lobes that we possess compared to other primates, was an evolutionary adaptation to a nomadic hunter-gathering lifestyle (Leakey 1994; Bradshaw 1997). These changes favoured in turn the natural selection of visually controlled manual dexterity, high capacity long-term memory for places and objects, and the ability to react quickly and flexibly to unexpected dangers and opportunities. The brain evolved complex, innate mechanisms for using stored knowledge to process percepts and plan motor actions. The neural regions associated with foresight and planning became greatly expanded. However, survival depended more on the brain's ability to make fast, flexible responses to unexpected opportunities and dangers than on its capacity to plan for distant futures. An earlier species of our genus, *Homo erectus*, learned to domesticate fire 400,000 years ago and the Levallois technique for working sharp symmetrical flint tools from many flakes from the same stone is 250,000 years old (De Lumley 1998). By 35,000 BP the modern *Homo sapiens* of Ice-Age Europe made sophisticated, decorated tools from stone, bone and clay, cooked food, ceremonially buried their dead and made extraordinary paintings on the walls of caves. It must be remembered throughout the period 35,000 to 10,000 BP our "anatomically modern" subspecies, *Homo sapiens*, was a rare animal. Archaeologists estimate that the total population in France during the Magdalenian era (19,000–11,000 BP) was not more than 50,000 and the total population in the world perhaps less than one million (De Lumley 1998). A huge biomass of fauna and flora was available for food. Humans lived by gathering fruit and edible roots, and hunting reindeer, horses, wild oxen, bears and ibex. Many other species of game existed, now extinct in Europe, such as lions (which were bigger than today's animals) and bison, or are extinct in the world, such as the woolly rhinoceros, mammoths and the hump-backed megaloceros. Climate was an important factor in the evolution of our brains. The weather was often so cold that a glacier 1.5 kilometres in diameter covered the whole of northern Europe and caused sea levels to fall 150 metres. Clearly, very large memories and great inventive tool-making skills were necessary to survive. Ample evidence of creative intelligence is provided by the artefacts that have survived. The invention of the technique for calcining flint, making it sharper and easier to work, the invention of the spear-thrower and the barbed harpoon all come from this period. So also does the invention of sewing (c. 20,000 BP) when eyed needles as fine as some modern ones were ground from ivory using only a flint awl and a specially designed grooved stone (Musèe de l'Homme, Les Eyzies, France). The "Venus de Brassempouy" is four times older than the invention of writing (Lewin 1993). It is a tiny but perfect ivory carving of a young woman wearing a coiffure or head-dress worthy of St Laurent. A palaeolithic sepulchre at Sounguir, Russia, shows the ceremonial burial of a 40-year old man dressed in an elaborate coat with sleeves and trousers with shoes attached. The material has long since disappeared, but the shapes of the clothing can be seen from the beautiful lined decoration of beads, with bracelets and head-band, which remains (De Lumley 1998). This evidence and much more (White 1999) makes it easy to believe that the hunter-gathering brain of the upper palaeolithic was at least as intelligent and creative as ours. Clearly, there existed a sophisticated culture four times older than writing.

Two inherited components of our mental resources are especially relevant to design thinking – the "language instinct" (Pinker 1994) and the ability to make visual images, "the visualizing instinct." In order to design better sketching technology, we need to understand which capacities of our brains are innate and which must be learned or culturally augmented.

The Language Instinct

There is good evidence that we have innate cerebral resources for acquiring and using spoken language both to communicate ideas to others and to represent them to ourselves. Of course, we are not born with knowledge of a particular syntax and vocabulary. However, as Chomsky (1957, 1980) has shown, all languages share a common "deep structure." Pinker (1994) surveys persuasive evidence to show that children's ability to acquire and use language is innate. For example, he quotes a study that shows how children of immigrants can spontaneously improve on a pidgin language, the only language they have been exposed to. Pinker also quotes an astonishing discovery that a new Nicaraguan signing language (ISN) was "created in one leap" by deaf children when "the younger children were exposed to the pidgin signing of the older children." ISN has a consistent grammar that in many ways is superior to the pre-existing official signing language. Further, "ISN has spontaneously standardized itself; all the children sign it the same way."

There are roughly 5000 languages in the world today. By studying the similarities and differences between existing languages it is possible to infer an evolutionary family tree of language origins from earlier, now extinct root languages. It is also possible to infer an evolutionary family tree of our genetic origins by studying the DNA sequences of tissue from different races all over the world. Interestingly, these two trees, derived from completely unrelated sources, show a close match (Cavalli-Sforza 1991). Such a parallelism between genetic and linguistic data is consistent with the evidence for a genetic component to language. The cultural evolution of language tracks our genes.

We are born with a complex of neural circuits in our brains that underlie the ability to acquire and understand spoken languages (Pinker 1994). Thus, Broca's area, in the frontal lobe, is necessary for the grammatical production of speech. Further back in the cortex, Wernick's area is involved in speech understanding. The two areas are connected but other parts of the brain are also necessary. Brain-imaging studies show language activating many circuits of the brain and its neural basis still uncertain (Pinker 1994). Exactly when, in hominid evolution, language first appeared is also uncertain. Moulds of the inside of the *Homo habilis* skull 1470 show clear evidence for the existence of Broca's area 2 million years ago (Leakey and Lewin 1992). However, this area may have changed its function since then. More persuasive evidence for an early origin of language comes from a curvature of the base of the cranium in fossil skulls. This has been shown to correlate in primates with how low the larynx is in the neck. A low larynx is necessary to provide the large pharyngeal space needed for speech. However, a low larynx carries a heavy penalty. It prevents simultaneous breathing and swallowing. Evidence for a fully flexed basicranium (and thus a low larynx) is found between 400,000 and 300,000 years ago in what is called archaic *Homo sapiens* (Laitman 1983). The low larynx must have had strong selective advantages to override its disadvantages. What advantage could this have provided other than that of spoken language? Since speaking leaves no traces, the evidence for prehistoric language must be indirect. However, there is evidence for trading and social