

The Domestication of the Second Fire

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I N T R O D U C T I O N

This story could have been called
" The Domestication of Fire Revisited " .

As the saying goes: history repeats itself.

After 700,000 years of laborious mastery of fire,
history does indeed repeat itself, this time, on a higher plane.
This second fire is nuclear energy; of intensity 700,000 times greater
than that of fire; 700,000 hotter, more delicate and more difficult to
handle; and 700,000 times more explosive than dynamite.

Energy production from nuclear fission gives rise to
a small quantity of ashes and gases around 700,000 times more toxic
than the ashes and gases produced by conventional fuels.

History, more like a spiral than a circle, has thus repeated itself
on a much more superior plane and at a considerably faster pace.

As humanity has made enormous progress
in a vast number of fields in 700,000 years,
it is now able to meet this new challenge.

This story is an effort to rediscover the conquest of fire
in the light of current impediments to nuclear energy
and to draw parallels between the two.

THE DOMESTICATION OF THE FIRST FIRE

Before its domestication, it was a slow and laborious conquest. The conquest of fire is estimated to have begun 700,000 years ago, during the Stone Age. The Primitive Man of that age - the Pithecanthropus - by then, had come up with the idea of a tool.

By chiselling bits of silex they could then sharpen them into knives and spear points.

At that time, there were more active volcanoes around than now and several pithecanthropine tribes could observe mountains smoking from afar. This aroused curiosity, as it did fear.

And for a long time fear supplanted curiosity and no Pithecanthropus ever dared venture close.



Curiosity overcomes fear

Among these pithecanthropuses there were some endowed with that innovative spirit which makes man audacious, enterprising and even defiant.

Approaching this miracle to get a better look at it, these men marvelled at what they saw:

The phenomenon of fire:

- Ate wood, directly secreting excrement (ashes)
- Died as soon as it ran out of wood to eat
- Therefore fed like an animal or perhaps like a god
- Bit, like a snake, when touched
- But also bit from a distance. If they got close to a big fire they risked singeing or burning the fur on the hides they wore. This remote effect was incomprehensible. It was magic!
- At the right distance, it could be a pleasurable source of warmth
- In the night, it could light everything up. This too was magic!
- It frightened wild animals (tigers, leopards, rhinoceros, elephants etc) keeping them a good distance away
- Heavy rain could kill it



Attempts to domesticate fire

After observing this fascinating phenomenon for some time, the most intrepid of the pithecanthropuses tried to domesticate it. The idea of domesticating an animal was no longer new to them..

Some had already tried to tame a young dog, wild boar or a monkey.

Why not try and tame a " young " fire? And it was soon discovered that fire could be fed, kept alive and that it could also be contained and finally prevented from spreading and from intensifying. All one had to do was to feed it with neither too much nor too little fuel. It was also important to realise that it could be killed if smothered, providing it was not too big.

During this familiarisation period, the Pithecanthropus had thus learnt to find and feed dry wood to this ever-greedy fire.

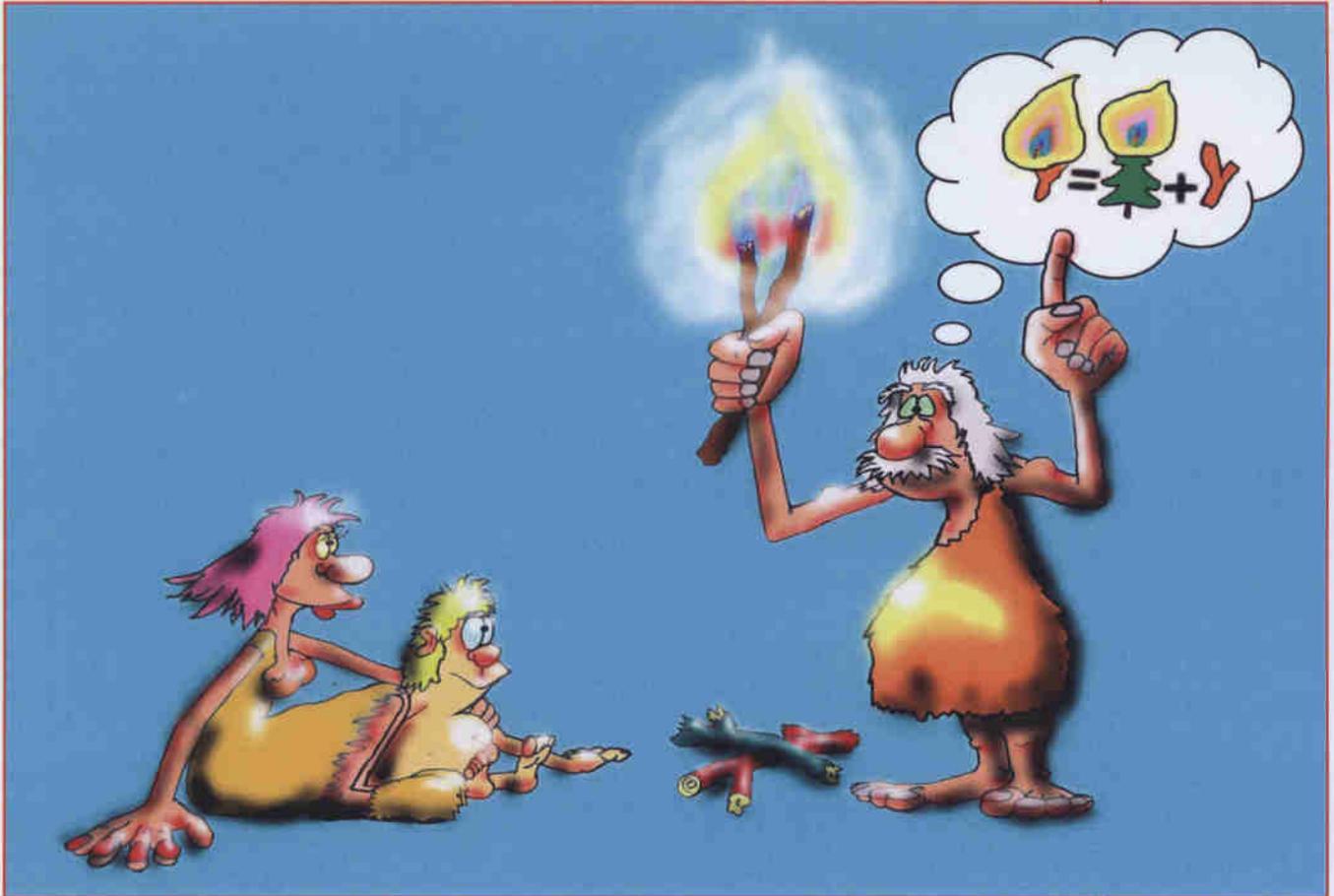


All these observations and preliminary experiments could only be made where there was fire, whether lit by lightning or lava. Until this moment of evolution, no one had as yet had come up with a means to transport fire.

Beginnings of domestication

This is when the Albert Einstein of Pithecanthropuses stepped in. His discovery had the same consequences on his age as " $E = mc^2$ " had on ours. He quite simply realised that a branch that burned at one end was cold at the other.

He could therefore hold this branch in his hand and carry it to another place. In carrying this branch, lo and behold, he was transporting fire!



Moreover, once he got to his destination, he could use this first torch to start another fire. The idea was brilliant. To get it to work however, presented quite a few problems. Man had to realise that too strong a draught could extinguish the lit branch, and that by blowing just the right amount of air onto it, one could bring a dying flame back to life. Thus, by dint of patience, Man, primitive though daring, would set off to fetch his fire, bringing it before his cave and sharing it with his entire tribe.

Educational function of fire

The Pithecanthropus did not yet know how to make a fire, but he now knew how to transport it. Setting off to fetch fire and bringing it back home, however, constituted a big-scale expedition, which could last several months. This is why, when this fire was ultimately brought before a cave, a good level of organisation was needed to watch over it, to feed it and to see that it did not die out, even during heavy rain. Consequently, taming fire required care, order, mutual aid, involvement, organisation, discipline and responsibility. Fire was perhaps behind organised social life.

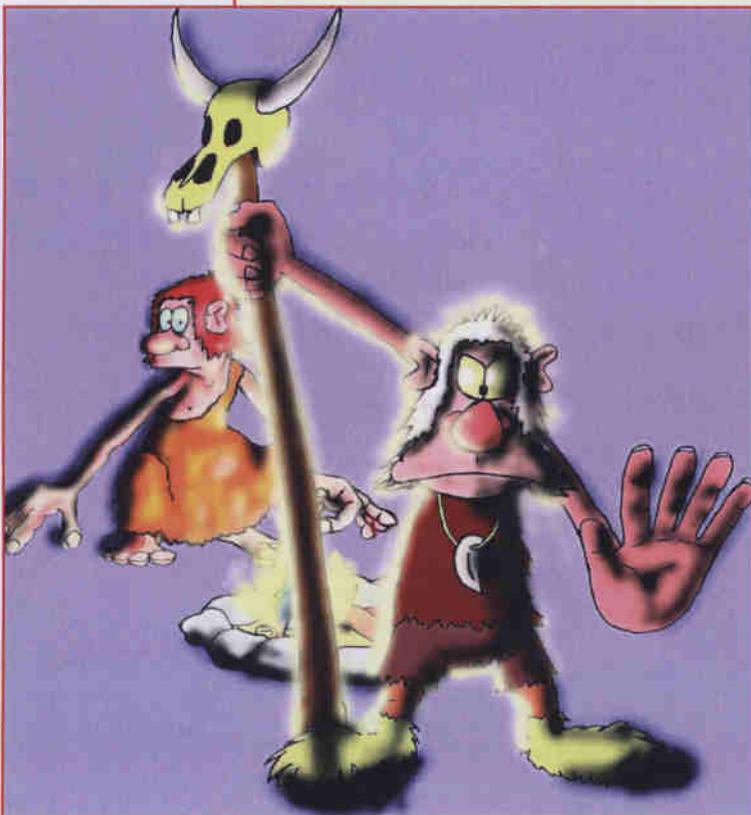
Man had to come up with shifts and the idea of taking turns.



Moreover, control and iron discipline had to be exerted and harsh punishment inflicted on the undisciplined. Thus, man had begun to ponder on the idea of responsibility.

Power, greed and non-proliferation

Those of the tribe who somewhat understood what fire was, knew how to



master it, look after and transport it and who did not fear it, had an advantage over their fellow men. This understanding gave them power. And this engendered the beginnings of sorcery. The most daring or cunning among the pioneers became sorcerers. These were the people who quickly understood that their power depended on their knowledge and it was in their interests to keep all of it to themselves.

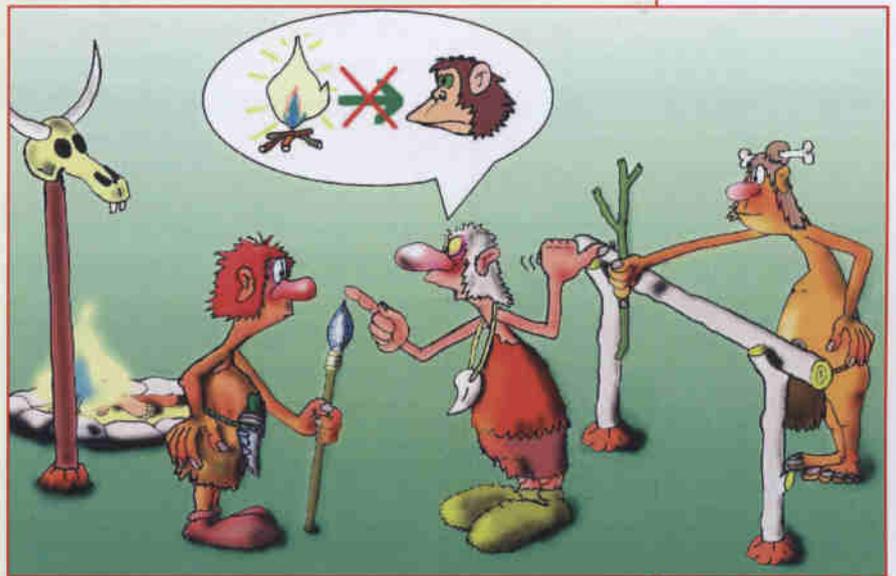
This was the beginning of secrecy.

A tribe that possessed and mastered fire was no doubt far more advanced than their neighbouring tribes considered more primitive since they had not yet succeeded in vanquishing fire. These so-called under-developed tribes began to covet the dominant tribe's new tool, and strove to reach their level of development. However, by seeing to it

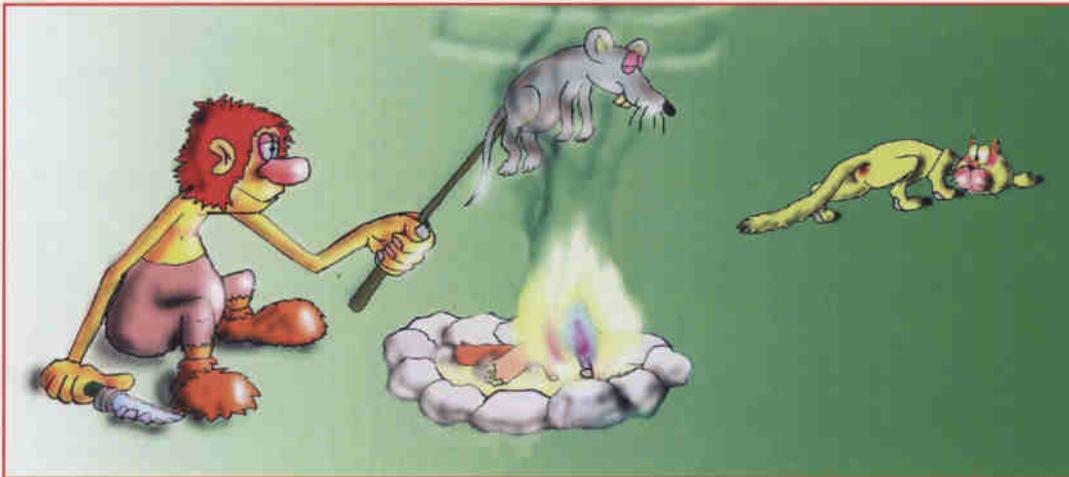
that the secret was well guarded and that the fear of fire was well nourished, the sorcerers came up with an effective way of preventing any proliferation of fire.

The dominant tribes felt that primitive and relatively under-developed tribes who had not yet acquired the sense of responsibility they had should not be granted access to such power.

At a period when language was still in its primal stages and only comprised a few dozen sounds, man had already pondered the idea of non-proliferation of an energy considered too dangerous if it fell into the wrong hands.



A more or less tamed fire placed before a tribe's cave was soon to bring newer advantages and powers:



- *By chance, it was discovered that meat, when roasted, was easier to chew than raw meat, and that it was also much easier to digest.*
- The realisation that a spear point hardens when blackened by fire was probably accidental as well.
- Fire, they realised, gave them access to more comfortable homes. A tribe that had set its sights on a better cave, inhabited however by bears or other wild beasts, could at night evict these animals by quite simply waving torches, lit by the magic flame, at them.

Mastering the lighting of a fire

If, by misfortune, the tribal flame were to die out due to heavy rain, or human error (a lack in discipline) the tribe risked regressing by approximately 10,000 years. In such a case, they would have to go back immediately in search of a fire which they would then have to transport back to their cave.

The sorcerer knew this, and was also aware that the absence of fire would reduce his magical powers to nought. This gave birth to a new and strong motivation: a means to light a fire, practically anywhere and with the use of whatever was at hand, had to be found. It was sometimes discovered, that a fire could be started from the sparks produced from silex when sharpened

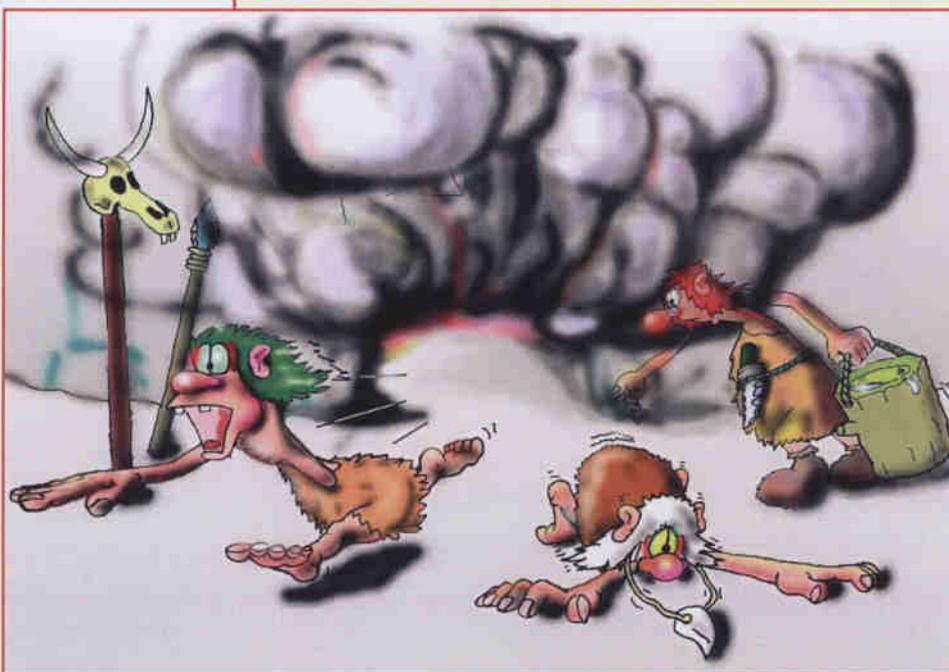
Through sheer persistence and constant effort, for all of a thousand years, the Pithecanthropus finally managed to light a fire by striking silex or by rubbing two wooden twigs together.

Mastery over fire was now gained! Primitive man knew how to start a fire, and possessed a relatively good understanding of how it could be put to use. But there were accidents, and sometimes even major accidents.



Becoming conscious of serious dangers

Not only smoke from a fire, but also invisible gases from the red embers of a



nearly extinguished fire could mildly or even gravely endanger the health of those living in a badly ventilated cave, sometimes leading to their death.

This fire could thus have perfidious and even diabolic effects. Without realising it, man could breathe in highly toxic substances released by fire.

Forest fires were another serious peril. In dry seasons, a fire could get out of hand, setting an entire forest ablaze, wiping out a whole tribe along with the forest game it lived on. In addition to their short-term consequences, such catastrophes had grave delayed effects. These ruined regions became uninhabitable due to their lack of game. For the game to return the trees would have to grow again and this would take 30 years. Tribes involved in such a disaster would thus have to evacuate and move towards more promising lands. This is what we meant by a major-accident scenario. After such an accident, we can imagine the animated debate among the survivors leading to the grave question

"Would it not be best to abandon this fire and go back to living in the trees like monkeys?"

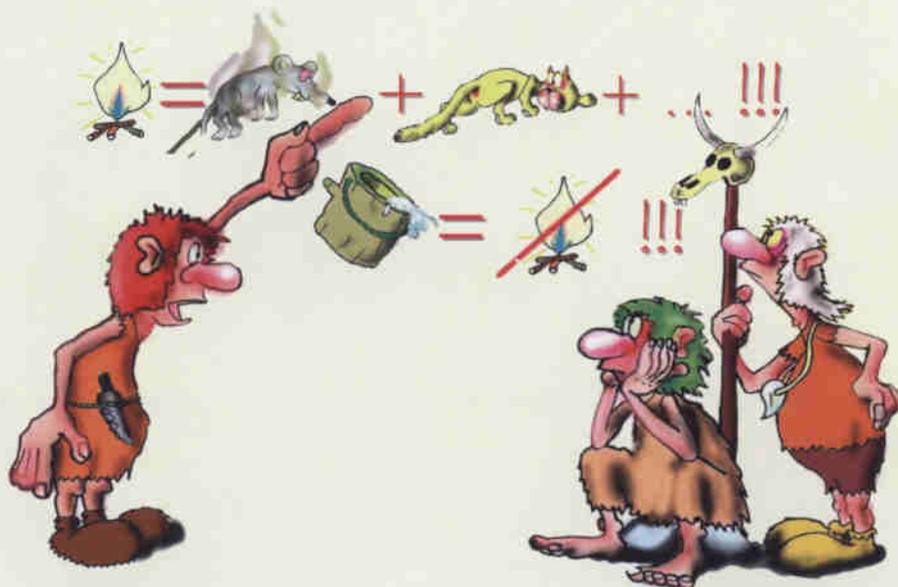


Already, at that time, man responded to this question in three different ways:

• *The Pioneers' response:*

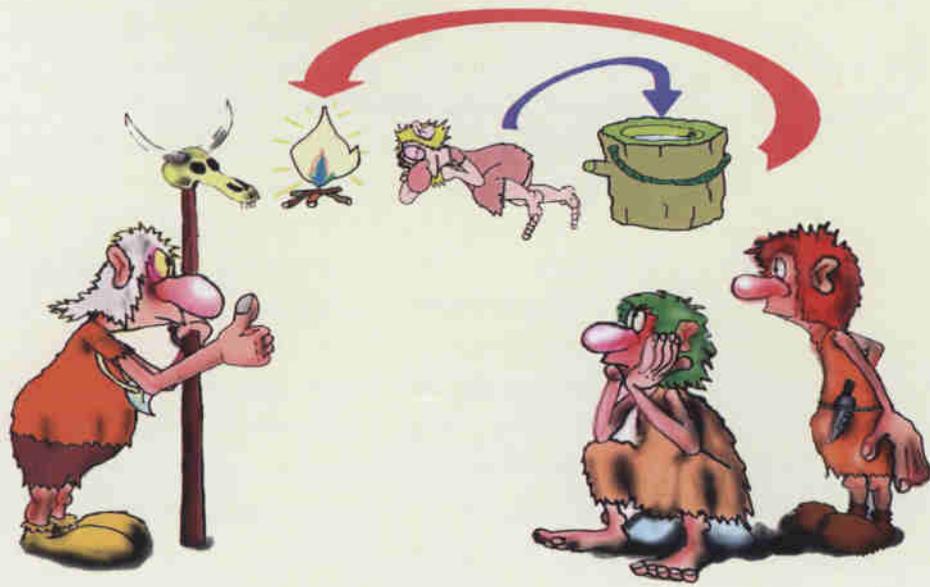
they admitted that this accident was serious, however the chances of it recurring, they said, were limited.

- The advantages that fire brought with it were too great for them to even think of abandoning it. It would be better to accept these risks, which were but residual, as the price they had to pay if they wished to continue to benefit from the advantages offered by the domestication of fire.

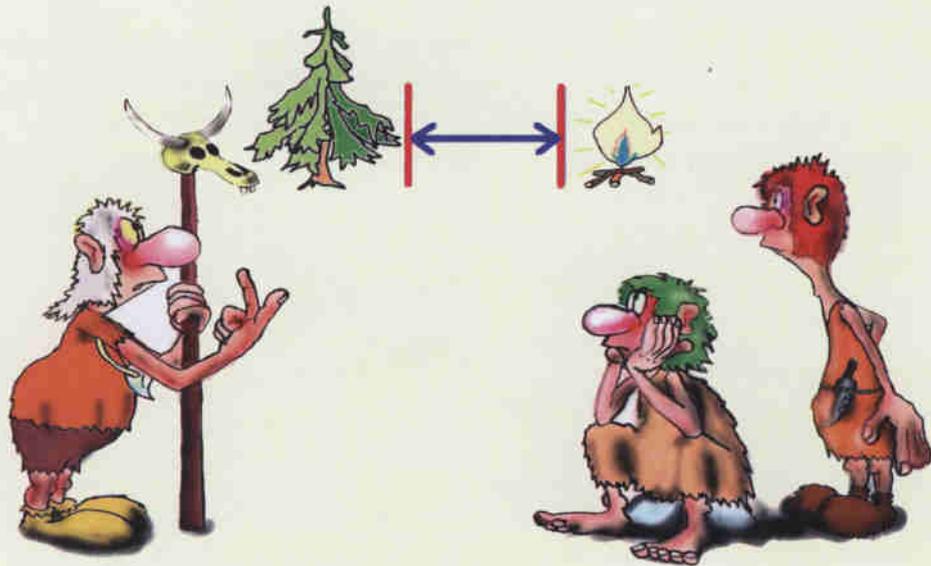


• *The tribal authorities' response:*

This was a serious accident and should never be allowed to recur.



- Rules and controls had to be reinforced along with supervision and punishment for any kind of indiscipline.



- Moreover, fire had to be kept away from the forest and confined to a risk-free zone cleared of wood and twigs.

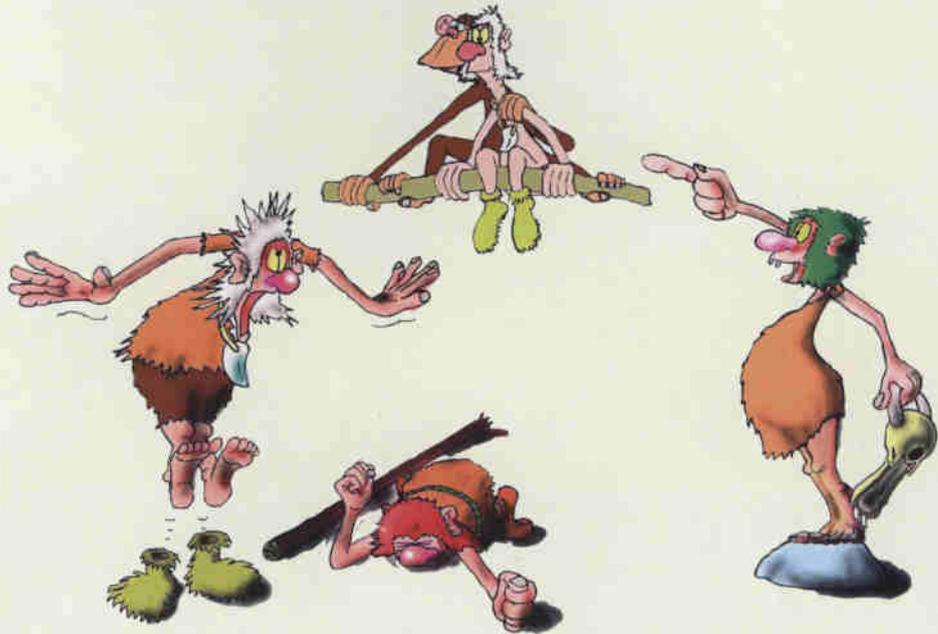


- The number of " fire-watchers " (the first fire-fighters!) would have to be increased during dry and windy seasons.

• *The Ecologists' Response:*

Man should not have tampered with nature. These accidents justified their theories on this matter. We must not play with fire. Fire was not made for Man. It is the prerogative of the Gods, they said.





- "Let us respect Nature and go back to living in the trees, without fire, as Nature wished us to".

Renunciation through wisdom

This renunciation could have been an act of great wisdom. Some of the neighbouring tribes however were against this. Since a single forest then housed at least four or five tribes, all these were at the mercy of the most careless or stupid tribe that set the entire forest aflame. This argument once again strengthened tacit agreement on the non-proliferation of fire. It had to be assured at all costs that the less developed tribes be denied access to fire and that tribes who already possessed fire be made to demonstrate to the others

that they functioned both seriously and responsibly.

One can imagine a very scrupulous tribe abandoning fire, at least for some time.

But then however, glaciation arrived and man had to survive the cold.



Brushing aside scruples

For 700,000 years, the Pithecanthropus had to survive three glaciations. Although their evolution was slow - since they devoted all their energy to survival and reproduction - they managed to diversify the types of tools they made use of. For instance, besides stone, they also used bone.



They also tried their hand at domesticating animals such as goats and cultivating one or two types of cereal.

Fire was one of the main elements that allowed the Pithecanthropus to survive three glaciations and to progressively change into Homo sapiens..

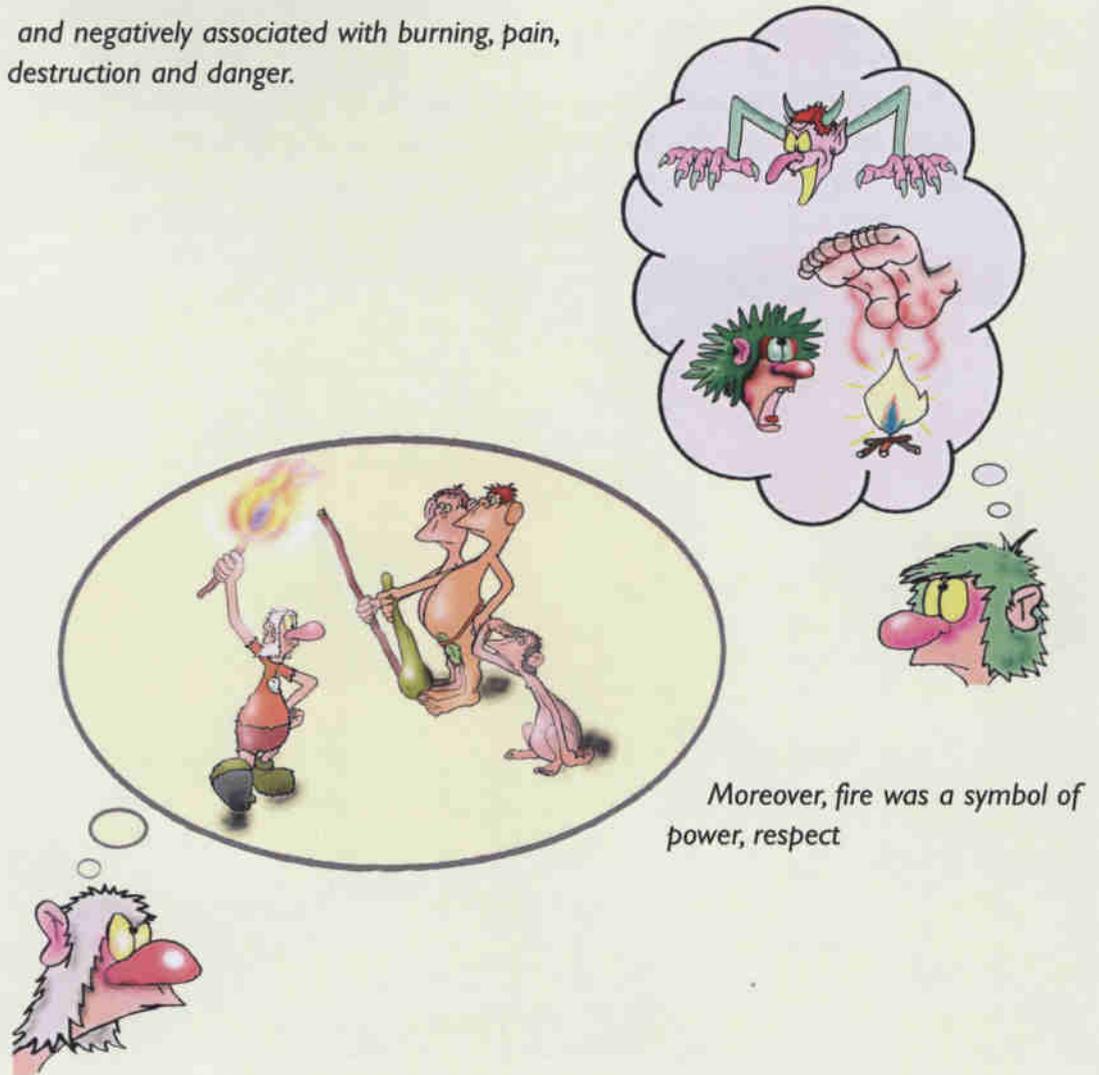
An avalanche of symbols

Fire is a universal phenomenon, which way before the breakthrough of the scientific mind, was used to explain all sorts of blessings and evils.

It was positively associated with warmth, comfort, purification and healing;



and negatively associated with burning, pain, destruction and danger.



Moreover, fire was a symbol of power, respect

and the transformation of matter. Also connected to it were the notions of magic and divinity. Understandably, fire fascinated and occupied a large part of Primitive man's subconscious. It had become the concrete expression of several still nebulous and muddled abstract ideas that haunted man's soul at the time: fire as a symbol of purification or destruction or of power. Today, it is nuclear energy, with the radioactivity which is associated with it, that has taken over from this fire of yesteryear in its ability to provide an answer to everything: the wilting of our forests, higher rates of leukaemia, congenital malformations, etc.

Hot water

The last ice age ended about 10,000 years ago, when, with the Earth's climate becoming much more temperate, real evolution began. About 7,000 years ago, fire was used for something new: pottery.



With the advent of practical clay containers, man could heat up water, thus coming up with the idea of cooking his food.

2,000 years later brings us to the Bronze Age and the beginnings of metalwork. Then, around one to two millenniums before our era, the Iron Age began.

Paradise lost

After the invention of the boat, the wheel and leverage, progress picked up speed. Great civilisations (Chinese, Egyptian, Greek and Roman...) emerged. Man began to write and invented the pulley, the windmill and the watermill, which now brings us medieval age. With the advent of an explosive powder, later called gunpowder to be used in rifles and canons, we witness the reappearance of fire. With this new application of fire, the enemy could be harmed from a greater distance. Wars became deadlier.

The idea of humanity living in paradisiacal peace was done away with forever.

To try and bring back some peace to the tribes' search for tranquillity, watchmen were posted around at night and man had to come up with fire brigades and fortifications.



In itself neither good nor bad

It is not Fire per se that is either good or evil, it is the use we put it to. Yet, it has been made the scapegoat for all the evils that civilisation has brought about, by some, who were no doubt traumatised by the belligerent and destructive purposes for which fire has been used, and who are once again asking for its abolition.

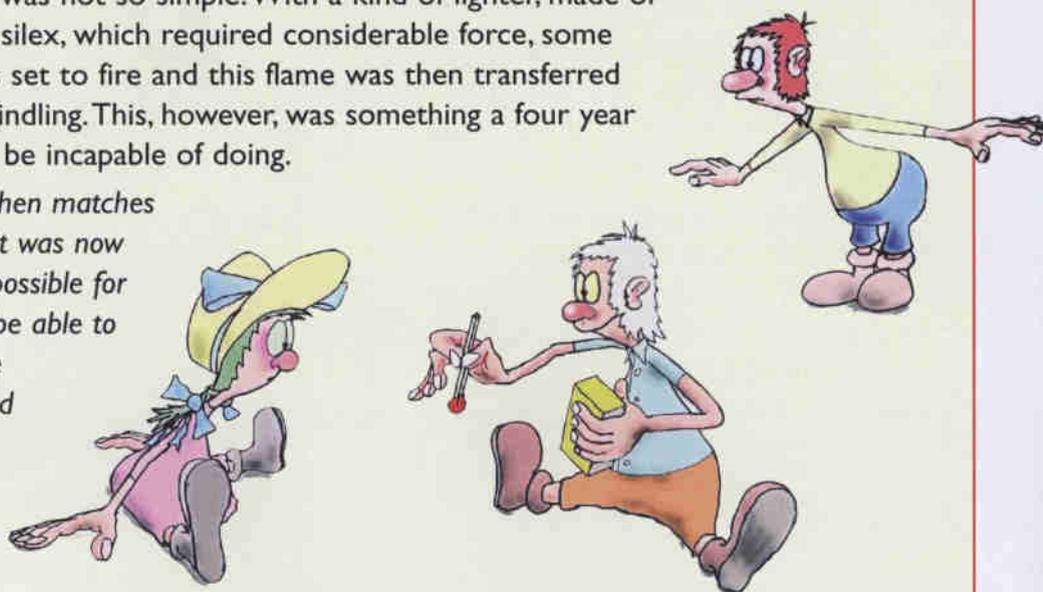


The point of no return, however, had been crossed ages ago.

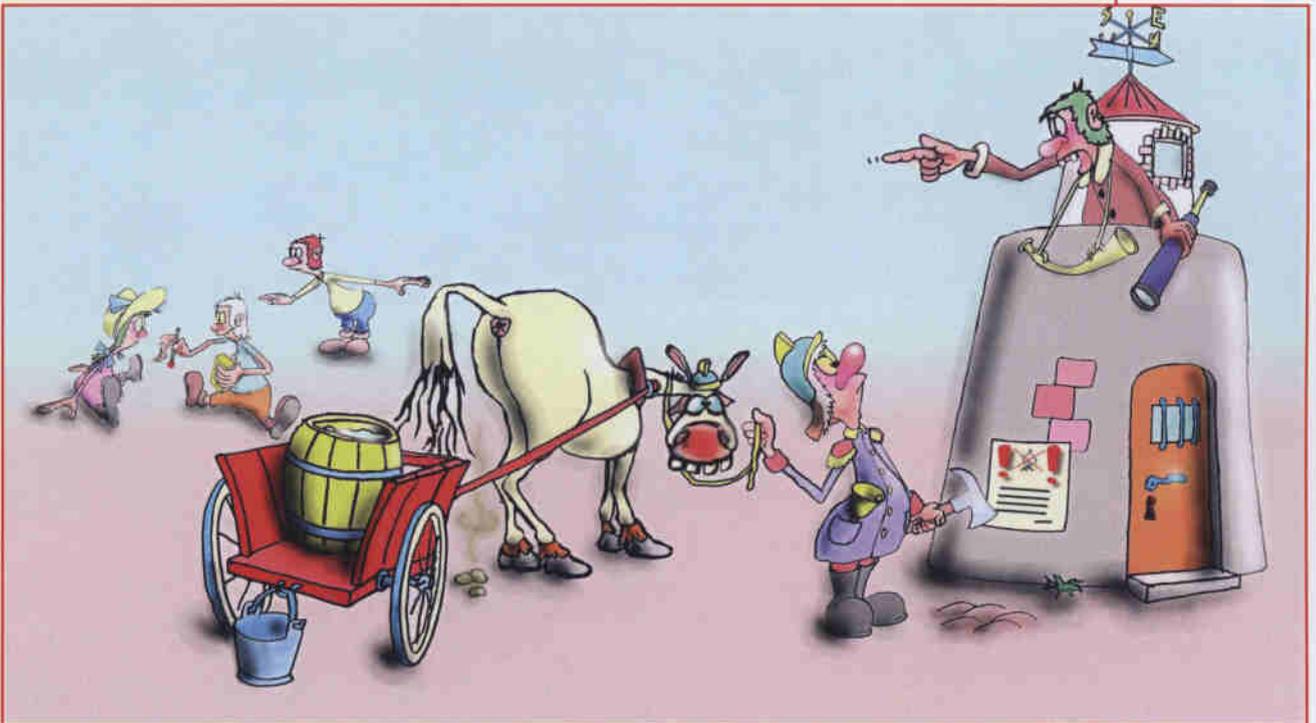
Trivialisation

Before the beginning of the 19th century, it was possible for any family to make a fire, but it was not so simple. With a kind of lighter, made of metal and silex, which required considerable force, some tinder was set to fire and this flame was then transferred to some kindling. This, however, was something a four year old would be incapable of doing.

This was when matches appeared. It was now becoming possible for anyone to be able to make a fire anytime and anywhere



and man had thus reached the stage of trivialisation, where making a fire, which until then used to be a privilege reserved for the elite, was becoming commonplace and popular. Pessimistic moralists had prophesied a lot that humanity was not ready for this trivialisation of the use of fire. They felt that entire cities risked being destroyed by gigantic fires caused by inattention, absent-mindedness, carelessness, clumsiness, or irresponsibility. In fact several fires had already broken out by then and this continued after matches came into use. The trivialisation of fire did not really aggravate the situation since the lessons fire brought with it had begun to concern everyone.

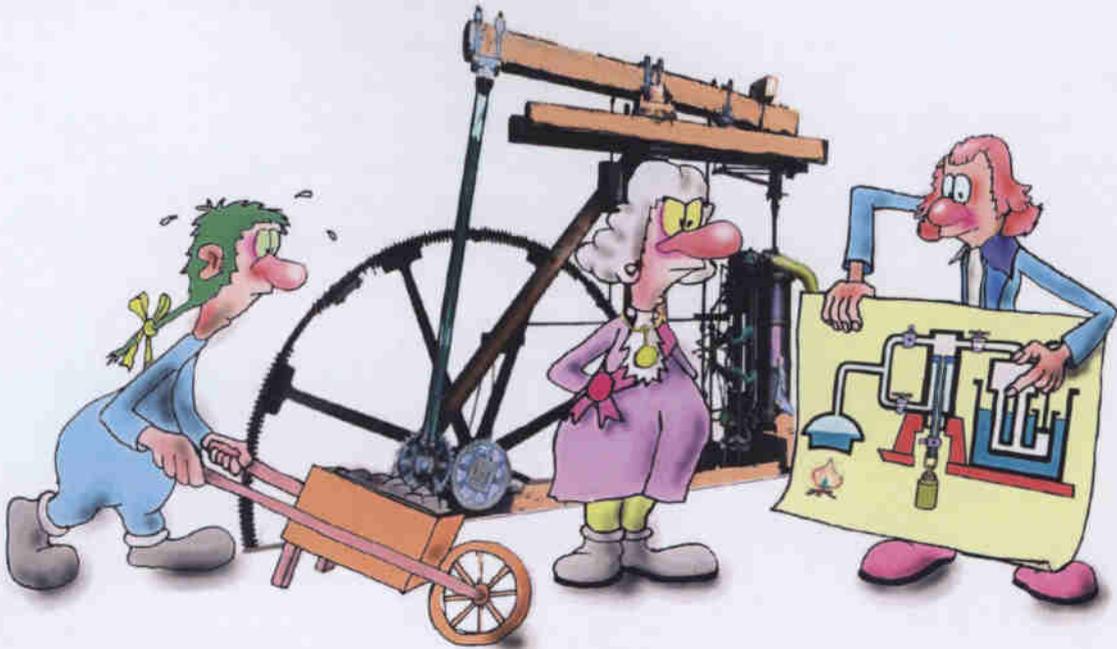


With this trivialisation of the use of fire, human society had to become more responsible.

More risks and greater vulnerability do not necessarily lead to more catastrophes, and they can lead to a greater sense of responsibility.

The final breakthrough

Until this era, man had been using fire to cook, heat and light his home, for pottery and to make steel tools and utensils. The great invention that remained to be discovered was that of the mechanical use that fire could be put to: no one until then had used fire to produce force or movement. Yet humanity had an urgent need to lift, carry and transport heavy loads. When force was required, slaves were recruited, or horses were harnessed, or hydraulic or wind power were used. Humanity lacked something vital: an engine.

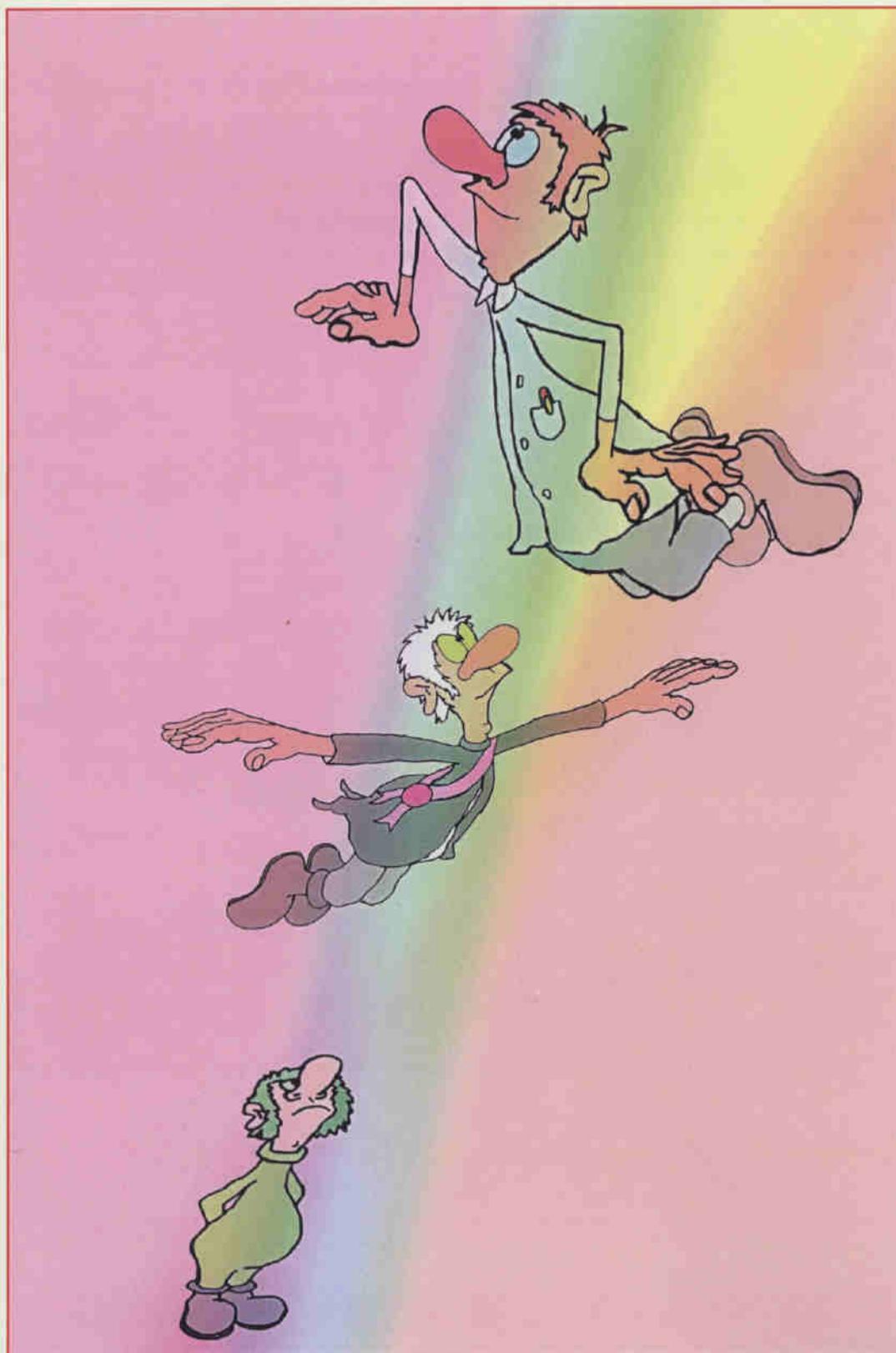


*Watt invented the steam engine in 1752
and the internal combustion engine came a century later.*



The different types of combustion engines that currently propel cars, trucks, locomotives, planes and boats and which are behind the operation of cranes, mechanical diggers and tractors are proof of our total domestication of fire, which we shall call here " the First Fire " .

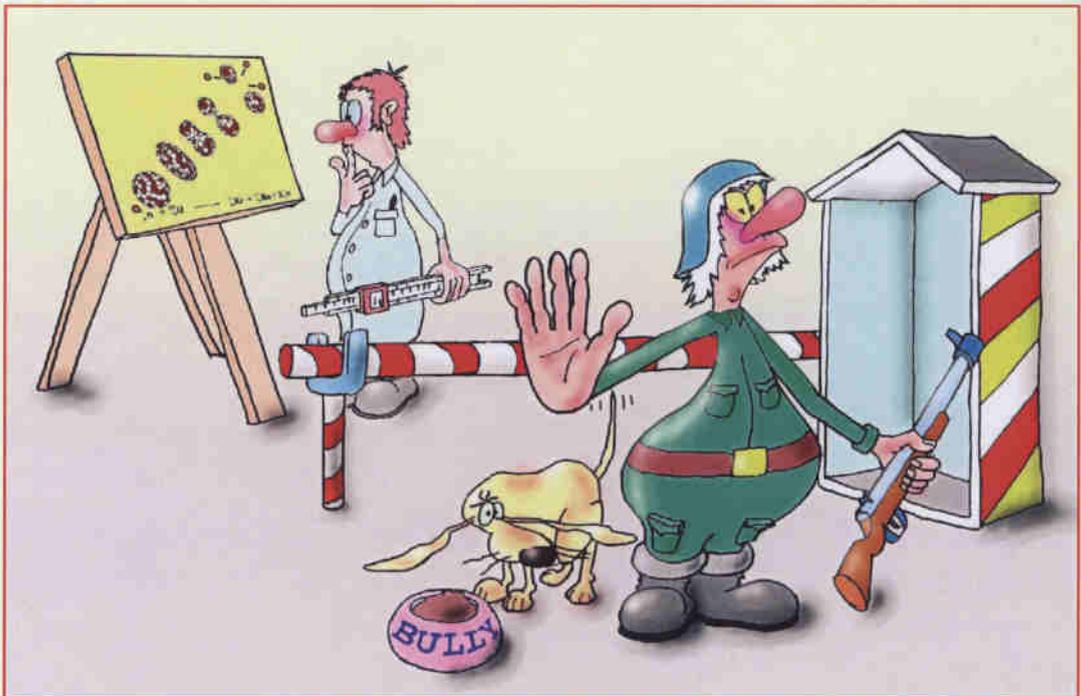
With the trivialisation of fire, the drama, illusion and mystery that this element had been covered up in for so long were dispelled. Scientific and technological research was becoming freer; gone were those fears of being accused of sorcery and of dying prematurely at the stake. Scientific and technological creativity could be displayed liberally.



People were beginning to believe that nothing was impossible.

THE DOMESTICATION OF THE " SECOND FIRE "

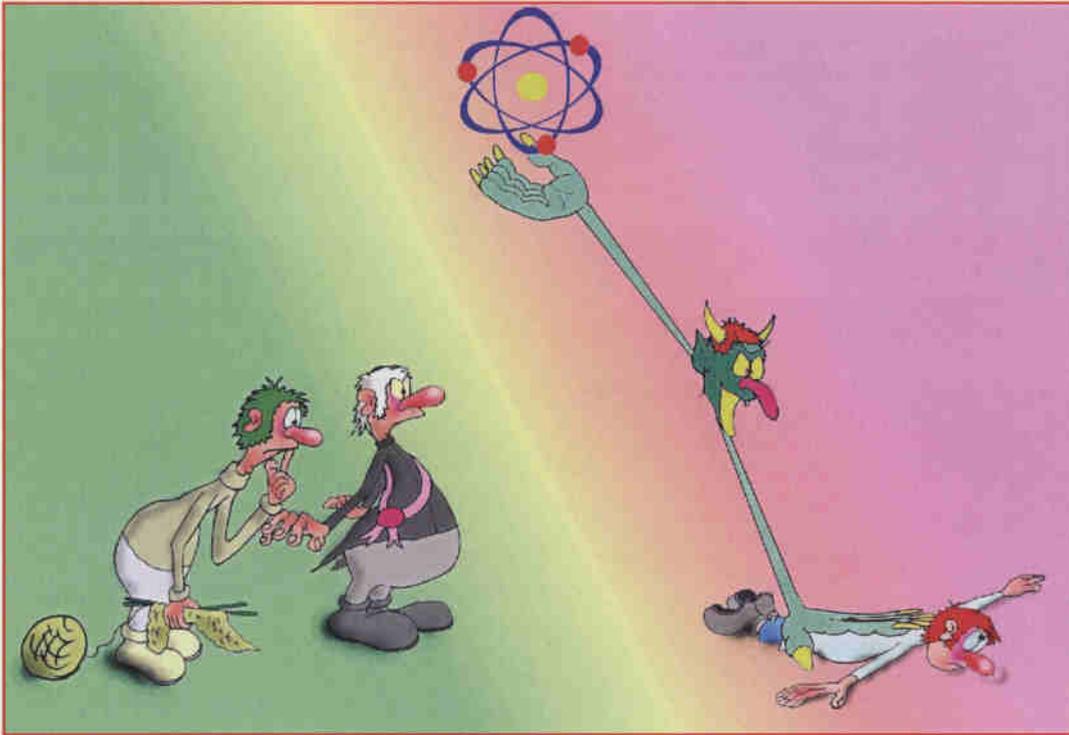
Nuclear Energy took seed at a time when the world was euphoric over science and progress. This period, when the first atomic bombs were built, was an age of audacious and enterprising pioneers. Due to military secrets, scientific knowledge that was acquired was confiscated by an elite made up of physicists who thus took on the role of the sorcerers of the past we have already spoken about. Extraordinarily great was the power of those nations that had begun to master nuclear technology due to this knowledge and know-how.



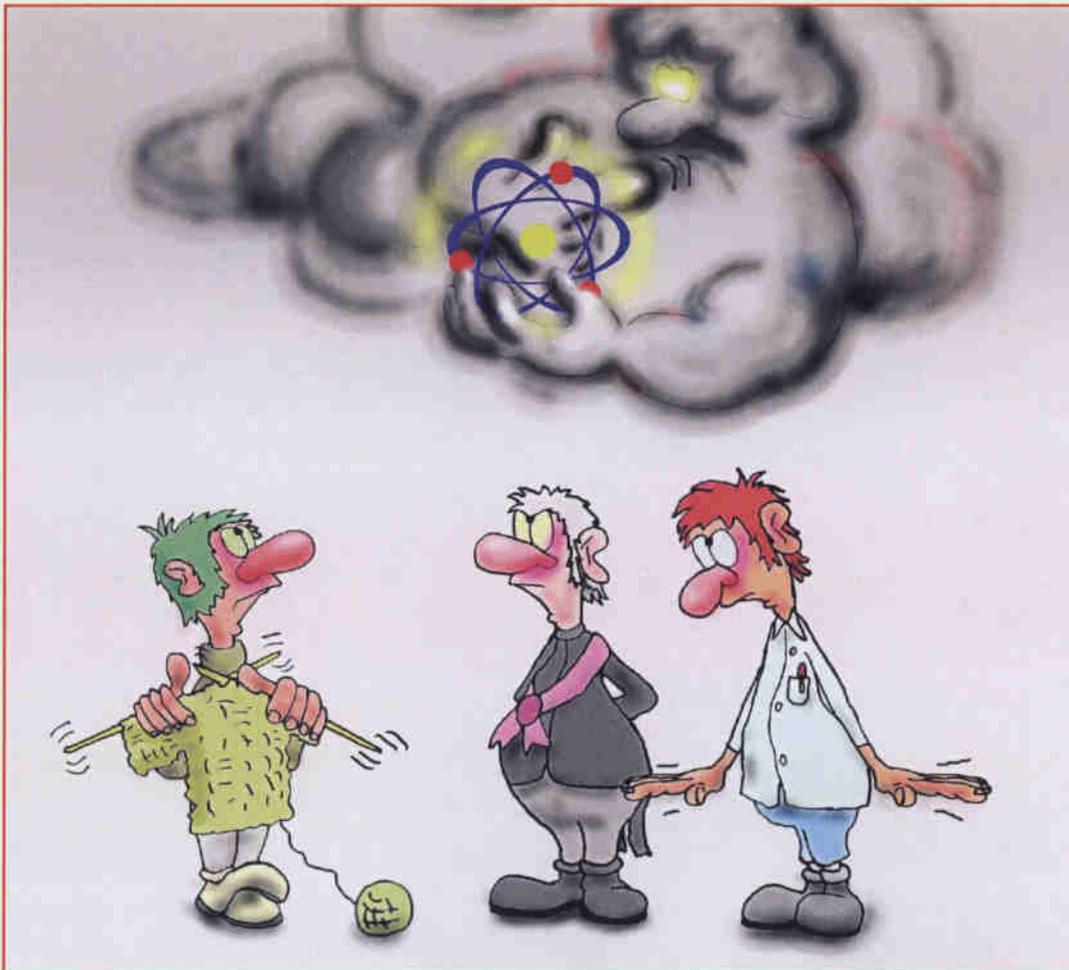
Since other nations coveted this advantage, the old concept of non-proliferation reappeared.

The secret thus was extended and included a lot of the knowledge related to nuclear technology.

Those age-old symbols, that fire had suggested 700,000 years earlier, reappeared:



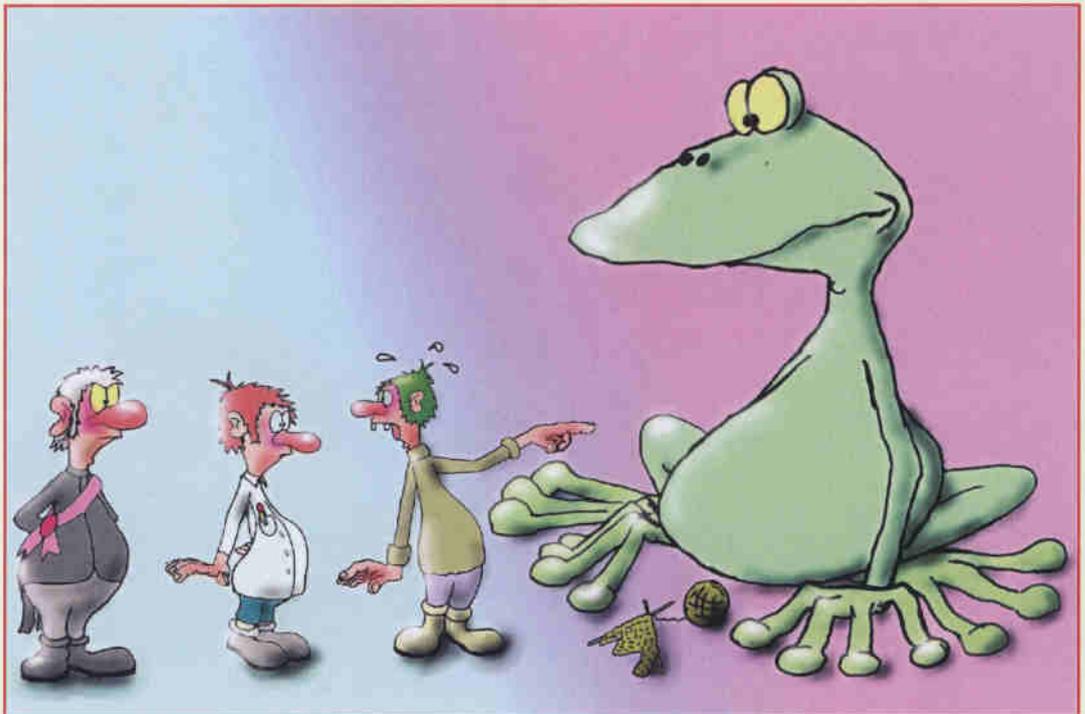
• *The Sorcerer's apprentice overtaken by his own invention*



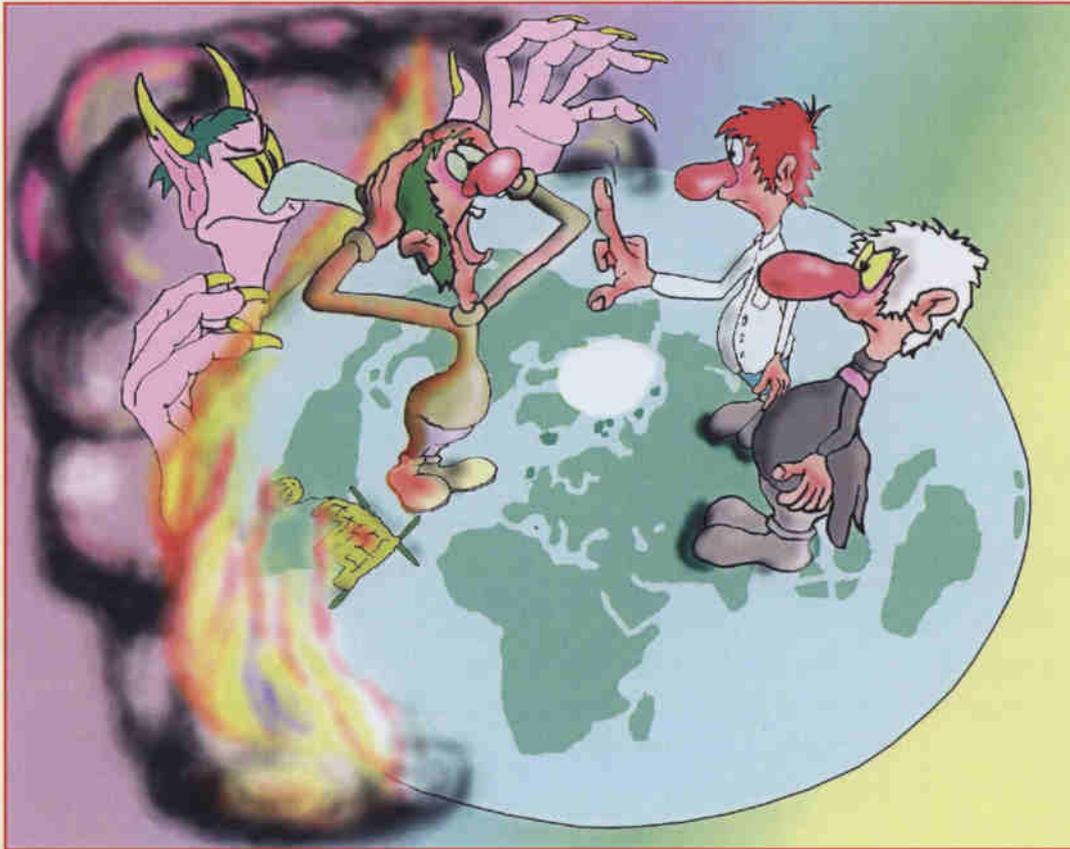
• *The appropriation of a secret reserved for the Gods.*



• The fear of divine punishment.



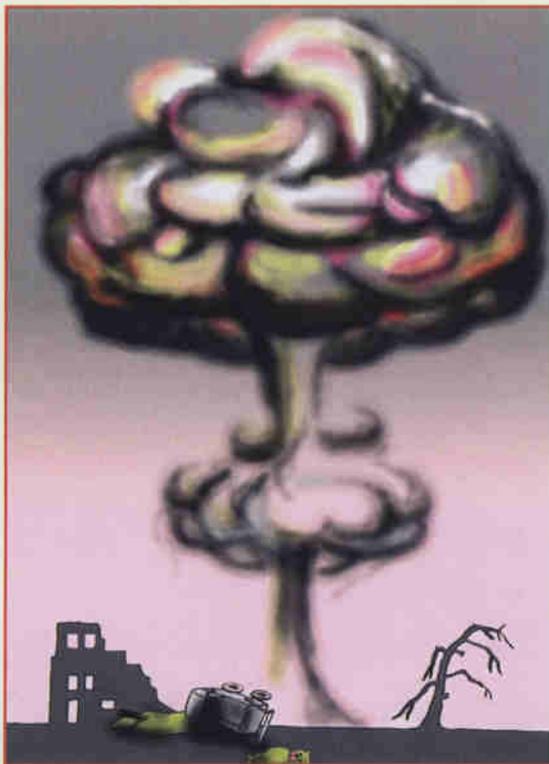
• The tainting of Nature considered as virgin and untouched until the advent of nuclear power.



- Fear of provoking the Apocalypse.

Hiroshima and Nagasaki

The atomic bombing of the Japanese cities of Hiroshima and Nagasaki, extremely brutal acts, concretely demonstrated that the second fire, yet unknown to most, could potentially destroy the world.



In a very brief period of time, these two nuclear explosions killed more than 120,000 people by their mechanical effects (shockwaves and projectiles) and their thermal effects (burns and fires).

Later, a census was taken of some 50,000 survivors, nicknamed "hibakusha". The radiation dose received by each of these survivors was calculated according to where they were at the time of the explosion. The survivors were then provided with sustained medical care which has been continued ever since.

This epidemiological study has revealed a slight increase in the rates of leukaemia and cancer among the hibakusha. If the average Japanese citizen incurs a 25% risk of dying of cancer, this risk for a hibakusha is approximately 27%.

It is known moreover, that smoking, eating habits and the consumption of drugs exposes the hibakusha to more risks of cancer than the radiation they had suffered during the nuclear bombings. Nevertheless, this study demonstrated the possible cause-effect relationship between nuclear radiation and cancer. But, the media forgot to state the low likelihood of this effect. The fear of cancer got the better of the fear of radiation and the hibakusha have lived and still do in fear of an imminent discovery of this mortal disease in them. Statistically, about 10 hibakusha die every year from the effects of the radiation received in August 1945.

The influence of television

With television and science fiction the old symbols and peoples' fears were strengthened and intensified. Doubt returned and, overall, confidence in science and progress weakened. Serious accidents, which should have remained virtual, actually occurred resulting in a shattering of confidence in nuclear energy, even among nuclear supporters.



Groups of purists and ecologists grew and became more organised demanding that nuclear energy be stopped once and for all.

Once again, a new energy questions the deeper meaning of peace and tranquillity in the world and is accused of elitism and esotericism and, therefore, of jeopardising democracy. Radioactivity awakens the sense of time that man would have liked to perceive as cyclical whereas it runs in linear fashion. People began to worry about the legacy of nuclear waste, the way it would affect the far future. One generation after another, they thought, would be heir to this highly radioactive nuclear by-product.

Chernobyl

The explosion of the nuclear power plant of Chernobyl was a grave catastrophe, the main effect of which was the severe radiological contamination of a few thousand square kilometers of land rendered uninhabitable for several decades.



The effects on the health of local and regional populations have, however, proved to be short of predictions and well below expectations. These medical observations do not, in particular, allow for the conclusion of increased rates of leukaemia or for genetic malformations. In contrast, however, a significant increase in the thyroid cancer in children was observed. Undoubtedly the state of health of the populations of Ukraine and Belorussia are mediocre. However, the same level of mediocrity has been observed in both contaminated and uncontaminated zones.

Unfortunately, these countries' governments, for the sake of humanitarian aid, have published facts and figures, in the knowledge that it is strategically advantageous for them to use the Chernobyl catastrophe for the ills that have befallen them whether health-related, economic or ecological. Thus, the vigorously propagated pseudo-reality overshadowed the more reserved scientific reality.

A few decades from now, when people will have recovered from the shock, humanity will become aware of the real consequences of the Chernobyl catastrophe. It was an extremely heavy toll no doubt, but it was not the beginning of the end of the world.

The extent and gravity of this catastrophe can be compared to those natural catastrophes such as volcanic eruptions, earthquakes or tidal waves. Later, it will perhaps be found that fear of radiation caused more damage than radiation itself.

Radioactive Waste

The heritage that today's mankind passes on to future generations does not consist only in knowledge, experience, works of art or technical achievements. It consists also of highly toxic waste decaying extremely slowly. Some of these wastes, e.g. CO₂ (produced by the first fire!), lead, arsenic or mercury were already existing well before the discovery of nuclear energy but humanity had not realized that they were posing a new problem of ethics. The merit of radioactive waste has been to raise and emphasize this new ethical problem. It concerns our responsibility toward future generations even very far in the future.

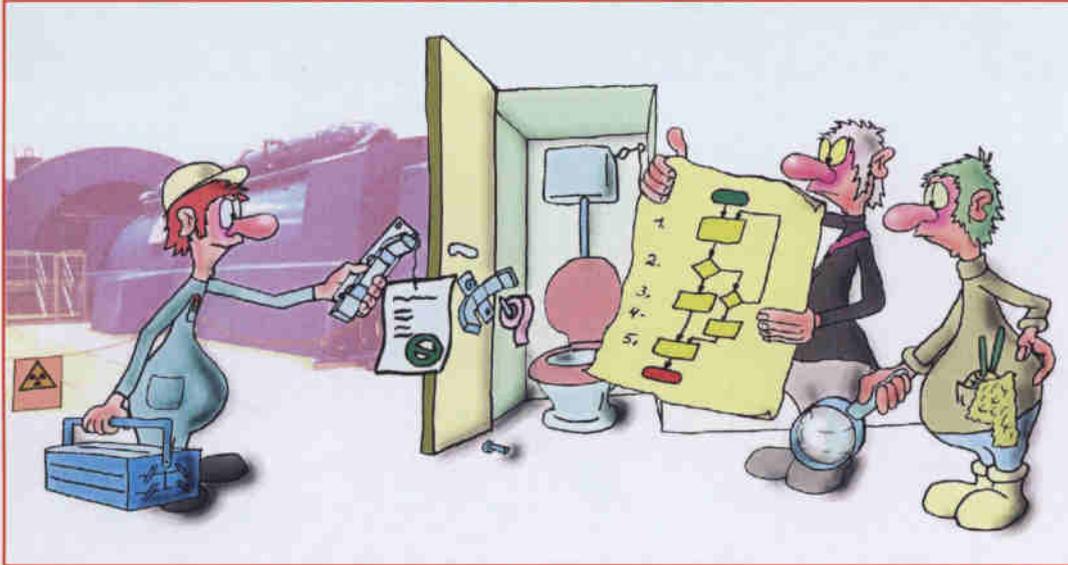
The management of this waste requires its concentration, packaging, confinement and its isolation from the biosphere for a very long time. The possible sites for reaching such a long lasting isolation are geological layers which are especially dry and stable. If the technique of rocket launching became reliable, one could even envisage sending some parts of the waste into the universe or into the sun.



As today's mankind is not deeply convinced it knows what to do and is reluctant to make definitive or irreversible choices, the radioactive waste will be temporarily stored until the progress of science will show an acceptable and accepted solution.

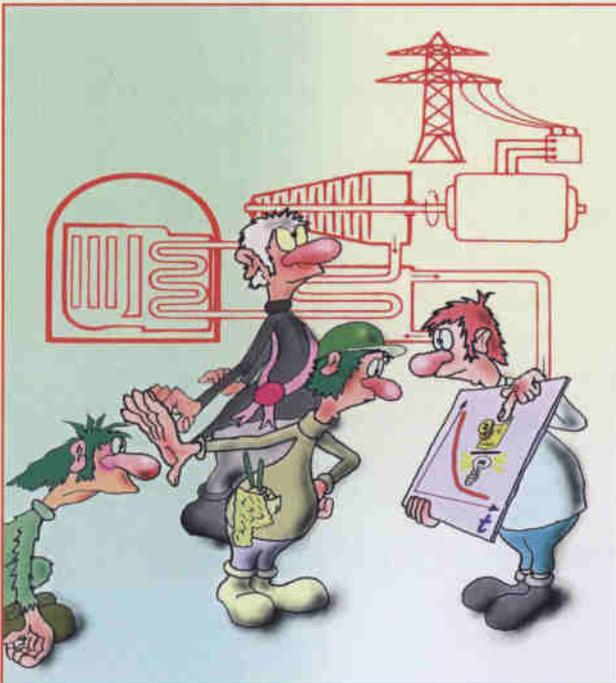
A weakened neo-romanticism

With the passage to the new millenium, however, another movement began. There is a change in attitude, which could even be called a paradigm shift. This new paradigm, too complex to explain in a few words, originated perhaps with the fall of the Berlin Wall, Glasnost and the collapse of communism, and represents the victory of authenticity and reason over artificiality and lies. This movement is strengthened by the emergence of a globalisation of the world market and of all-out competition between countries around the globe.



New criteria of evaluation appear, such as, quality assurance, and the need for work, staff and institutions to be accredited, certified, properly trained, etc.

Competency is once again set at the top of the list of criteria for enlistment. Preserves and privileges disappear. People begin to respect efficiency more and pay less attention to the code of ethics they used to rely on in the past. Breakthroughs in cell phone and internet technology bring back our confidence in science and modern technique.

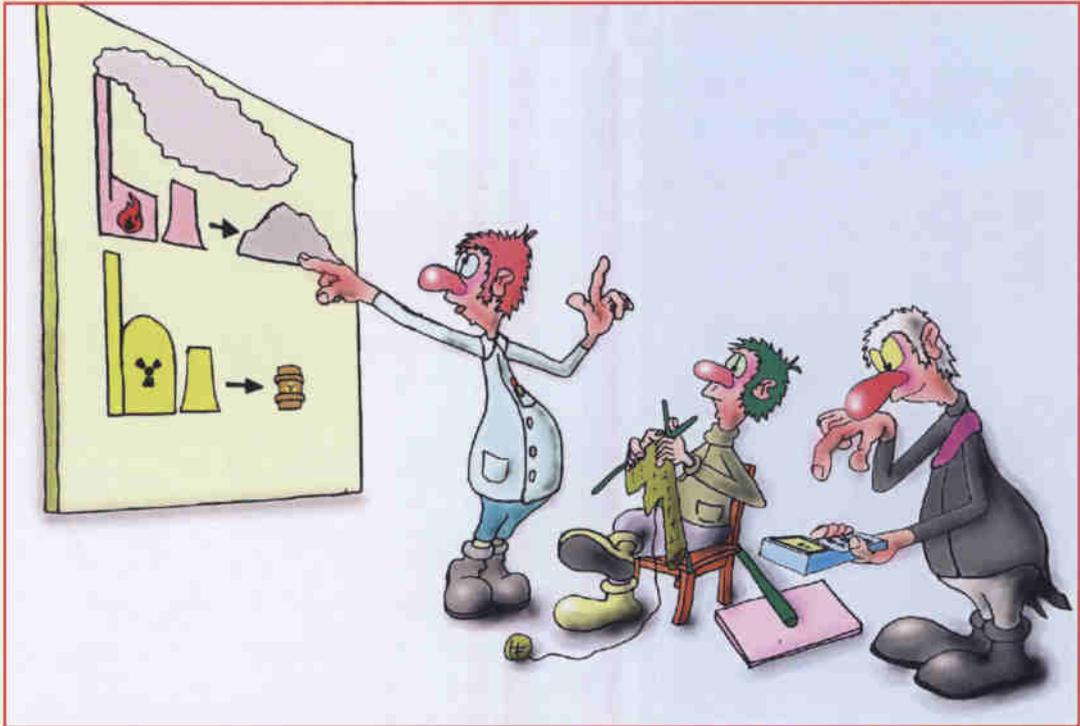


Moreover, the dawn of a new century and millennium has a radically stimulating effect, since, a lot of young people realise that the future has arrived and that keeping pace with it is a question of survival.

The neo-romantic movement in the last third of the 20th century accompanied by its ecological activists then give way to a neo-pragmatism or a kind of positivism, which is currently gaining ground.

Secularisation and trivialisation

With the disappearance of its pioneers, nuclear energy loses its elitism, secrecy and esoterism (and resulting arrogance). The new generation of leaders no longer feel the need to use the past emotional rhetoric of nuclear energy and national autonomy and identity. Gone are the quasi-fanatical defences of this form of energy. Nuclear energy is demystified in the same way that medicine was secularised.



The dialogue between pro and anti-nuclear activists loses its fanaticism and becomes more objective and therefore, less spectacular and less of a media event.

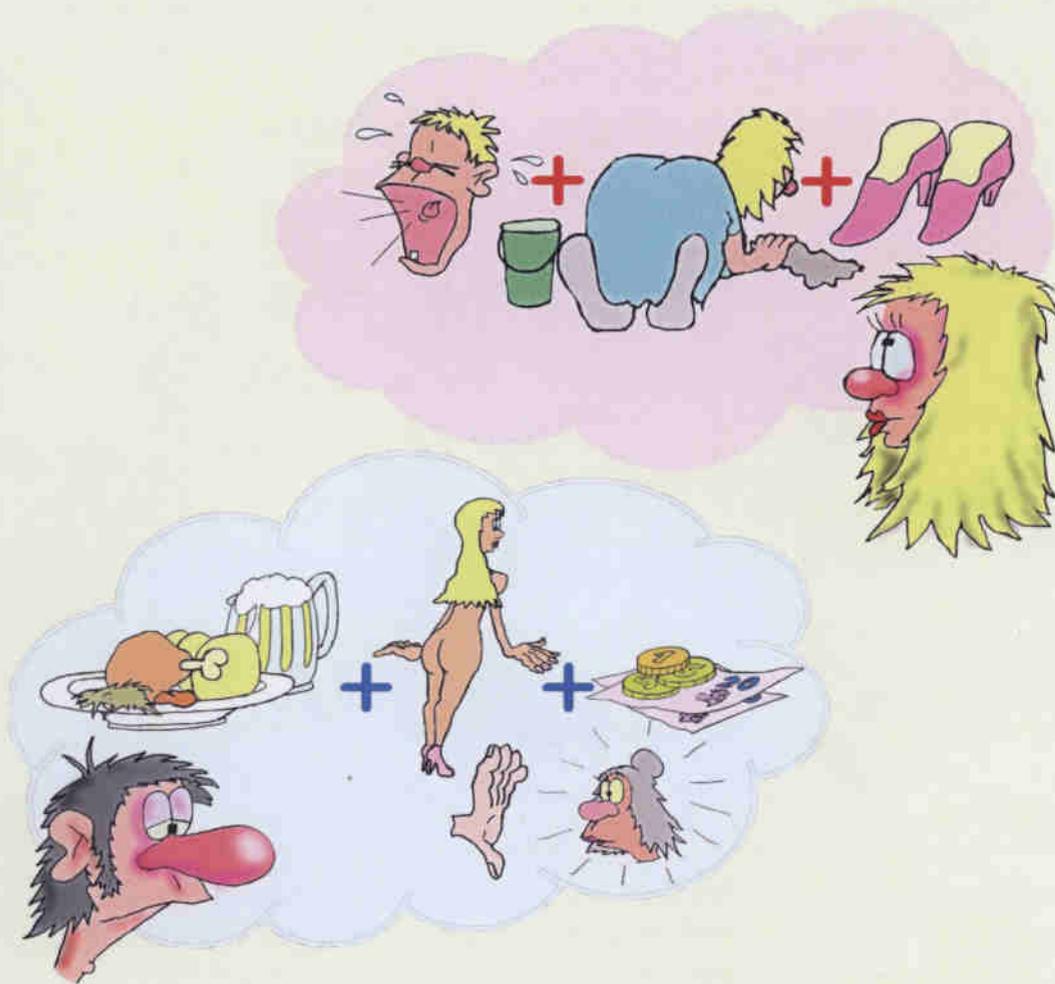
In a way, this current approach to nuclear energy is similar to the decline of the feudal system. What was noble now becomes common and trivial. We can also compare this to the trivialisation in today's world of aviation. Taking a plane has become as much of an everyday affair as taking a bus or train ride, and pilots whom we once looked upon as heroes are now the unionised employees of the airlines they work for.

It was undoubtedly the heightening speed at which global markets opened up that made flying a daily or at least regular occurrence. Pressure from competition brings with it the need for airlines to make cutbacks in all areas and we are still worried about the evolution of safety in air transport systems. However, the brutality of competition has also called for greater efficiency and effectiveness in the field of safety. Here again, as seen in the evolution of fire, trivialisation leads to improvement of the sense of responsibility and effective innovation in the field of safety as well.

Indifference

Trivialisation will lead to indifference.

Human society will focus on other problems and progressively

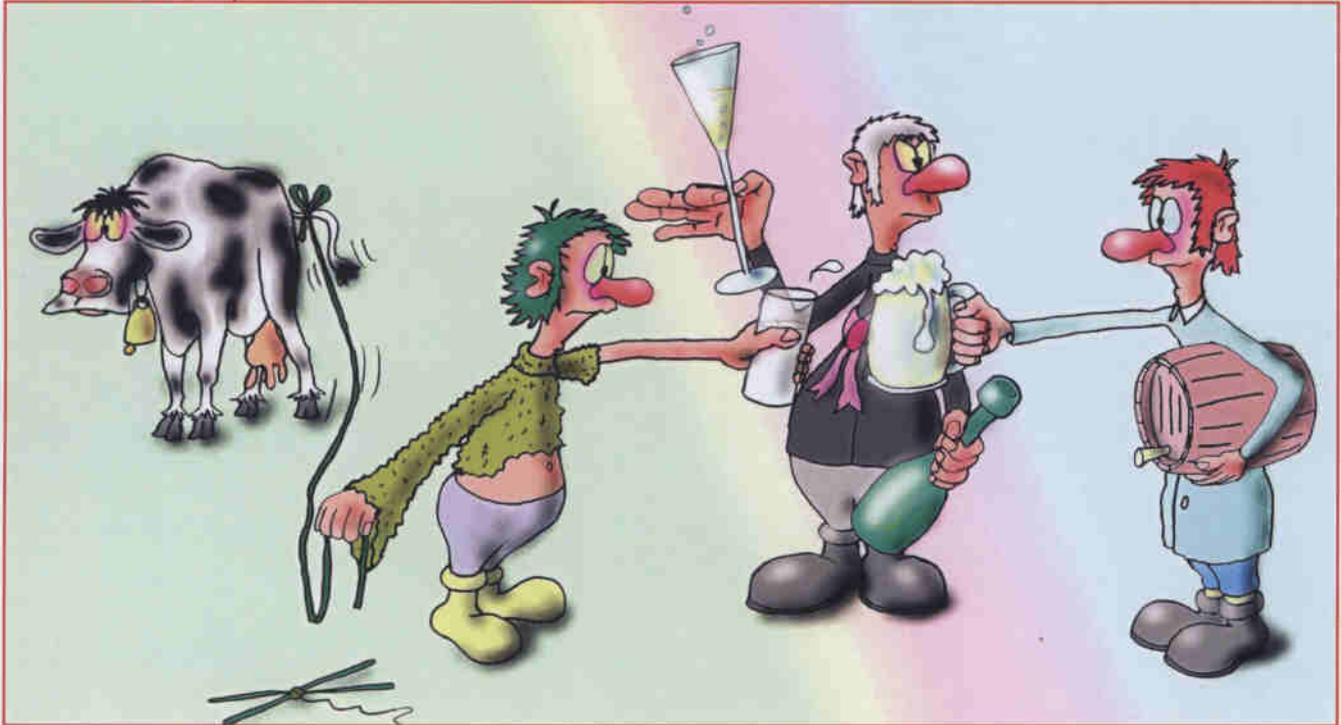


will forget this controversy. Nuclear power will be neither accepted nor refused in the end: the issue will remain suppressed.

To conclude, it is important to mention that this trivialisation per se is neither positive nor glorious and that it will lead to nuclear safety-related problems in the future. Levels of excellence must not at any cost be allowed to deteriorate. As in the case of fire and aviation, however, trivialisation will bring with it a greater sense of responsibility. This will not totally prevent accidents from occurring. But, thanks to innovative techniques, nuclear accidents will be less serious and humanity will get accustomed to them. This trivialisation will also liberate nuclear energy by making it discard the dross it is associated with, composed of symbols, of fears, of mysticism, of arrogance, of magic, of secrecy and of elitism. Trivialisation also leads to indifference and this indifference will free nuclear energy of all these painful attributes.

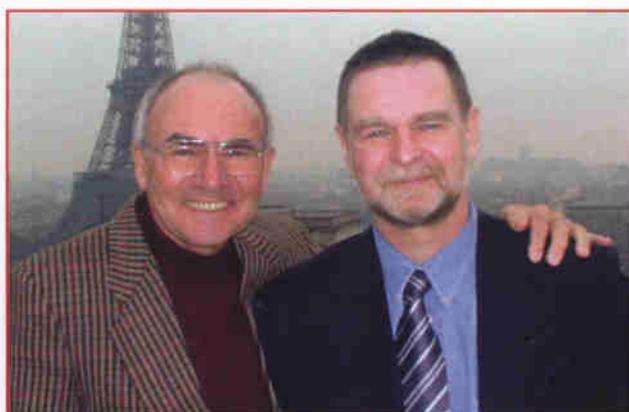
E P I L O G U E

About 700,000 years ago, the slow conquest of fire marked the beginning of the story of humanity. This fire was the main agent in progress and civilisation. We now embark on a second cycle and history repeats itself on a much higher plane.



Nuclear energy (the second fire) announces the beginning of something new and enormous which at first awakens ancestral fears but which will take over from the first fire and will propel humanity towards an even more inconceivable future.

The author and the illustrator



The author, Serge PRÊTRE, is a physicist who is professionally devoted to and internationally acclaimed for studies in the field of radiation protection. While working with the Swiss Nuclear Safety Authority, he was called on to, inter alia, manage the crisis caused by the Chernobyl fallout in Switzerland.

He has, moreover, attentively followed the criticism of nuclear energy, trying to bring to light the reasons for its acceptance and refusal. In this document, Serge PRÊTRE tries to draw a parallel between the laborious conquest of fire and the current difficulties in accepting nuclear energy.

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The illustrator Karl BRELLINGER grew up in an industrial area in the middle of Germany commonly known as the "Brown coal fields". He is married and a proud daddy of two successful children. The family lives in Schleswig Holstein in the far north of Germany.

Karl Brellinger is a skilled electrician and has since achieved a degree in Nuclear Engineering Power Technology. He works for one of the leading utilities in Germany, where he prepares concepts for quality assurance of the internal set of rules of nuclear power plants.

In his spare time he is a dedicated carnival fan and he loves to read history books.

Since childhood he has loved to draw caricatures. He has developed his own style that depicts what the subject is feeling at that moment in time. For this brochure he especially created a group of figures that lead us graphically through the story. But, they do not want to be taken too seriously. Despite their very different characters they get along quite well together

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