The importance of test rigs in research and development

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What is a test rig?

- Test rigs are bespoke testing devices
- Used for lab testing of new ideas
- Demonstrate key functionality

- Made of configurable circuits and modules
- Emphasis is placed on obtaining reliable data
- Designed to be easy to reconfigure

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What is a test rig?

Broadly speaking a test rig can be defined as a bespoke research and testing device designed for a specific application. It is a form of hardware prototype built for lab testing and is usually a collection of configurable circuits or modules that demonstrate the key functionality of a new idea or piece of technology. When building and testing rigs, emphasis is placed on obtaining reliable data in ideal conditions over consideration for the commercial embodiment of the technology and its industrial design.

Test rigs vary from one industry or application to another so this discussion provides a general overview of the process, key components and benefits.

What are test rigs used for?

There are many reasons why building test rig devices is beneficial or even essential, but they are broadly broken down into 5 main benefits:

- **Understanding** the benefit of a new process, idea or piece of technology and providing benchmark data to support further development
- **Demonstrating** a working proof of concept to stakeholders before investing more resources into further research effort and commercial realisation
- **Analysing** and characterising highly dynamic data in a lab environment where external factors such as power supplies and ambient temperature can be controlled
- **Accelerating** early integration with other parts of the system I.e. software
- **Validating** the suitability of the new technology with early user feedback

Why are test rigs important?

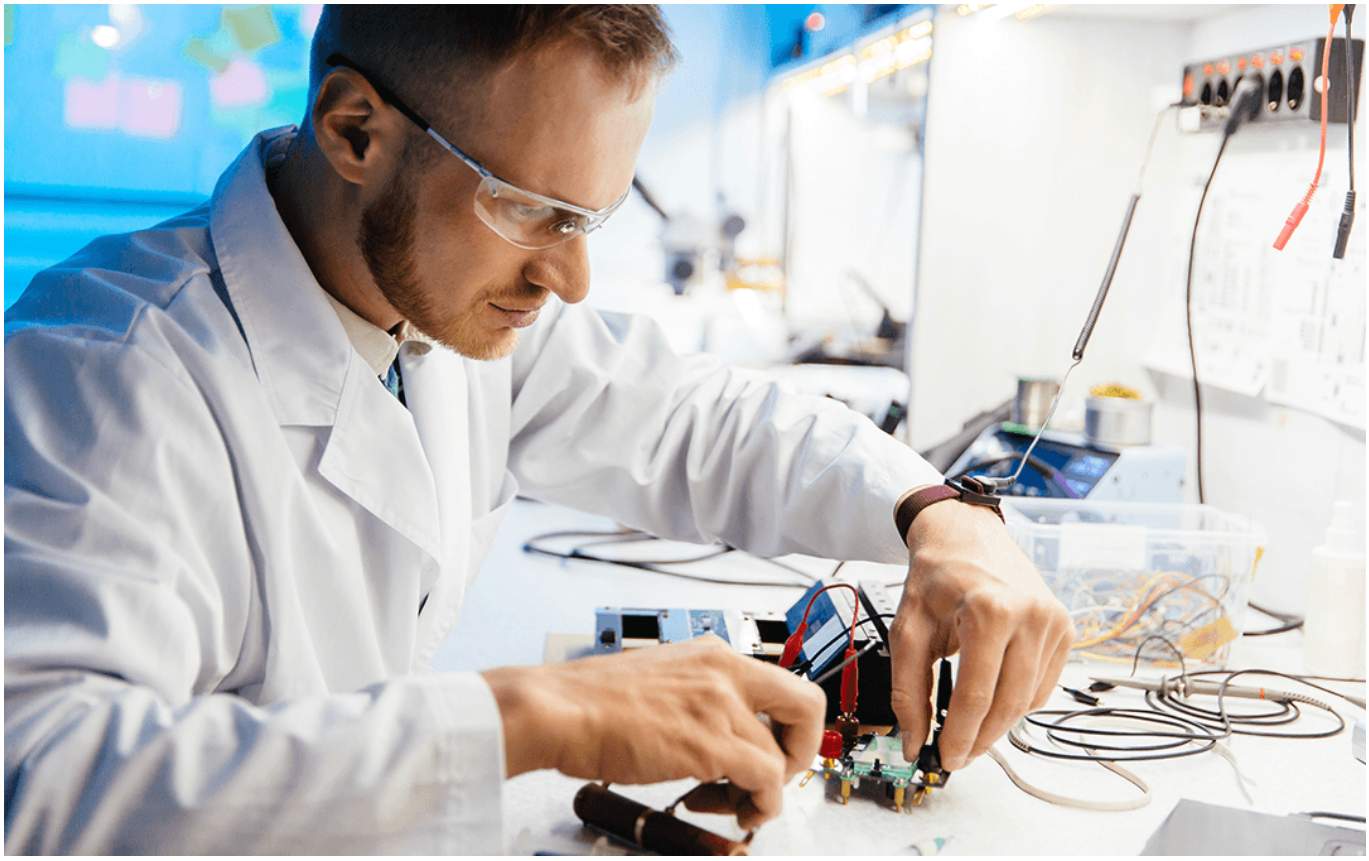
In the early stages of research and development, reliable data is critical and it is important not to be constrained by the physical limitations that must be considered when developing industrialised devices. From the outset, the focus should be on reliable data acquisition; measuring the efficacy of the new technology in ideal conditions by controlling as many variables as possible. By building test rigs to prove new technology on the test bench it is possible to put aside many of the industrial design considerations which could obstruct and complicate the collection of reliable data and unnecessarily delay progress. Some of the considerations which can in many cases be put to one side include:

- Size, weight or form factor
- Mass manufacturing limitations
- Material limitations
- Regulatory constraints
- Power requirements
- Real world conditions

The benefits of putting these factors to one side is that test rigs can be built quickly. Test rigs also provide the flexibility to change parameters and reconfigure things easily. It is normally possible to reconfigure or try out different settings and also carry out tests using bench top test instruments for measurement which are often more accurate than on device sensors.

How do test rigs work?

Because the applications for test rigs is so broad, they can work in many different ways. They tend to integrate one or more elements from a proposed system, developed to a level where they can be reliably tested. They can include any number of output devices and mechanical components which perform pre-programmed testing routines, the performance of these components within the system are measured by sensing devices either integrated into the test rig itself or externally. They are generally powered by a stable power source e.g. a bench top power supply and tested under controlled conditions.



How do you build a test rig device?

Given the diverse nature of test rigs it isn't possible to give a definitive answer to how to build them, however they are usually comprised of common off-the-shelf modules to accelerate the build time. Sometimes other bespoke modules are designed and fabricated to assist with integration, these modules can include:

Processors

Off the shelf control modules and dev kits such as a Microcontroller, Microcomputer or FPGA systems. Examples of such modules are Arduino, Raspberry Pi or Red Pitaya. Sometimes it may be necessary to build bespoke processing hardware if there are not suitable off the shelf solutions available.

Bespoke hardware

Test rigs can sometimes include bespoke hardware to perform other functions which might not be supported by the main processing device. This could include interfaces to other elements of the system such as motor drivers or amplification and filtering for sensor inputs. They can also provide interface to other devices via wireless protocols such as WiFi or Bluetooth.

Input sensing

Off the shelf sensors, sensor kits, modules and breakout boards are often used to provide the output data generated by the test rig. Examples of the kinds of sensors used in test rigs include gas sensors, barometric and absolute pressure sensors, thermocouples, infrared thermopiles, thermistors, flex sensors, visible light sensors, microphones, gyroscopes, compasses, accelerometers, mass airflow sensors.

Output devices

A test rig may incorporate electromechanical components that respond according to sensor inputs or run specific routines which are monitored by sensors in the system. Some of the types of output devices commonly found in test rigs include pumps, stepper motors, valves, piezos, solenoids andrelays.

Mechanical components

The mechanical design of a test rig ranges from the physical chassis to which all other components attach, down to the fixings that connect all of the mechanical parts together. The mechanical parts can also perform various functions such as controlling fluids, incorporating channels and seals and may need to be designed to withstand various external conditions such as temperature, pressure, humidity etc. The components can often be fabricated or rapid prototyped.

Firmware

Firmware runs on the main processing device, usually written in C++ it is compiled into binary and uploaded to the device during programming. Firmware controls the low-level logic and functionality which takes place at a hardware level. The firmware is responsible for functionality such as reading sensor values and taking actions based on certain pre-programmed conditions.

Software GUIs

Software GUIs are sometimes used in conjunction with test rigs to provide greater control over device input and functionality or to provide more options for data display, data logging and export to file formats such as CSV or excel. Test rig software can be built using off the shelf software packages

such as Lab View or bespoke software can be written, usually in C++ or C#. Some of the additional functionality software can provide includes charts and graphs displaying sensor data or user controls which make it easier to set multiple parameters. Software GUIs can be built as desktop, mobile or web applications and can also be embedded into the device themselves.

External hardware

In some cases, external hardware such as signal generators, oscilloscopes and other instrumentation may be used to create inputs or measure outputs of the test rig device where incorporating them into the device itself would be impractical or unnecessary.

Find out more about building test rigs

At Ignitec building test rigs is a key stage in our research and development process. If you would like to find out more about how to build your own test rigs please get in touch.

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