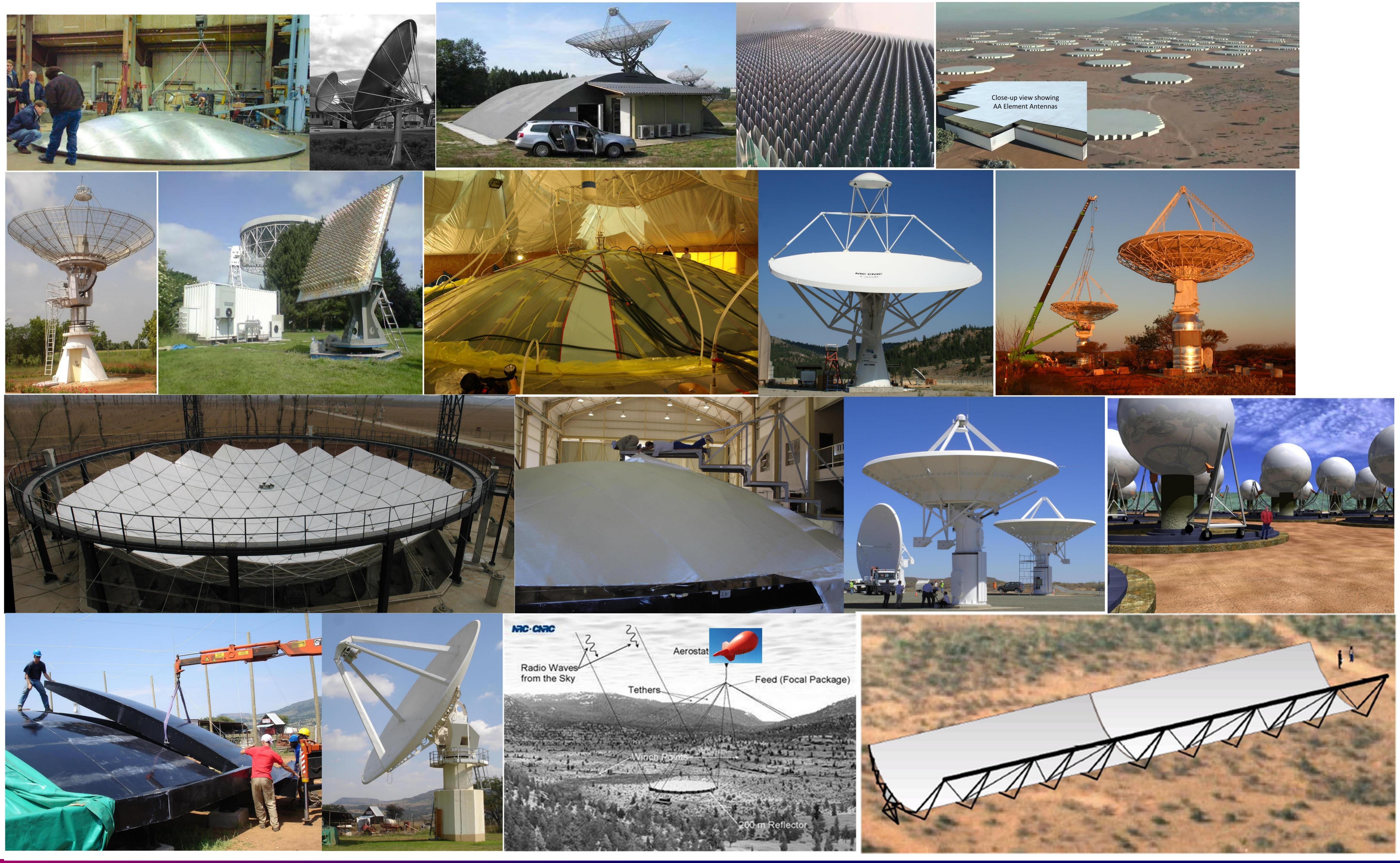
Ch6: Innovation Meets Reality. SKA's Formative Stage.

- Traces the evolution of the roles of innovation, technical development and engineering.
  - Approach – Written for a non-specialist, well-informed reader, even though the underlying subject is technical.
- How the chapter could inform future science projects – some persistent, age-old themes.
  - Examples – Psychology of cost projections, project complexity, technology diffusion, need to deliver.
- Many early concepts (next slide).
- Memo 100 (2007) (comprehensive set of science goals & specifications) – Set the scene for real technical development.
- PrepSKA funding (2008) – Necessitated a change in engineering and design directions.
  - From the 'integrative Approach' => formal system engineering and systematic reduction of options. "Scale is everything".
- Spawning technical requirements from science requirements.
  - Sensitivity (100x VLA) – a key driver from the beginning (collecting area, instrument noise, survey speed).
  - Challenges of defining a general-purpose telescope. Discovery space and design flexibility (exploration of the unknown) played an important role.
- Many decisions had to be made – key enabling ingredient was the design review.
  - System Concept Design Review, 2010 (2 years after PrepSKA began).
    - Impasse at the architecture level that had to be broken. Each of the national participants strongly believed that their approach to technology was the best, but choices had to be made. Led to a definition of a buildable telescope, SKA Phase1.

Ch6: Innovation Explosion.



Ch6 – cont'd

- Pervasive themes – Cost and performance
  - Conundrum of early cost estimates. – The perils of estimating too low or too high and relying on industry quotes or previous projects.
  - Dish cost dominated discussion, but low frequency arrays are also expensive for other reasons.
  - Ingenuity at its best.
    - Mould-based dish fabrication – Several large prototype projects.
    - Dense Aperture Arrays – viewed as the epitome of flexibility but very difficult to realise in practice.
  - Complex cost/performance decisions are still being made during construction. Great care is needed to not sacrifice the original promise of the SKA as high-performance telescope.
- Critical supporting roles
  - Software and data reduction – not amenable to Moore's Law effect.
  - Computer engineering – 'saved' by some form of Moore's Law.
  - Feeds, Low-Noise Amplifiers (LNAs), cryogenics.
  - Signal Transport – 'connective tissue' – performance increasing faster than Moore's Law.
  - Correlators and beamformers, technology impact has led to many revisions of design.
  - Pulsar and astrophysical transient processors – major SKA design aspect.
- Radio Frequency Interference (RFI) and electromagnetic interference (EMI)
  - The design and cost of signal processing chains and software are now dominated by RFI.
  - Has become a serious threat to the long-term health of radio astronomy.

- 30 Electronic Supplements, 33 Figures, ~306 SKA references, ~75 published references.
  - Electronic supplements are explanatory or expand on certain topics.

SKA Phase 2 – Our Shared Goal to Achieve

- Tribute to the builders – SKA illustrates the creativity of a host of engineers and scientists to build a groundbreaking radio telescope with the performance needed to extract the scientific treasures buried in weak radio signals from the distant Universe, of which there were previously only hints.

- From the URSI 1998 Large Telescope Working Group.
  - “This will be the world’s premier astronomical imaging instrument. No other existing or planned instrument in any wavelength regime can provide simultaneously: spatial resolution better than the Hubble Space Telescope (<0.1”), a field of view significantly larger than the full moon (1 square degree), the spectral coverage of more than 50% ($\nu/\Delta\nu < 2$), and a spectral resolution sufficient for kinematic studies ($\nu/\Delta\nu > 10^4$) and all at a sensitivity which is about 100 times that currently achievable.”
  - Add the transient sky to this vision.