



WS AMATI GLOBAL INNOVATION FUND

# Innovation Frontier

## Machine Vision



By Fund Manager, Graeme Bencke





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**A**round 500 million years ago life on our planet suddenly changed as oxygen levels rose high enough to support complex animals. This 'Cambrian explosion' started an evolutionary arms race where predation and defence became the most important determinants of success for almost every species. One of the most important developments was the sense of sight. Today eyes are present in more than 95% of animal species on the planet suggesting that they confer significant benefit. Vision was such an important development that it changed the evolution game forever, and now it appears set to do the same thing all over again.

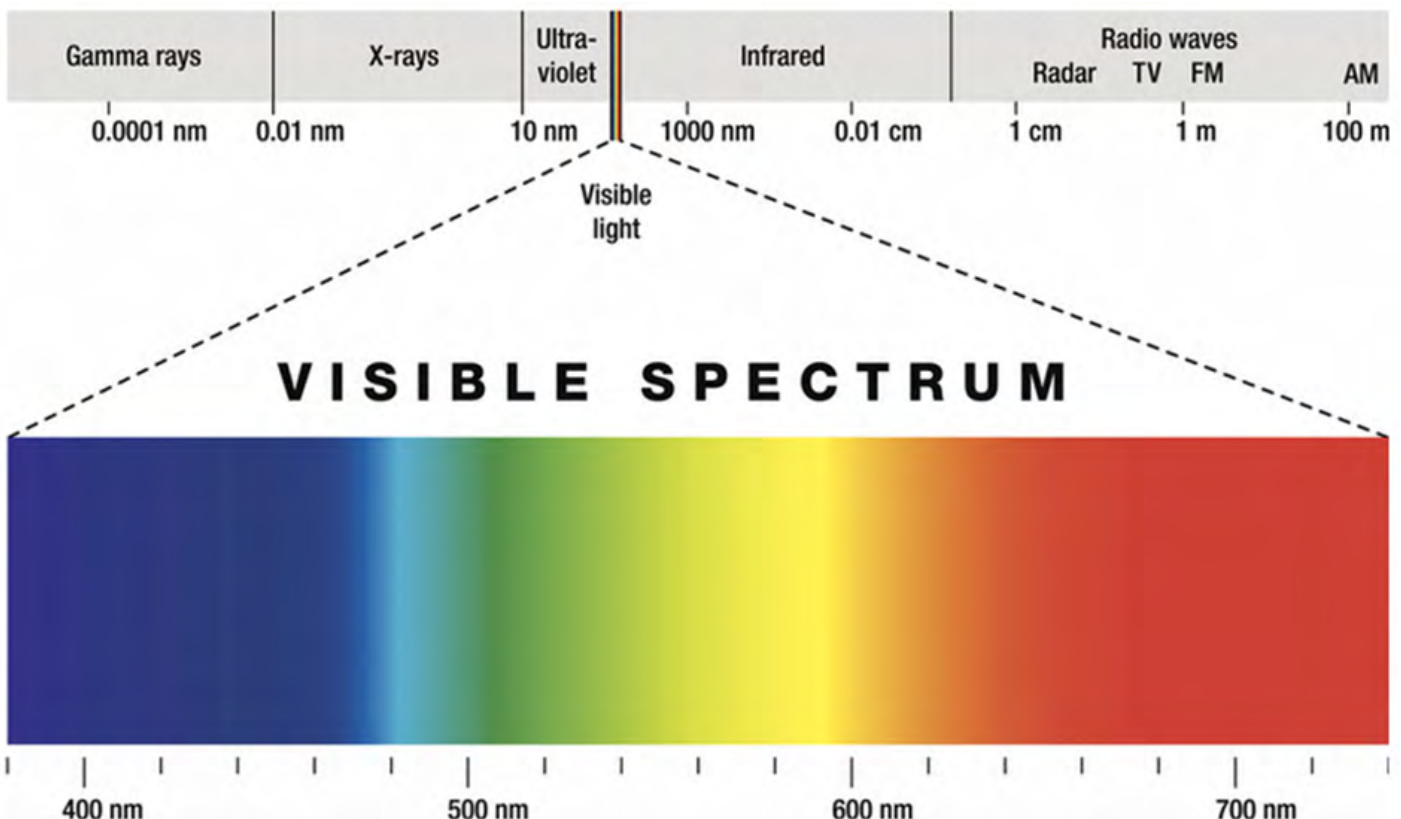
### Robots with Eyes

Machines have been working with us for decades, and cameras in industrial processes are far from new. Indeed, all modern production and assembly lines incorporate cameras and other light sensors for robotic guidance, product inspection and quality control. However, these processes are typically limited to pre-programmed and highly repetitive tasks

Since the Industrial Revolution the concept of truly autonomous machines has been the holy grail, and it is finally becoming reality as numerous technologies simultaneously converge.

Robotics, machine learning, cloud, 5G, and graphics processing each play a crucial role in creating the truly autonomous machine. Yet beyond these important building blocks the machines must have the independent ability to make sense of the world around them, and for this they need to 'see'.

Most of us experience the wonder of sight every day, indeed our perception of the world is very largely based on how we see it. The process is second nature to us and the benefits are abundantly obvious. Machines using colour cameras incorporating the visible spectrum can access a very similar version of reality, but their choices don't end there. They can access a far wider range across the electromagnetic spectrum including radio waves (RADAR) or laser based projections (LIDAR) which don't require visible light. Their sensors can 'see' heat patterns or radiation signatures or view the world in infra-red - or any combination of these.



→ Source: Teledyne Imaging<sup>1</sup>

For example, when an iPhone recognises your face it does this using miniature lasers; modern waste recycling plants use automated water jets using thermal imaging to detect fires before they start; grain silos use miniature radars to measure fill levels.<sup>2</sup>



→ Source: Bytronic<sup>3</sup>

The scope of detection is already well beyond the limits of humans, allowing machines enormous flexibility and capability - and this is where the confluence of the technologies mentioned above comes into play. Only now are we beginning to be able to build miniature image processors which can process high data rates in remote locations in real time and using little energy. The recent development of 5G allows for high speed wireless communication with the cloud where the data is collated and monitored in order to provide incremental deep learning (using AI) for the benefit of similar machines connected to the network. A problem or an efficiency improvement encountered in one location can then be 'learnt' simultaneously in all other locations, with every future iteration building on the knowledge gained before. As machines proliferate and become more advanced the flow of information and the levels of sophistication increase exponentially.

Even familiar equipment is developing "vision", and this improved image capture and processing provides often dramatic improvements in functionality. Security and surveillance cameras (such as those offered by Motorola Solutions and enabled by Ambarella image processor chips) can now recognise faces and read number-plates, as well as help to detect aggressive behaviour, concealed weapons and other threats. Heating and air-conditioning units are paired up with laser scanners (from suppliers such as Lumentum, the company behind Apple FaceID) to count the number of room occupants and fine-tune the heating or cooling output of the unit.

This development of technological capability is bringing a wave of autonomous machines designed to operate in a much more flexible manner than their repetitive predecessors on the production line. Once machines are able to navigate the environment around them and to manipulate objects without external inputs the potential becomes truly staggering.

In the same way that sight and other senses led to an explosion of animal variations during the Cambrian period, we are likely to see a multitude of mobile robotic machines, but over a much shorter timeframe.

Companies are working quickly to bring down the size and cost of the components so that even low value jobs can be replaced. In the consumer space think of more capable lawn mowers and vacuum cleaners, as well as robotic assistants. In the commercial world imagination is likely to be the primary restriction as more and more mundane or dangerous jobs transfer to machines.



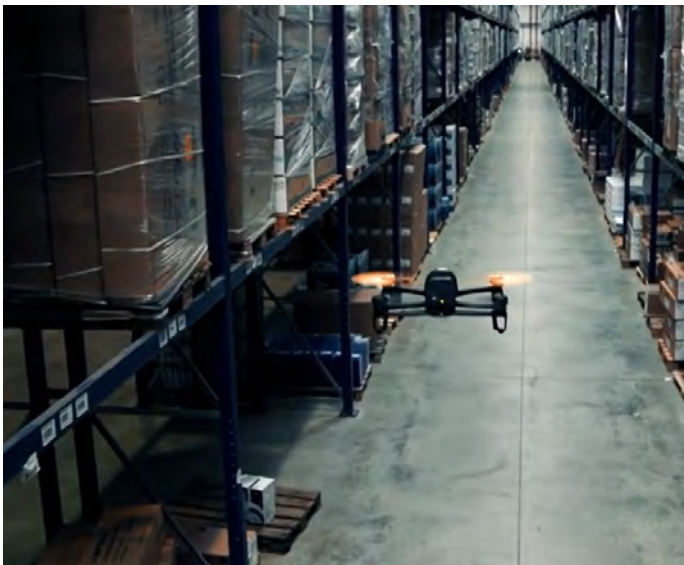
→ Source: Rio Tinto<sup>4</sup>

According to a recent report by ResearchAndMarkets.com<sup>5</sup> the market for autonomous mobile robots (AMR) and automated guided vehicles (AGV) is growing at 35% annually and will reach \$13.2 billion by 2026. Bear in mind that this is only one segment of the machine vision market, which incorporates much larger areas associated with automated production lines for robotic guidance, product inspection and quality control. Although still some way off autonomous driving represents yet another vast market for 'vision' sensors in the coming decade and beyond.

## Intra-Logistics

**W**ithin the scope of autonomous robots, one area of particular focus is logistics, and in particular the activities within the warehouse - intra logistics.

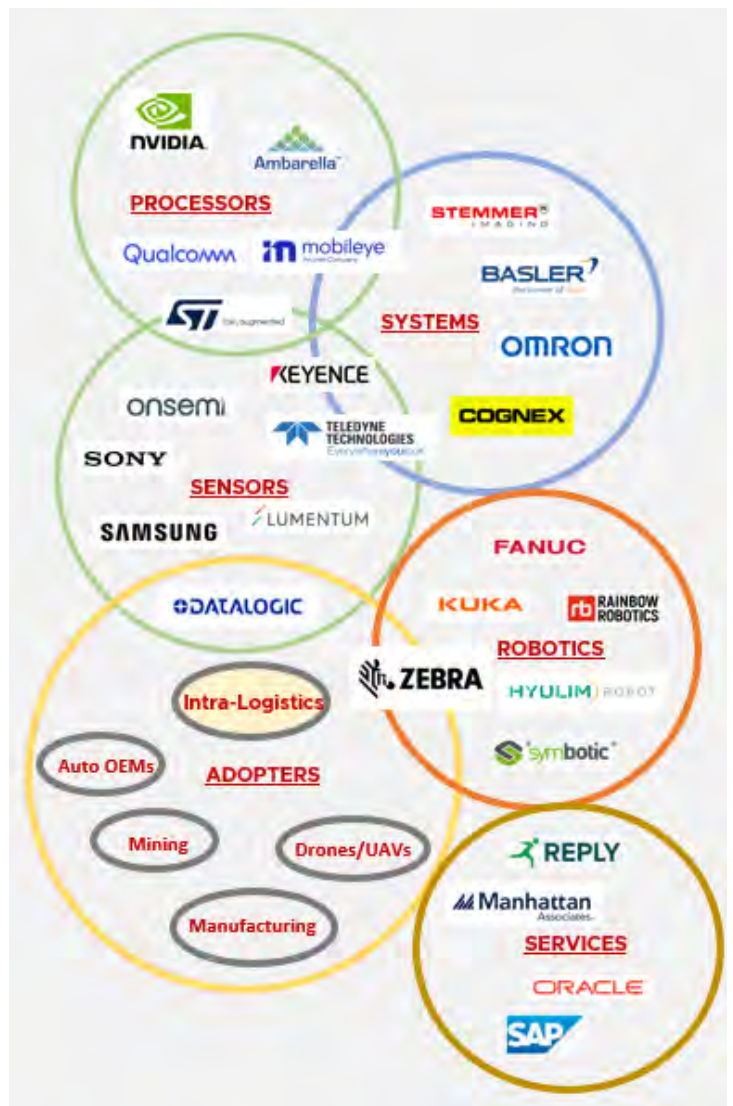
Unloading, identifying, transporting, storing, monitoring and retrieving are all tasks which are increasingly carried out by machines. This makes sense when we consider that in 2021 global parcel volume reached 159 billion, equating to 5,000 parcels per second and that this is expected to reach 256 billion by 2027, with an 8.5% CAGR from 2022. In a recent update, DHL, the parcel delivery arm of Deutsche Post, reported a 30-180% increase in units picked per hour by the inclusion of robots. This area represents an exciting and highly connected Innovation Frontier which is rich in investment opportunity.



→ Source: LEA Reply<sup>6</sup>

After identifying such a clear innovation frontier our approach is then to find the companies which are structurally best positioned to benefit as the innovation develops. In this instance we identified a number of important elements across the supply chain including semiconductor components, machine vision components, robotics, operating software, integrators and engineering services groups. The resulting array of companies is known as the 'Innovation Cluster' and by digging into each segment we can assess their respective advantages and challenges.

Each segment of the cluster faces different competitive dynamics, regulatory challenges and growth opportunities. By reviewing these different factors and speaking with experts from across our network we home in on the those with the most attractive reward for the risk. Here we are looking for structurally advantaged businesses with limited competition and a long potential runway for growth. If mature enough, these companies tend to display high operating margins, have low financial leverage and generate solid returns on capital through the cycle.



→ Source: Amati Global Investors

## Warehouse Automation

The fast growing penetration of machine vision into the logistics space is particularly clear across warehouse automation where the improvement in machine autonomy dramatically improves productivity and reduces costly errors. While there are a number of companies leading the way in design of AMRs (Autonomous Mobile Robots) many of these are privately held businesses still highly dependent on capital markets for funding. However, our assessment of the space highlighted Zebra Technologies, a US listed producer of logistics management and tracking systems.

With their origins in barcode scanners and associated systems they have developed their offering to include machine vision, robotics and deep learning to lead the technology transition. Zebra is also an interesting example of a company making its own transition from being an Adopter of innovation to a Pioneer in our terminology. Their large customer network and installed base gives them the perfect platform to drive development across the industry. In addition, the Group operates a highly effective venture capital division which invests in many of the most innovative start-ups in the space giving them early access to acquiring the strong products and ideas of tomorrow.

As retailers, wholesalers and specialist logistics companies attempt to improve productivity and circumvent labour shortages and rising costs, they are leaning more and more on technology. However, the transitions are complex and multi-faceted and specialist help is often needed. Here we identified a fast growing and strategically well positioned Italian company which offers technical and strategic consultancy services in this domain. Reply is a multi-specialist technology services group with a strong franchise in Logistics & Manufacturing. Their Warehouse Management Systems business enables global companies to achieve world class standards in fulfilment and incorporates cutting edge machine vision solutions. Reply still has a strong founder shareholding which ensures a focus on longer term success rather than chasing quarterly results - very much in-line with our own approach.

## The Future

The roadmap to a fully automated supply chain is already evident with shipping, road haulage, packing, sorting and last mile delivery all possible without human interaction. Yet the reality of the 'dark' supply chain (machines don't need the lights to be on) is still some years away and regulation for areas like autonomous driving is likely to move more slowly than the technology. However, the compelling cost and efficiency benefits will continue to drive the process onwards and as always there will be winners and losers. Society will need to get to grips with the changing employment dynamics, but this is nothing new. Ever since the Industrial Revolution the nature of work has continued to change and the outcome has generally been higher standards of living and less dangerous and monotonous working conditions. Thankfully those issues are beyond our remit, instead we confine ourselves to trying to identify the likely commercial winners and to invest in companies like Zebra and Reply before the future value is fully reflected in the share price.

## Citations

1. <https://possibility.teledyneimaging.com/how-deep-is-your-light-imaging-across-the-spectrum/>
2. <https://www.libelium.com/libeliumworld/new-radar-sensor-to-control-liquid-tanks-and-grain-silos-levels>
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6. <https://www.youtube.com/watch?v=jRV1T3tHAKQ>

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## Sales Team Contacts

### Financial Intermediaries

#### Rachel Le Derf

Head of Sales  
Scotland and Northern Ireland  
[rachel.lederf@amatiglobal.com](mailto:rachel.lederf@amatiglobal.com)  
07979601223

#### Colin Thomson

Sales Director  
Northern England, Midlands and North Wales  
[colin.thomson@amatiglobal.com](mailto:colin.thomson@amatiglobal.com)  
07884026517

#### Jonathan Woolley

Sales Director  
Southern England and South Wales  
[jonathan.woolley@amatiglobal.com](mailto:jonathan.woolley@amatiglobal.com)  
07818203013

### Direct Investors

#### Samantha Dalby

Investor Relations Manager  
[samantha.dalby@amatiglobal.com](mailto:samantha.dalby@amatiglobal.com)  
01315039116



### **Amati Global Investors Ltd**

8 Coates Crescent, Edinburgh EH3 7AL

+44 (0)131 503 9115

[info@amatiglobal.com](mailto:info@amatiglobal.com)

[www.amatiglobal.com](http://www.amatiglobal.com)

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