Pataudi & stereoscopic vision

s ananthanarayan describes how the maestro's skill in fielding almost defied the laws of optics

LAST week India and cricket lovers the world over mourned the passing of the legendary Mansur Ali Khan Pataudi. Crowned India's captain in 1962 at the young age of 21, he captained the country for 40 tests. While Pataudi was a phenomenal batsman and fielder, what is remarkable is that he was this despite being handicapped by not having the vision of one eye.

But how remarkable is that? Would the lack of effective use of both eyes be, in fact, a major handicap? The paragraphs below describe how living things have evolved to have a pair of eyes, for a good reason, that two eyes allow us to see not just twice what one eye could see, but something that one eye, howsoever keen and sharp, could never make out. That Pataudi, denied this basic facility which has guided the path of evolution, could still manage highly sight-intensive activities like batting and fielding in the covers is a triumph of technique and determination.

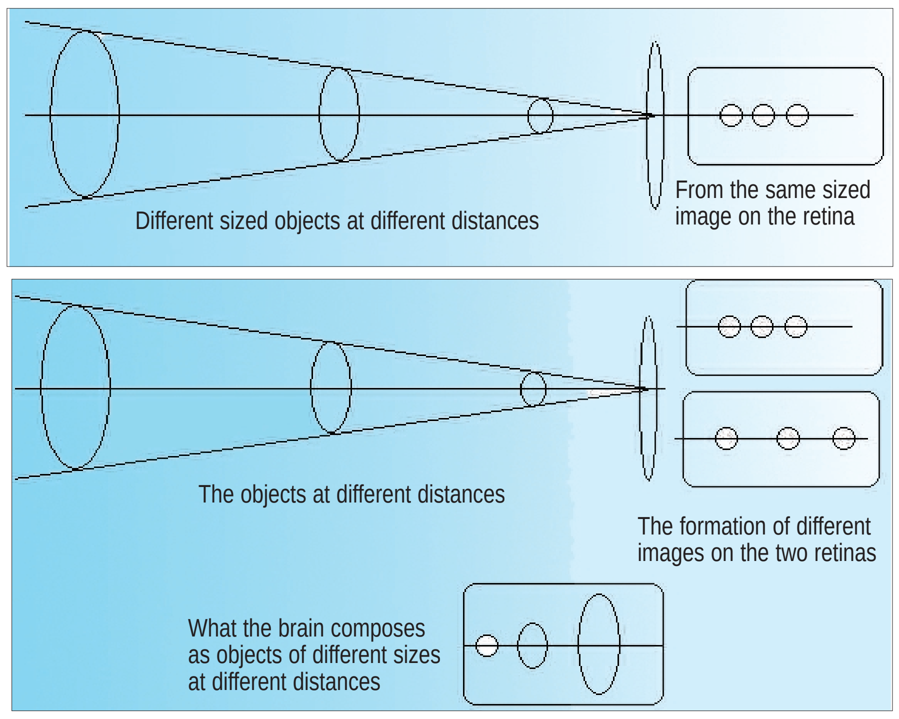
Stereoscopic vision

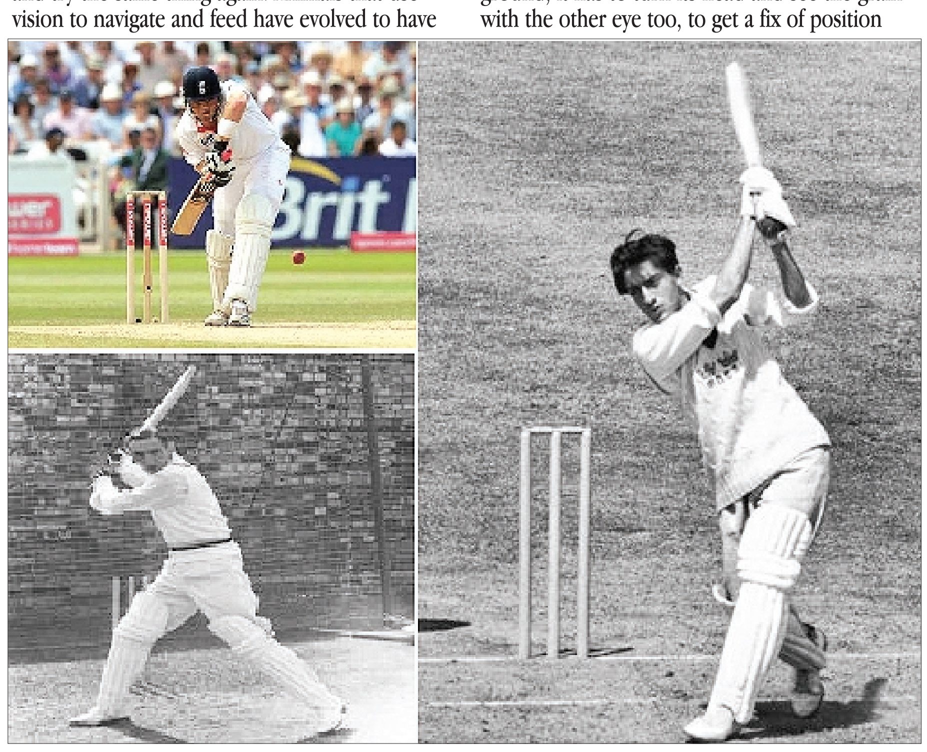
What a single eye sees is the image of the objects before it as is projected on a planar screen, the retina of the eye. Thus, what is recorded in the image formed by one eye is the apparent size and brightness of each object, the image of a smaller and nearby object being similar to the image of a larger but distant object. The image of small and nearby objects would thus be little different from that of large but distant objecta. This amounts to saying that a single eye sees in two dimensions only, the length and breadth, but cannot make out the third dimension, of depth.

But when we have two eyes, these are placed Few inches apart and though they both "see" planar, two dimensional images, these images are not the same. For instance, one eye may seen a distant object partly covered by a nearer object, but the other eye, being slightly to the side, may see both objects, albeit of the same size. But the brain, by comparing the two images, can work out that one object is behind the other, and also conclude that it must therefore actually be bigger.

This facility, to see in three dimensions, is called stereoscopic vision and allows us to make correct judgments in hundreds of actions throughout the day. Picking up a pencil, for instance, calls for a continuous relay of distance information from the eyes to the brain, to control the movement of our fingers, till the fingers accurately close just around the pencil itself. Running down a flight of stairs, again, is rapidly judging the position of each step and doing this with the use of only one eye can be as risky as doing it in the dark! A simple experiment would demonstrate the utility of stereoscopic vision — ask someone to throw you a small object, from some seven-eight feet away, so that you can catch it. After doing it a few times, blindfold one eye and try the same thing again. Animals that use vision to navigate and feed have evolved to have the most suitable placement of eyes. Birds of prey need to spot their quarry and strike rapidly.

The eagle, to this end, has both its eyes placed wide apart, in front, like headlights. But the chicken feeds on grain or slow-moving earthworms. What the chicken needs is not rapid stereoscopic vision but a wide range of view, both to spot tidbits as well as to watch out for that eagle. The chicken has its eyes on either side of the head, to spot things all around. But when it needs to pick up grain from the ground, it has to turn its head and see the grain with the other eye too, to get a fix of position before it can peck!





"Tiger" Pataudi (right) facing the ball or, after a stroke, body well in line. In contrast, another batsman not constrained by his eyesight, with effective results but subject to the wiles of clever bowler, lacks that great discipline..

Pataudi's method

The trial with the friend throwing an object for you to catch would have shown the reader the difficulty of dealing with a moving object when one has the use of only one eye. The batsman has to do this every time, with a ball coming from a cunning bowler, at nearly 90 miles an hour. The action of batting is a combination of trained reflexes, which react to the bowler's action and the course of the ball, in its half-second flight to the batting crease. While the basic stance would be assumed as the ball leaves the bowler, the batsman's taught muscles firm up the stroke as he sights the ball till the last fraction of a second.

A sound discipline in batting is for the batsman to line himself with the flight of the ball. But for making the best of the situation, the batsman often steps out of line and with the help of his physical fitness and training, can use the "cross bat". Pataudi in his early days was known for a range of strokes that used this effective, even if risky method. But in 1961, when just 20 years of age, he had an accident that put his right eye effectively out of action. It seemed his cricketing days were over. But Pataudi went into a few months of trial and training and soon discovered that his years of practice were not in vain and he could compensate for the loss of binocular vision.

His batting method had to do away with the risky "cross-bat" and coming into the line of the ball became imperative. The result of this compulsion, on top of phenomenal physical condition and talent, was a "perfect" batting style that went on to become the despair of younger cricketers to emulate. The panel of pictures shows "Tiger" Pataudi facing the ball or, after a stroke, body well in line. In contrast, another batsman not constrained by his eyesight, with effective results but subject to the wiles of clever bowler, lacks that great discipline.

On the field

The batsman at least has the advantage of standing before the stumps, which to strike is finally the bowler's objective. But on the field, a fielder has to cover a wider area and the batsman's target is the wide boundary. The ball can thus come wide or come high and there may not be time or scope to "get in line". Yet Pataudi was a phenomenal fielder and his signature position was covers, or the area on the left of the bowler and fairly close to the batsman. With only one eye, effectively, in use, it is undeniable that Pataudi was grossly disadvantaged. There is but one way to compensate — in the fraction of a second, as the ball comes off the bat, the fielder has to fling himself "in line with the ball".

Strokes into the covers are often powerful strokes that can send the ball to the boundary and the fielder has little time. Even once "in line", fielding involves more than watching the bat come into contact with the ball, the fingers have to close too. There is little to explain how Pataudi did it. This was fitness, experience, determination, genius!

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Not just about disease

In developing countries, nanotechnology for health should even improve living conditions, writes guillermo foladori

IF nanotechnology is to play an important role in developing countries' health systems, two conditions need to be fulfilled. Research and development must target the main health problems in each country; and developing countries that face similar challenges should form a strategic R&D alliance, preferably with a common fund set up by governments to finance R&D relevant to their needs.

Development related to water purification could be a key application of nanotechnology.

When it comes to nanotechnology and the health sector in developing countries, some issues simply cannot be ignored. First, we must remember that health policies are not just about curing disease but about keeping people healthy. The main health problems have socioeconomic and lifestyle causes and they cannot be solved by technology alone, however sophisticated it may be.

Second, people often suppose that new technologies are more efficient than old ones and that the cure with high-technology treatments will be faster than with alternative and complementary medicines. But the increased use of alternative medicines, even with a minimal or non-existent budget for R&D in these areas, suggests the "silver bullet" approach that prevails within mainstream drug development is not necessarily the best.

Third, nanotechnology research is increasingly expensive and tends to be concentrated in developed countries. Nanotechnology remains mainly in the hands of major pharmaceutical companies with interests in diseases — and markets — that can pay for expensive treatments.

Does that then mean it would be better for developing countries to stay out of R&D in nanotechnology for health? No! It is not wise to stay out of global developments in science and technology. Instead, every effort should be made to channel R&D towards solving the most important problems facing the populations of developing countries. But that is not straightforward.

When a company shows interest in production, it is aiming at those who can afford to pay. This means that their production models for a new medicine, medical device or diagnostic device is oriented towards the most affluent, deepening inequity and blocking development. New technologies won't help development if they lack a strong strategy linking research, production and consumption. Fortunately, examples of this kind of strategy already exist in public health sectors in some developing countries.

Perhaps the nanotechnology application areas most likely to benefit poor populations and trigger development relate to water purification, clean environments and waste processing, and to vaccines and devices that make transporting, storing and applying them easier. Put simply, nanotechnology that improves living conditions could have massive benefits for health.

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Shoots in the dark

It's more efficient, reduces transport costs and won't fail because of the weather. hal hodson wonders if farming without sunlight is the future of food?

SUNLIGHT. It is the foundation of life on earth, the daily pacemaker of human existence and, with the exception of geothermal, the basis for all energy consumed on our little marble. Without it, earth would be cold, dark and unrecognisable. Light's contribution to food is particularly important. Crop plants use it to convert carbon dioxide and water into sugars and oxygen, for eating and breathing respectively. It's our most precious chemical reaction but, as global population diverges from the planet's ability to feed it, one group of Dutch scientists thinks we need a new approach. This approach isn't to meddle with genes, or to plug extra fertiliser into nitrate-soaked soils. The Dutch group, called PlantLab, have scrapped sunlight altogether. "The plants look black," says Gertjan Meeuws, one of the five-strong team. That's not because they're rotten or genetically engineered, it's because they are bathed solely in blue and red light — there is no green light in the PlantLab hanger for the plants to reflect.

The hanger looks like something a character in *Blade Runner* might have dreamt about. Huge sliding trays of leafy greens (blacks), are tended by an army of robotic arms and given, according to Meeuws, precisely what they need to thrive. He and his team have been studying plants since 1989, working to better understand their needs and to make the growing process more efficient. They are scientists and engineers, not just businessmen.

"Growing in an open field or greenhouse is not enabling plants to maximise their potential," Meeuws says. "You have to look at our system as taking two steps at once. First, we grow plants in totally controlled conditions — plant paradise, as we call it. The second step is placing these nurseries right at the end of the supply chain, to produce around the corner from the consumer."

PlantLabs's controlled conditions are underpinned by some interesting physics. Plants are green because they reflect green light, meaning those specific wavelengths are not involved in the process of photosynthesis. If you tried to grow a tomato plant under a green light, it would die. In the process of reflection, the plant heats up. Like humans, plants have a mechanism for cooling down, but it costs energy which the plant would otherwise use to grow.

"Plants have a very intelligent way of cooling themselves," Meeuws explains. "They take up water through their roots and evaporate it through their leaves. Energy is needed for evaporation, and this energy is taken from the leaves, cooling the plant." By giving the plants only blue and red light, PlantLab can avoid heating its plants up unnecessarily, leaving more energy for growth. The atmosphere in the underground hanger is completely controlled for the same reason — to give plants the ideal conditions for growth, rarely found in the real world.

Although there are technical kinks behind farming in the dark, the potential benefits are broad: more nutritious produce, eradicated air-miles, year- round access to fresh vegetables, in any environment on earth. "We have been talking to people in winter sport areas. In the seasons where those areas have the most guests, they have no real fresh salads. It's a very interesting idea to serve really fresh, just-picked salads right where the consumers are," Meeuws says. Human convenience factors are important, but not fundamental. Water is fundamental, and it's one resource that PlantLab's vertical farm does a very good job of conserving. Meeuws says that PlantLab's system uses 90 per cent less water than conventional open-field growing. The only water that ever leaves the facility is in the form of plant matter for human consumption. The rest — runoff and evaporation — is collected and fed back into the system.

"Water savings are probably the most important part of our work," Meeuws says. "Water will be more important in the future than energy."

Another benefit of growing indoors is the flexibility it allows for the grower. Dixon Despommier, a microbiologist from Columbia University and the blue-sky thinker behind the vertical farm, puts it, "Let's say you have a breakdown in your growing system. When is the next opportunity for an outdoor farmer? Next year. The opportunity for an indoor farmer is tomorrow."

This agility is down to the increased number of available growing hours for the indoor farmer. Meeuws gives a rough calculation, "In our climate, there are maybe 1,000 or 1,500 growing hours a year. When you go to the equator, they have a lot of sunlight, but it's so hot that the plants can't breathe properly. In our system we can give light to plants 24 hours a day, but it's usually 20 hours, to let them sleep."

Twenty hours a day, every day of the year amounts to 7,300 hours of growing time, a fivefold improvement over relying on natural light. Vertical farming comes with the bonus of easing the strain on diminishing agricultural real estate, perhaps even allowing for "re-wilding" of swathes of land previously dedicated to cucumbers.

But, as Kevin Frediani, puts it, "we're not there yet". Frediani is the man behind VertiCrop, a vertical farming experiment adjoined to Paignton Zoo in Devon, where he is the curator of plants and gardens. His project, which has run for three years, backs up PlantLab's numbers for water savings, which Frediani says can be pushed as low as four to six per cent of conventional use.

Vegetables grown using UV light at a futuristic Dutch farm.

Gertjan Meeuws.

Energy use is usually the number one concern among vertical farming naysayers. Everyone knows the story of the tomatoes, grown in British greenhouses and polythene tunnels, which, due to the cost of heating, actually have a larger carbon footprint than those shipped more than a thousand miles from Spain. Similar concerns surround the idea of artificially lighting and heating acres of underground crops.

The financial and energetic costs are big, but new technologies can help. By growing the plants in an insulated environment, temperature is easier and cheaper to control; polythene tunnels and glasshouses are rubbish at keeping heat in or cold out.

A new generation of lightbulbs is answering the lighting question too. Humanity has been stuck on the glowing strip of metal passing an electric current since Edison made the idea a commercial reality in 1879. New light sources — LEDs, high-pressure sodium lamps and fluorescent bulbs — cost less to run, and in the case of LEDs can deliver the exact colour of light which PlantLab requires.

Technology aside, there is the issue of public perception. Another step "away from nature", further removing ourselves from our hunter-gatherer ancestors, might not be popular with some sectors of the green contingent, but Meeuws has an answer for this too. "We have to let technology come into our lives where it concerns food production. A cell phone is normal, intensive care in hospitals is normal, and accordingly technology will be normal in order to save our world by producing food in a smart way."

Frediani's VertiCrop is one of the best examples of that "smart way". If you head to dinosaur country, south-west England, you'll find Frediani tucked away in the centre of Paignton Zoo, surrounded by the whirring and dripping of the UK's first attempt at growing vertical crops.

Made from re-purposed manufacturing line equipment which was designed for making JCB engines, Frediani's farm consists of multiple stacks of shelves that rotate around the room, sharing the sun. While the system uses natural light rather than LEDs, Frediani says it has shown that vertical farming is viable.

"As a pilot project, what it's demonstrated is that food can be grown in urban areas that are higher density, and at a lower embedded energy than we currently do growing it far away from cities. If you can put your food supply into your packing house and put your packing house into your distribution centre, and pack all that into the building people are living in, there's got to be an advantage in that," he says.

He compares Paignton's VertiCrop pilot to the earliest cars. "You wouldn't want to drive at four miles an hour behind a man holding a red flag, but you might drive a new Mercedes on modern highways — and it's the same with this technology." For the moment, he also has his doubts about LED-only growing. He points to a beautiful crisp lettuce as it trundles by on its carousel. "That red tinge only comes when you grow lettuce under the full spectrum of natural light," he says. He adds that light from current LEDs peters out after about 30 cm, severely limiting what can be done in an all-LED set-up.

But technology and knowledge tend to improve, and one day we may know the exact absorption spectrum for each and every crop we grow. Within five years, Frediani sees LEDs becoming good enough and cheap enough to provide plants with all the light they need. His set-up is pretty good right now, even if not on a commercial scale. "Try a bit of rocket," he suggests. I nip a leaf off with my thumbnail and bite. It's hot and crisp, perfect. My mouth tingles, and we eat some more.

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