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Reviewing Skills Needed to Leverage 4IR Technology to Remain Relevant: Insights from a Makerspace

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Overview

- Brief review of academic institutions and the 4IR
- Review of needed skills and core competencies required
- Applications using 4IR
- Functional practices from a makerspace to channel 4IR technologies

What is the 4IR?

4IR describes technological disruptions driven by increased automation of labour and increased digital connectivity.

At the core of which is its disruptive/ smart technologies.

What about South Africa?

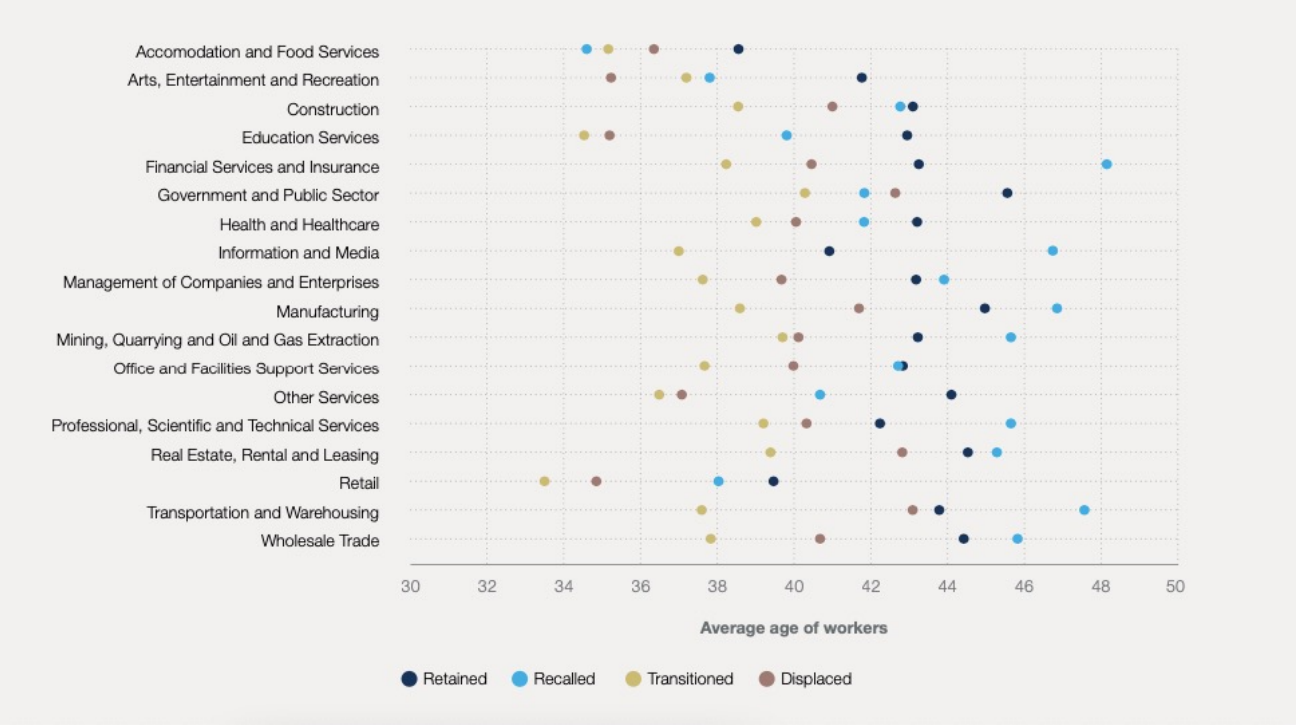
The official unemployment rate was 35,3% in the fourth quarter of 2021.

‘Real’ matric pass rate is **51.4%**, as the official results do not take into consideration the high dropout rate.

Academic Institutions

- Custodians of knowledge
- Various opportunities to scale collaborations across fields
- However, challenges exist
  - Exacerbated not only by emerging technologies
  - COVID-19
- South African landscape is in a "**Watch Out**" Economy
  - Skills and infrastructure challenges

Effects on Future of Work



WEF

Despite these challenges

Through Technological Innovation

FinTech	Education	Healthcare and Bio

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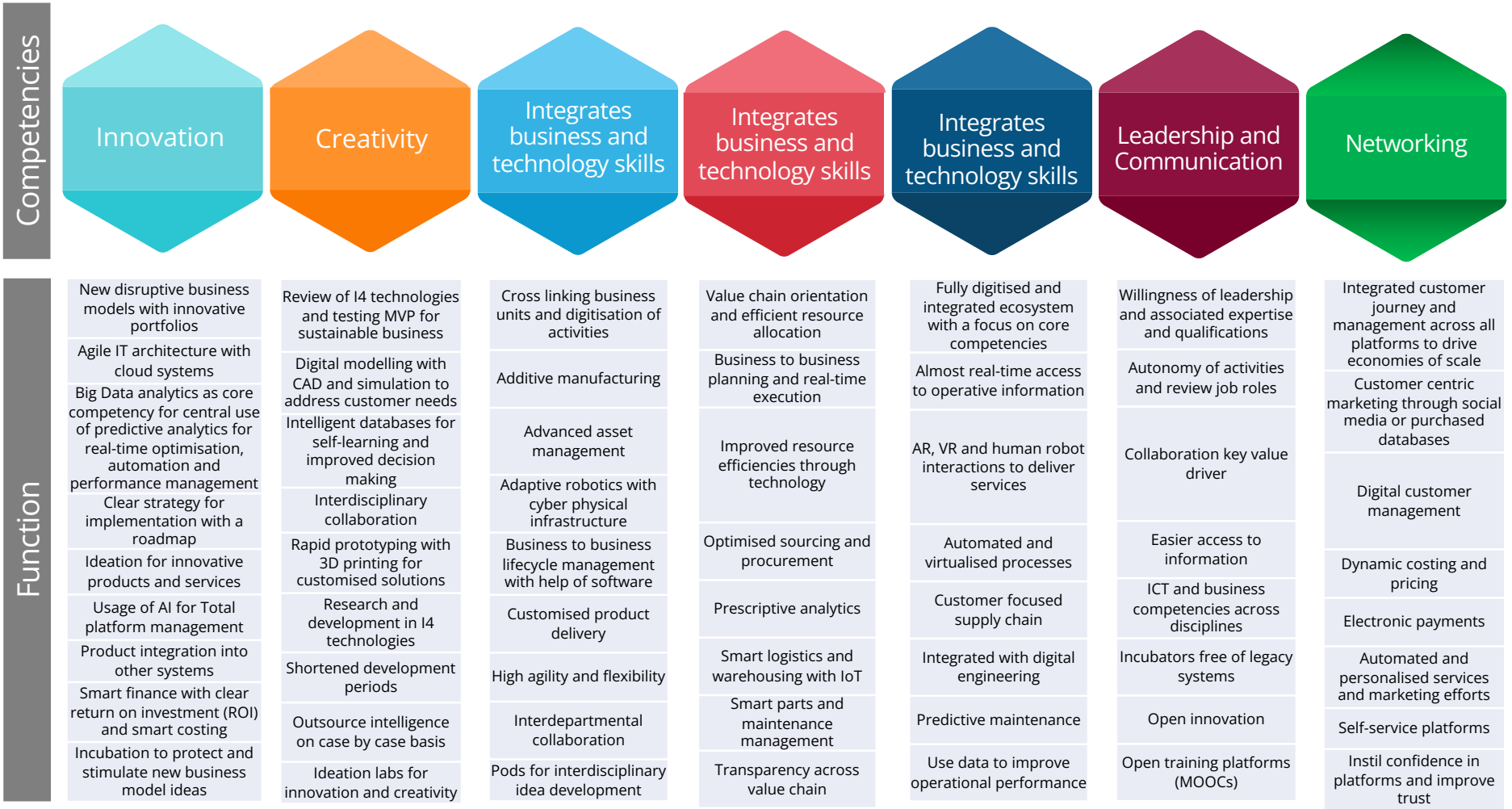
To leverage 4IR:
Certain core competencies are required


Competencies
Innovation
Creativity
Integrates business and technology skills
Integrates business and technology skills
Integrates business and technology skills
Leadership and Communication
Networking
Function
New disruptive business models with innovative portfolios
Agile IT architecture with cloud systems
Big Data analytics as core competency for central use of predictive analytics for real-time optimisation, automation and performance management
Clear strategy for implementation with a roadmap
Ideation for innovative products and services
Usage of AI for Total platform management
Product integration into other systems
Smart finance with clear return on investment (ROI) and smart costing
Incubation to protect and stimulate new business model ideas
Review of I4 technologies and testing MVP for sustainable business
Digital modelling with CAD and simulation to address customer needs
Intelligent databases for self-learning and improved decision making
Interdisciplinary collaboration
Rapid prototyping with 3D printing for customised solutions
Research and development in I4 technologies
Shortened development periods
Outsource intelligence on case by case basis
Ideation labs for innovation and creativity
Cross linking business units and digitisation of activities
Additive manufacturing
Advanced asset management
Adaptive robotics with cyber physical infrastructure
Business to business lifecycle management with help of software
Customised product delivery
High agility and flexibility
Interdepartmental collaboration
Pods for interdisciplinary idea development
Value chain orientation and efficient resource allocation
Business to business planning and real-time execution
Improved resource efficiencies through technology
Optimised sourcing and procurement
Prescriptive analytics
Smart logistics and warehousing with IoT
Smart parts and maintenance management
Transparency across value chain
Fully digitised and integrated ecosystem with a focus on core competencies
Almost real-time access to operative information
AR, VR and human robot interactions to deliver services
Automated and virtualised processes
Customer focused supply chain
Integrated with digital engineering
Predictive maintenance
Use data to improve operational performance
Willingness of leadership and associated expertise and qualifications
Autonomy of activities and review job roles
Collaboration key value driver
Easier access to information
ICT and business competencies across disciplines
Incubators free of legacy systems
Open innovation
Open training platforms (MOOCs)
Integrated customer journey and management across all platforms to drive economies of scale
Customer centric marketing through social media or purchased databases
Digital customer management
Dynamic costing and pricing
Electronic payments
Automated and personalised services and marketing efforts
Self-service platforms
Instil confidence in platforms and improve trust

Innovation

- New disruptive business models with innovative portfolios
- Agile IT architecture with cloud systems
- Big Data analytics as core competency for central use of predictive analytics for real-time optimisation, automation and performance management
- Clear strategy for implementation with a roadmap
- Ideation for innovative products and services
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Review of I4 technologies and testing MVP for sustainable business

Digital modelling with CAD and simulation to address customer needs

Intelligent databases for self-learning and improved decision making

Interdisciplinary collaboration

Rapid prototyping with 3D printing for customised solutions

Research and development in I4 technologies

Shortened development periods

Outsource intelligence on case by case basis

Ideation labs for innovation and creativity

- Cross linking business units and digitisation of activities
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- Business to business lifecycle management with help of software
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- Open innovation
- Open training platforms (MOOCs)

To leverage 4IR:
Active and life-long learning

What can we do to support this?

Functional Practices

- Giving a voice or face to innovation
- Collaboration within ecosystems and industry
- Access to key technologies
- Ensure staff competence

A space to create and channel innovation

DEPARTMENT OF LIBRARY SERVICES

SPACE TO CREATE

Innovation starts with an idea, and associated action. UP's Library Makerspace has helped many an idea leap off the page and into action.

The University of Pretoria (UP) opened the first academic Makerspace in sub-Saharan Africa in 2015 to provide an environment that all staff and students can use to not only generate ideas, but to put them into action with the aid of technology, expertise and collaboration.

The resulting environment continues to lead the way by fostering an inclusive place of productivity and creativity that promotes innovation capabilities.

As with most centres of innovation, Makerspace is constantly evolving to remain relevant in an ever-changing and demanding climate. At the core of this, is Makerspace staff, who keep abreast of various specialist fields and technologies in order to guide users in addressing their complex problems in the most efficient way, and to design and test concepts towards tangible outputs.

Critical to its success is access to novel technologies such as additive manufacturing (3D printers), internet of things (IoT) design kits and 3D scanners.

Makerspace designed an artificial egg that can be placed in the nests of vultures to understand ideal nest conditions and ensure optimal hatching of future eggs in simulated environments.

Putting ideas into action

The Makerspace team worked with UP's malaria prevention team to develop prototypes (using 3D printing and IoT kits) that can be used in the field to collect data on mosquitos more efficiently. They also collaborated with the Department of Zoology and Entomology and one of its subsidiaries, VulPro, which specialises in vulture conservation, to create an artificial egg that can be placed in the nests of vultures to accurately collect temperature, moisture levels and sit times. The data is being used to understand ideal nest conditions and ensure optimal hatching of future eggs in simulated environments.

Makerspace is a breeding ground for collaboration within the University ecosystem. "We assess where the design ideas of users reside and guide them in taking these ideas further," says Sean Kruger, coordinator of Digital Scholarship and Innovation. "There are so many functional and amazing capabilities within UP that users are not always aware of, or when to use them. The role of the Makerspace is to remain a strategic unit that develops a community that is digitally fluent for the 21st century, and provide an open, safe place for students and researchers to test their ideas and turn them into a reality."

Photo Credit: UserGI15613517 on iStock
Photo Credit: 3D-Printed vulture egg - Sean Kruger, Makerspace

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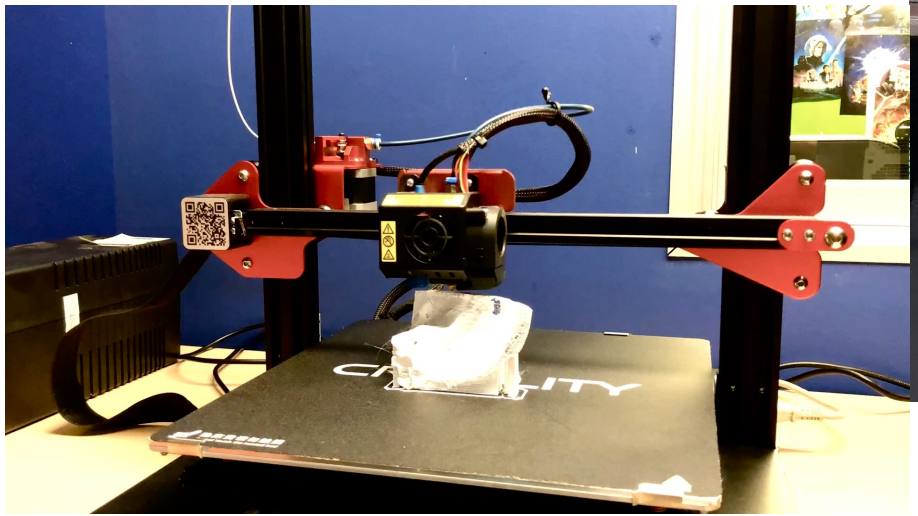
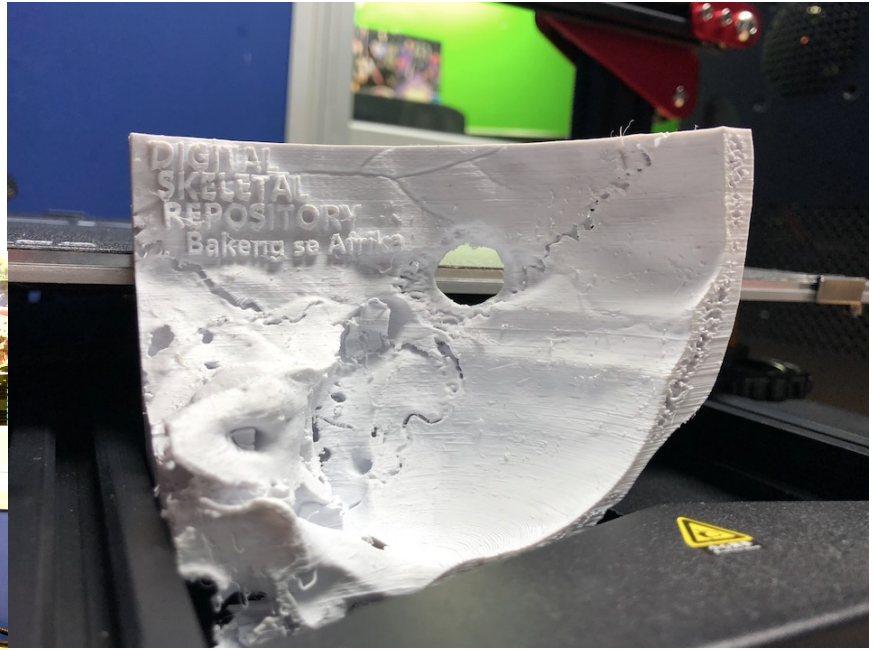
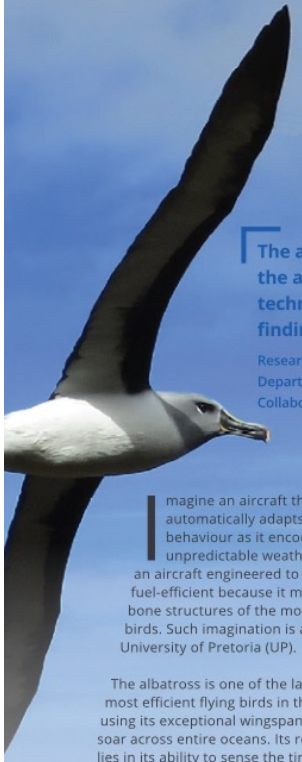
Collaboration within ecosystems







COLLABORATION SOARS AT MAKERSPACE

The albatross is one of the most energy-efficient travellers in the animal kingdom. With the knowledge of Mother Nature, technology and interdisciplinary collaboration, UP researchers are finding ways to make future air travel cheaper, cleaner or faster.

Researchers: Janine Schoombie, Dr Lelanie Smith and Professor Ken Craig, Department of Mechanical and Aeronautical Engineering
Collaborator: Department of Library Services

Imagine an aircraft that automatically adapts its flight behaviour as it encounters unpredictable weather. Imagine an aircraft engineered to become more fuel-efficient because it mimics the bone structures of the most efficient birds. Such imagination is at play at the University of Pretoria (UP).

The albatross is one of the largest and most efficient flying birds in the world, using its exceptional wingspan to glide and soar across entire oceans. Its real talent lies in its ability to sense the tiniest changes in air pressure and wind direction. While some studies have studied albatross wing scans and applied this to drones, accurate measurements under varying conditions of albatross wings are currently not easily accessible.

Creativity at work

Enter UP's Library Makerspace, a collaborative space synonymous with innovation, interdisciplinary research and creativity. In discussion with Janine Schoombie of UP's Department of Mechanical and Aeronautical Engineering, the Makerspace suggested it could capture an accurate 3D digital representation of the albatross's anatomy for detailed study.

Initial scanning was performed in a static environment in the Makerspace to generate a still scan of the wings and feathers. Later, another scanning session took place inside the University's wind tunnel facilities in the Department of Mechanical and Aeronautical Engineering to compare the differences in flex and shape under flying and gliding conditions.

"This gives us quantitative data on the aerodynamic forces acting on the wings of this specific albatross species [the grey-headed albatross] under varying conditions," Schoombie says.

"These findings have several implications in the aerospace industry, where aerodynamics – the study of how objects move through the air – plays a vital role in the design of next-generation aircraft, among other applications," adds Dr Lelanie Smith, Schoombie's supervisor.

While 3D scanning is quite common, it is the fusion of biology and mechanics that makes this collaboration novel. "Thanks to access to equipment, such as the EinScan Pro 3D scanner and the University's wind tunnel, we can begin creating digital models of the albatross wings and broaden the study even further using computational simulations," Schoombie says.

What's next?

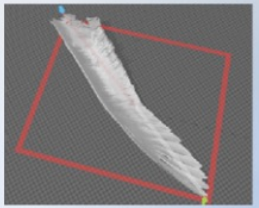
The next phase is to compare the surface 3D scans to internal scans. The team is collaborating with UP's Faculty of Veterinary Science on the Onderstepoort campus to use its CT scan machine.

With the research outputs, there will be further collaboration with the Technology Transfer Office at UP to determine industry interest.

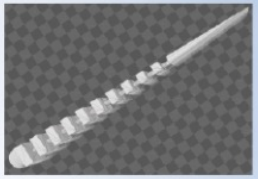
Why is this research important?

The albatross has a special tendon in each shoulder that allows the bird to lock its wings in place – a quality it shares with fixed-wing aircraft. Understanding the physical principles that explain the behaviour of the wings would help engineers redesign the wings of aircraft or develop more sensitive wind sensors, both of which could make future air travel cheaper, cleaner or faster.

A more immediate application of albatross efficiency might be for drones, or unmanned vehicles in remote locations, that need to be constantly airborne to receive radio or telemetry signals.



Underside of the 3D-scanned wing with measuring points



Cross-sectional structural rendering based on wing attributes attained from scanning

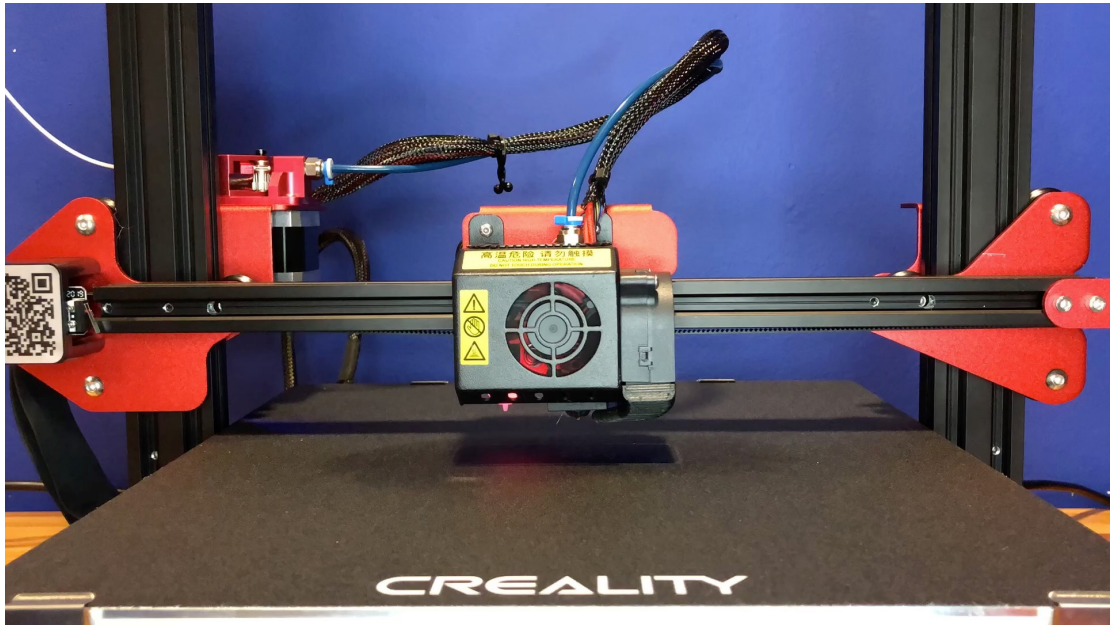
2.2 metres
Wingspan of the grey-headed albatross

115 million
Number of cloud points for the largest quality scan of one albatross wing

3.5 metres
The formidable wingspan of the wandering albatross

Photo Credit: J Schoombie

Access to technologies and needed expertise



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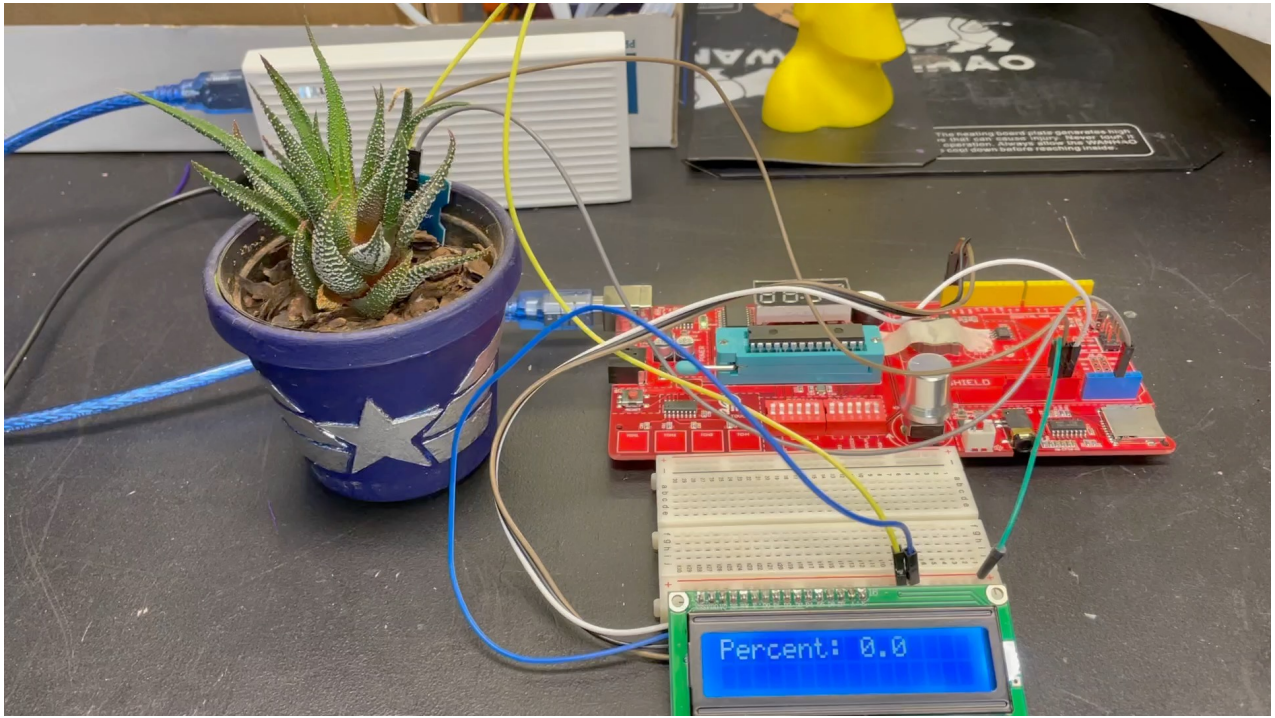
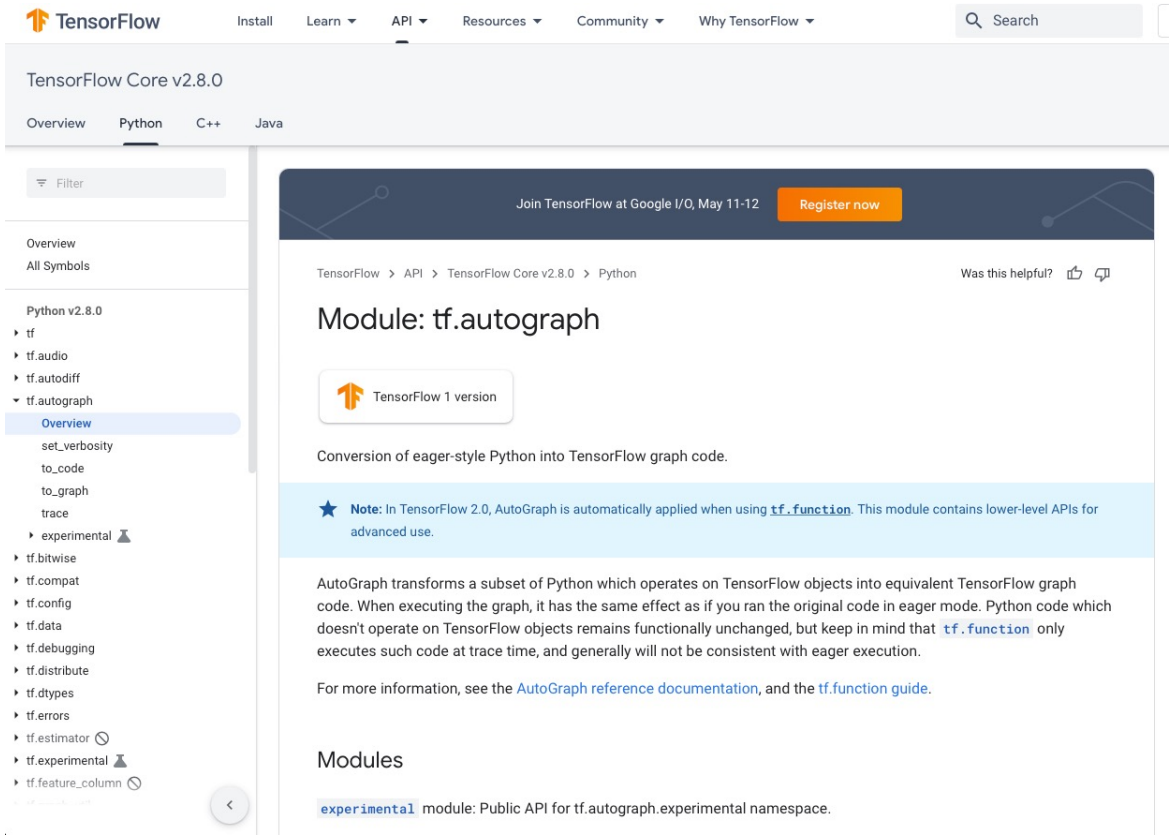


Ensure competent staff: Digital and physical sphere



Thank you

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