (simple) web application.
- **Mobile app** that exchanges data between machine and smartphone via Bluetooth and provides additional functionalities for the user, along with a web app for the customer and the machine builder.
- **'Full IoT' solution** where the machine can exchange data directly and at any time with a web application via a mobile network (e.g. 5G, NB-IoT, etc.). A mobile app serves as a backup machine interface and is used for software updates.



Various possible digital solution concepts applied to an Eliet wood chipper (LTR): user interface (HMI) in the machine, QR code via smartphone, mobile data link, mobile app and Full IoT solution.

From simple to comprehensive digital solutions

The solution concepts differ in terms of tasks, added value and costs.

- **The QR code and mobile data link are simpler and mainly internally oriented.** They allow the machine builder to exchange limited data to improve its services.
- **A mobile app and full IoT solution are more comprehensive and more customer-centric.** They offer more features and therefore bring more costs. But through paid services, they do provide additional revenue to the machine builder.

Simple solutions are often a low-threshold stepping stone. By rolling out an initial solution, you gain experience with the technology and build understanding of your customers' needs before launching larger developments.

What do you need to successfully expand your machines with digital maintenance solutions?

At several companies expanding their products to include digital solutions, we saw multiple pitfalls and success factors. These can be summarised in six focal points:

- **Product management:** check whether potential customers are really waiting for the solution. Identify which aspects are essential for them before you start development.
- **Digital impact on business and product:** digital solutions change not only your offering, but also your relationship with customers and even your revenue model. So consider agreements on security, data and software maintenance, which are crucial for continuity.
- **Technology knowledge:** build sufficient knowledge of digital technology (electronics, embedded software, cloud, applications). This allows you to manage the development together with external parties.
- **Embedded system:** the challenges are very case-specific, depending on the sensors and algorithms required. Remember that hardware can't be changed as easily as software. Make sure the added electronics do not undermine the lifetime and reliability of the machine.
- **Connected software:** fortunately, you don't have to start from scratch. Make use of existing building blocks or IoT platforms. Don't underestimate the UX (user experience) part and foresee structural software maintenance to keep the solution up-to-date.
- **Product design:** take machine life and maintenance into account right from the physical product design stage. See digital solutions as complementary, not as replacements.

Getting started with digital machine maintenance solutions yourself?

Digital maintenance solutions in machines can be a **win-win-win** for the machine builder, customer and the environment. To make this a reality, start from the **needs of your customers**. Translate these into an appropriate digital solution and take into account the **digital nature** of such development.

Eliet gathered valuable insights into how digital technology can support circular strategies in the Living Lab project. The company is now moving forward with this.

As a machine builder, do you want to work on a circular basis, extend the life of your products and provide better customer support? Please contact [Pieter Beyl](#) or [Thomas Vandenhaute](#).

More information on the project: [Circular Machine Building | Design region Kortrijk](#).

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