The Idea Factory: Bell Labs and the Great Age of American Innovation. Jon Gertner. The Penguin Press. 2012. 432 pp. Price: US$ 29.95.

Bell Labs was undoubtedly the foremost industrial research laboratory of the last century. Jon Gertner's book chronicling its history is appropriately titled *The Idea Factory*, because the products coming out of it were innovative ideas, and not the physical products that one associates with a factory. It is no exaggeration to say that the inventions and discoveries to come out of Bell Labs have created modern electronics; to think that the branch of engineering in which I did my undergraduate did not even exist a century ago!

Reading the book is an eye-opener about how science and technology research should be done. It is not enough to have good people, but the environment has to be right. The Murray Hill facility – where most of the basic research was done – was a design marvel that attracted people from all over the world who were interested in creating a similar laboratory. The place was designed so that you could not go to your office or go for lunch without bumping into other scientists. The resultant exchange of ideas was the catalyst for much of the innovation. Many times a person who is not working directly on a problem can give useful suggestions compared to a person working full time on it. Another significant aspect in the success of Bell Labs was the importance given to the thousands of technical assistants (TAs) employed there. Often, they only had high-school diplomas, but were given as much respect as the top Ph D scientists. This was because the TAs had practical knowledge, knew how to take apart a car engine or a radio and put it back together – talent that could be used by Bell Labs in translating ideas into marketable products.

The intellectual stars who worked there – William Shockley (co-inventor of the transistor), Claude Shannon (father of information theory), John Pierce, Jim Fisk and others – were sometimes referred to by their colleagues as the 'Young Turks'. They came to Bell Labs with an interest in attacking the hard, fundamental questions of science, something that was believed could only be done in a university setting. But Shockley and others used Bell Labs' resources to create 'a new kind of science – one that was "deep" but at the same time closely coupled with human affairs'. Most of the significant R&D achievements – transistors, microwave towers, digital transmission, optical fibre, cellular telephones – directly benefited society and long-distance communications. But other innovations, like the laser or the CCD camera, impacted human affairs in ways that could not have been anticipated; certainly their impact on the core business of a telephone company was not obvious. It was indeed visionary for the top administrators to invest in such long-term research. Telstar, the first communications satellite, represented the simultaneous use of 16 inventions patented at the Bell Labs over twenty-five years. It is no wonder that innumerable Physics Nobel laureates graced the place – Davisson (wave nature of electron); Bardeen, Brattain and Shockley (transistor); Townes (lasers); Penzias and Wilson (cosmic microwave background); Anderson (localization in solids); Chu (laser cooling and trapping); Stormer (fractional quantum Hall effect) and Boyle and Smith (CCD camera).

The book shows that good scientists do not necessarily make good managers. In fact, the best presidents of Bell Labs were not active scientists, but they were good at spotting talent. They went to various universities (MIT, CalTech, etc.) and picked the brightest stars to work at Bell Labs. A case in point is Shockley. He realized that he would not rise very high in the Bell Labs' hierarchy, and left to form an ill-fated company in California called Shockley Semiconductor. The only good thing to come out of his poor managerial skills was that the top scientists there – Gordon Moore, of Moore's law fame, and seven others – left to form a rival company nearby called Intel. The rest, as they say, is history.

Towards the end, the author discusses the afterlives of the Young Turks. Most disheartening is to read about the ugly change that took place in the thinking of Shockley. Even while he was on the faculty at Stanford University, he started believing in racial differences of intelligence. At a meeting of the National Academy of Sciences in 1968, he declared, 'An objective examination of relevant data leads me inescapably to the opinion that the major deficit in Negro intellectual performance must be primarily of hereditary origin and thus relatively irremediable by practical improvements in environment'. What deep-seated bigotry. It took him from being the world's most distinguished solid-state physicist to a fringe eugenicist.

The author also mentions briefly the name of Jan Hendrik Schön, who brought disgrace to Bell Labs by making up all the data in his papers. I think his story is important because it highlights the pressures of performing at the highest level, and that a scientist will stoop to any level to get some fame. Cases like this are on the increase, but the good thing about science and the peer-review system is that such cheats get caught, sooner or later. To get back to the case of Schön, for a while he was riding a wave of fame that everyone felt would culminate in a Nobel. Ironically, his department head (Bertram Batlogg) was quick to take credit for his 'achievements' and was invited to give several named lectures based on this work, but was equally quick to wash his hands off any wrongdoing when the scandal broke. As a consequence, most journals now require every author to own responsibility for a paper with his or her name on it, and state clearly what each author's contribution has been. No more 'piggy-back authorship'.

The last chapters discuss the current state of the labs itself. As a person who worked in the Murray Hill facility, it is saddening to read that most of the people have left, the buildings are run down, and the parking lots are half empty – it feels like the loss of a loved one. Bell Labs is dead. But it has taught us important lessons about how to do frontier research. John Pierce, one of the Young Turks, wrote in 1997 that there were four basic things that contributed to Bell Labs' success:

1. A technically competent management all the way to the top.
2. Researchers did not have to raise funds.
3. Research on a topic or system could be and was supported for years.
4. Research could be terminated without damning the researcher.

Wise words for all research heads. But it tells you that long-term research requires that you do not look at the immediate returns to the company. And AT&T could do that as long as it was a monopoly. Once the industry was thrown open to competition, Bell Labs was a goner. I remember Arno Penzias, then President of the Bell Labs, saying that the entire budget of the place was 500 million, whereas a TV ad (during the Super Bowl – a top sporting event in the US) to show that AT&T was better than its competitor MCI cost 1 billion. What irony that the cost of making innovative products was so much less than the cost of selling it. But that is the reality of a competitive marketplace, which ultimately benefits the consumer and forces one to run a tight ship. To give a personal example, the cost of making a phone call from the US to India – when AT&T was a monopoly – was US$ 2.50/min. Overnight, the cost dropped to $0.60/min, when MCI entered the market. Obviously, there was no change in the infrastructure, no new cables were laid. The clear inference is that AT&T was overcharging by a factor of four!

The book is a must-read for all administrators of science research, plus anyone interested in the history of science in the last century. The author correctly points out that the environment for the success of Bell Labs – monopolistic pricing for telecommunication, the need to connect people over long distances, the need for low-cost electronic switches, and so on – will never happen again. But there is a current worldwide need in terms of renewable sources of energy. And it requires the ingenuity of the best scientists and engineers to solve. Unfortunately, private businesses do not have the time and resources for this. But governments do. They alone can look ahead and invest in big but risky breakthroughs. It behooves them to set up Bell Labs-like places to solve the energy crisis.

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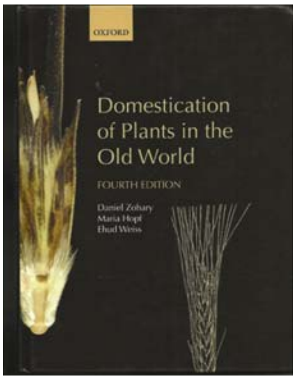

Domestication of Plants in the Old World. D. Zohary, M. Hopf and E. Weiss. Oxford University Press, Oxford, UK. 2012, 4th edn. xvi + 243 pp. Hardbound. Price: BP 55.00.

This is the fourth edition of a book published initially in 1988. It was then written jointly by Daniel Zohary (The Hebrew University, Jerusalem, Israel) and Maria Hopf (Roman-German Central Museum, Mainz, Germany). They published the first three editions jointly, and after Hopf passed away, the present edition has been co-authored by Ehud Weiss (Institute of Archaeology, Bar-Illan University, Ramat-Gan, Israel).

This book has been a required/recommended reading text in courses on agriculture, evolution and archaeology in some universities in Europe and North America, after it was first published 25 years ago. The authors have attempted to retain almost the same length and form in all the editions.

The book, according to the publishers, 'reviews and synthesizes the information on the origins and domestication of cultivated plants in the Old World, and subsequently, the spread of cultivation from south-west Asia into Asia, Europe, and north Africa from the very earliest beginnings'. The present edition also 'incorporates the most recent findings from molecular biology about the genetic relations between domesticated plants and their wild ancestors'.

The book contains 10 chapters, three appendices (maps, chronological chart of different regions and archaeological sites), and ca. 1100 references. The first chapter, 'Current state of the art', gives an overview of the work covered in the book. Chapters 3–9 summarize the work on cereals (ca. 10 nos), pulses (10 nos), oil and fibre-producing crops (ca. 7 nos), fruit trees and nuts (ca. 20 nos), vegetables and tubers (14 nos), condiments (5 nos) and dye crops (5 nos). Chapter 2 outlines briefly the sources of evidence used to determine the origins of crop plants. The last chapter (no. 10) lists the plant remains obtained from mostly the European Mediterranean countries.

The title of the book is a synecdoche. The book covers mostly only the crops of the region that the authors term as the 'classical Old World'. This region comprises Southwest Asia, the Mediterranean basin, and temperate Europe. This limited geographical coverage might have been in order 25 years ago when the book was first published. Most of the other regions were relatively unknown or little known archaeologically, and the science of archaeology was under the domineering influence of the work and writings of V. Gordon Childe (1892–1957), a pioneer in Neolithic agriculture and European prehistory. Since then, different regions of the Old Word, such as Africa, and South, Southeast, and East Asia, including New Guinea, have seen numerous excavations and studies. They have thrown much light on the prehistory of these regions, including cultivated plants archaeology (e.g. Allchin, F. R., *The Archaeology of Early Historic South Asia*, Cambridge University Press, 1995; Chang, K. C., *The Archaeology of Ancient China*, Yale University Press, 1986; Higham, F. W., *Encyclopaedia of Ancient Asian Civilizations*, Facts on File, 2004; Glover, I. and Bellwood, P., *Southeast Asia*, Routledge, 2004; Phillipson, D. W., *African Archaeology*, Cambridge University Press, 2005 and so on).

The book deals in detail with 'the crops of early Neolithic agriculture in southwest Asia', viz. the three cereals, emmer wheat (*Triticum turgidum* subsp. *dicoccum*), einkorn wheat (*T. monococcum* subsp. *monococcum*) and barley (*Hordeum vulgare*), and a few grain legumes that appear as 'constant companions' of the above cereals. These are lentil (*Lens culinaris*), pea (*Pisum sativum*), bitter vetch (*Vicia ervilia*) and chickpea (*Cicer arietinum*). Flax (*Linum usitassimum*) is also described as another 'founder crop' of the region. The authors are however less definite about the status of three other very early crops of the region, viz. grass pea (*Lathyrus sativus*), rye (*Secale cereale*) and faba bean (*Vicia faba*). They too have been covered to some extent.

In the classical Old World, the first definitive signs of domesticated plants