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"*La femme hydropique*", engraving by Godard d'Alençon after an image by Gerard Dow, published in Le Magasin Pittoresque, Paris, 1842

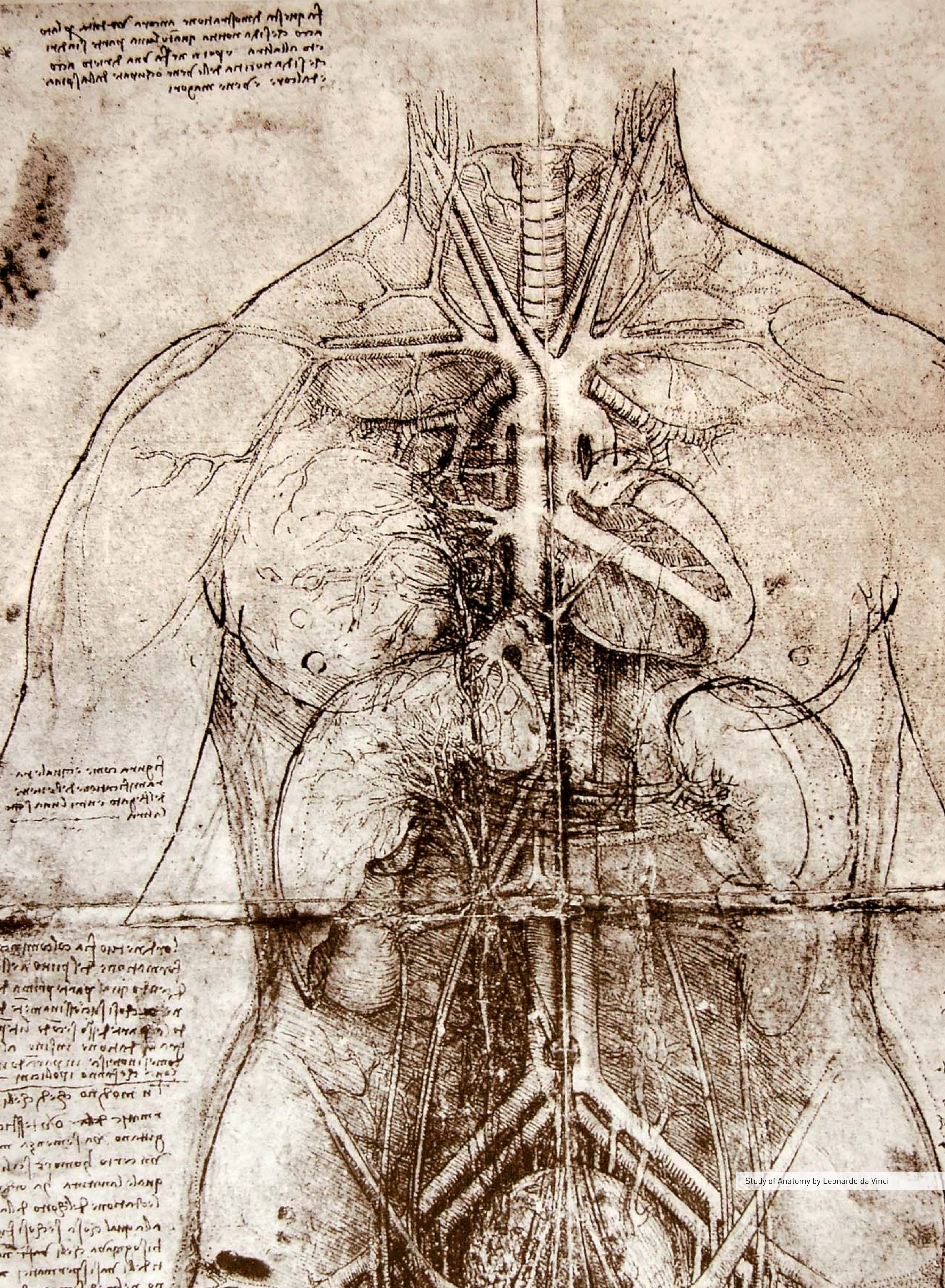
editorial

A study of the socioeconomic aspects of history, always exciting, provides the milestones marking the development of the medical concept of illness and its relation to human mortality and insurance. Through the authorised point of view of Dr. Ana Villanueva, Medical Director of Life, Health and Personal Accident business at MAPFRE RE, Trébol recalls the successes, advances and dramas that have been changing human life expectancy and the improvements in medical diagnostics methods. Personal lines insurance has also followed scientific and demographic developments, which is why, in the same historical vein, this issue also includes a report on the researchers who designed the risk analysis method that continues to improve today as technology progresses.

The so-called "Canterbury series of earthquakes" in New Zealand started on 4 September 2010 and was followed by three more earthquakes which devastated the areas most vulnerable to the phenomenon of soil liquefaction or loss of soil consistency in the city of Christchurch, on the archipelago's South Island. A select local team of scientists and researchers describes and interprets for Trébol the most serious social, economic and insurance effects which led to a rethink of the parameters of earthquake engineering codes, land-use planning and the rules of local insurance and international reinsurance.

Jorge Martínez Salvadores, a Valencian from Alzira, was given the nickname "Aspar" because of his grandfather's profession of *espardanyer* (pronounced "aspardanyer"), the Catalan word for "espadrille maker" and a metaphor for a life dedicated to working and travelling the roads, albeit competing worldwide on a motorcycle. Now he coaches a team of young riders – "one big family", as he puts it. A strong mental outlook and good people backed by ever more safety, both mechanical and at the circuits, is a recipe for success that guarantees the support of sponsors and allows team members to ride more and better.

Reducing the number of road accident fatalities is dependent on many factors. During the eight years that Spain's National Road Safety Observatory was in operation, Anna Ferrer used all the pedagogical skills from her university education in a tight work schedule based on the analysis of information, planning and the involvement of all the responsible players. Result: the annual number of fatalities has fallen from 5,000 to 2,000. Although she says that there is still a lot to be done, our children are already driving and are less afraid of doing so.



Study of Anatomy by Leonardo da Vinci

From traditional to modern medicine

Ana Luisa Villanueva
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The medical concept of disease has undergone great changes along history and helped understand the development and structure of society. Diseases suffered by the population are different upon the historical, economical, social and geographical moment. The cause of death along history changes according to different types of disease.

For most human history, life expectancy has been changing from 25 years from our hunter-gatherer ancestors, 37 years for residents of England in 1700, 41 years in 1820, 50 years by the early 20th century up to 77 years nowadays. This increase in life expectancy or decrease in mortality are explained by the near elimination of deaths from infectious diseases, most common cause of death up to mid-18th century. The improved nutrition and economic growth, as well as emerging public health measures from the mid-18th century to the mid-19th century and the delivery of clean water, waste removal and initial advice about personal health practices from the mid-19th century to the early 20th century. Since the 1930s, mortality has been reduced thanks to advances in medicine, primarily by vaccination and antibiotics and later by the new therapies that characterize modern medicine.

A quick review of the evolution of medicine

Galenism represents the prevalent medical concept in the Western world from Classical Antiquity until well advanced the 17th century. Disease had an Aristotelian philosophical background and a humoralist concept of the body. The causes of disease could be external or procatartic and internal or proergumenal. External causes came from natural causes: air, atmosphere, food, drinks, work, rest, sleep, vigil, secretions, excretions and mood changes. Temper and heritage determined internal causes.

For Galen, disease had an Aristotelian philosophical background and a humoralist concept of the body

The usual interpretation of disease was the humoral imbalance or corruption of humours. Diagnosis did not have the relevance it has now. The supposed triggering cause described the disease. Expressions related to excessive cold or heat, dryness or humidity, ascitis, fever and pore laxity or constriction were used. Many of the medical terms from this period remain today.

The descriptions of new diseases such as syphilis, the English sweat, gaol fever (typhus), among others, were introduced during the Renaissance and as a result of the European colonial expansion.

Rational Empiricism developed in the 17th century and is transferred to Medicine by the English physician Thomas Sydenham, who applied it to the analysis and classification of diseases. His work is the starting point for nosotaxia or classification of diseases.

In the 18th century, the development of this idea gave life to the construction of the nosological systems based on the botanical classification of Linnaeus.

In the 19th century, the anatomical pathology research and analytic experiments transformed science and medical practice turning back into clinical observation of

Rembrandt's "Anatomy Lesson"

Demographic changes and new social and working conditions arising from the First Industrial Revolution marked a dramatic increase of infectious diseases due to poor urban hygiene and sanitary conditions

both patient and dissection and brought new methods of physical diagnosis and research. Demographic changes and new social and working conditions arising from the First Industrial Revolution marked a dramatic increase of infectious diseases due to poor urban hygiene and sanitary conditions and mass migration from rural areas into the cities. This epidemiological change demanded new hospital facilities that could enable clinical observation and practice of necropsy.

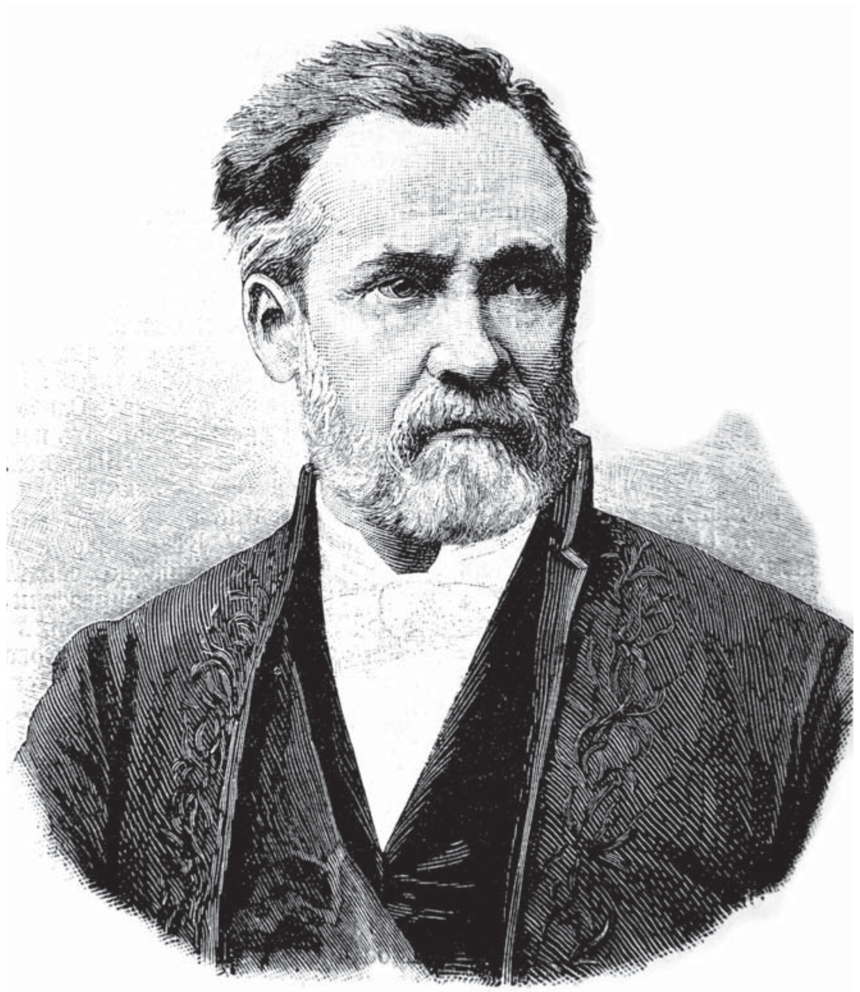
The French revolution ended with the old institutions and allowed medicine to reach its maximum splendour at the hospitals in Paris. A new era based on the pathological sign had started.

In the first half of the 19^{th} century, following the Paris Clinical School, the birth of Anatomical Pathology took place, a significant event for the development of Pathology and Therapeutics. Auscultation and percussion techniques along with radiology and endoscopy were developed. New diagnostic methods based on morphological changes showed up. The lesion becomes the element to define clinical diagnosis by referring to the local changes caused by the disease.

In mid 19^{th} century, laboratory medicine is born, focusing the explanation of the states of disease on the concept of dysfunction. As a result of this new approach comes the experimental pathology which tries to apply

Table 1: Main events timeline in the evolution of Medicine.
Source: Advances in Medical Technology, 2012.

When	What	Who
460 BC	Set base on objective observation	Hippocrates, Greece
130 AD	First knowledge of anatomy, physiology and pharmacology	Galen, Italy
910	First to identify smallpox	Rhazes, Persia
1249	Invention of glasses	Roger Bacon, United Kingdom
1302	First legal autopsy	University of Bologna
1590	Invention of microscope	Zacharius Jannssen, Holland
1670	Discovery of blood cells	Anton van Leeuwenhoek, Belgium
1816	Invention of stethoscope	René Laënnec, France
1818	First blood transfusion	James Blundell, United Kingdom
1844	First use of anaesthetic	Horace Wells, USA
1849	First woman to receive a medical degree	Elisabeth Blackwell, USA
1852	First hemocytometry	Karl von Vierordt, Germany
1864	First blood transfusion	Roussel, France and Aveling, United Kingdom
1869	First glass hypodermic syringe	Hermann Wülfing Luer, Germany
1877	First contact lenses	Adolf E. Fick, Switzerland
1882	First vaccine for rabies	Louis Pasteur, France
1890	First vaccine for tetanus and diphtheria	Emil von Berhing, Prussia
1890	First Clinical laboratory	London, United Kingdom
1895	Discovery of X-rays	Wilhelm Conrad Roetgen, Germany
1897	First commercial clinical laboratory	United Kingdom
1899	Aspirin is developed (original from willow tree bark and used since 400 BC to relieve pain)	Felix Hoffman, Germany
1901	ABO blood typing	Karl Landsteiner, Austria
1912	First treatment with insulin	Issued for treating diabetes
1913	Development of electrocardiograph	Paul Dubley White, USA
1927	First vaccine for tuberculosis	Albert Calmette and Jean Marie Camille Guerin, France
1928	Penicillin is developed	Alexander Fleming, United Kingdom
1935	First use of extracorporeal circulation	John H. Gibbon, USA
1937	First blood bank	Bernard Fantus, USA
1945	First vaccine for influenza	Macfarlane Burnet, Australia
1950	Invention of the first cardiac peacemaker	John Hopps, Canada
1953	Description of the structure of DNA molecule	James Watson and Francis Crick, United Kingdom
1954	First kidney transplant	Joseph Edward Murray, USA
1964	First vaccine for mumps	Jeryl Lynn, USA
1967	First heart transplant	Christian Barnard, South Africa
1978	First test-tube baby	Patrick Steptoe and Robert Edwards, United Kingdom
1983	HIV/AIDS identified	Robert Gallo, USA and Luc Montagner, France
1996	Dolly the sheep	First mammal cloned
1998	Discovery of stem cells	Thomson et al and Gearhart et al, USA



Louis Pasteur

Medical developments have substantially modified the traditional physician-patient relationship and the view of a patient as a person

this experimental method to the explanation of the origin and development of disease. The search for signs of functional impairment generates the use of tests to seek for functional performance, such as liver, kidney or respiratory function tests. This situation favours technical development creating a number of instruments to evaluate functional state and metabolic function and chemical tests for body fluids. Disease is no longer a local event but an ongoing and measurable process.

In late 19th century, the animal infection transmission is discovered. Bacteriology is born with two important precursors of modern microbiology, Luois Pasteur and Robert Kock.

In the 20th century, lab tests became the main tool to define health and disease criteria by normal biological patterns. In case of internal origin disease or caused by the body, the scientific explanation of pathological inheritance or inherited transmission of certain diseases started providing answers to processes previously considered mysterious to medicine and were subject to speculation.

In the second half of the 20th century, conventional radiology began to be used consistently as a diagnostic support to lab tests. The development of new radiological techniques, such as computerized tomography, have introduced a new independent diagnostic line, diagnostic imaging. At the end of this century, another new technique bursts in: the magnetic resonance. A higher resolution with no ionizing radiation boosted its race for developing new techniques that could improve diagnostic tests sensitivity and specificity, optimizing quality and timing. In the last few years, ultrasound, Doppler, positron emission tomography and photon emission tomography have joined, enabling physicians to visualize the body in ways that would have been considered almost a miracle less than a generation ago.

All these developments have substantially modified the traditional physician-patient relationship and the view of a patient as a person. The quick progress and development of the specialty of diagnostic imaging lead to a constant improvement of equipment, innovative technological applications, clinical and scientific maturity of the already involved radiologists and increased interest of other physicians on the value of the provided information. Advances in technology have allowed us making a diagnosis that was previously impossible. An enormous amount of elusive pathology is now available for research thanks to modern technology.

Health and illness throughout history

Mortality studies establish the technical principles and diagnostic expressions used by physicians at every stage of history. Moreover, they help us understand the concepts of health and illness at all times.

One of the main difficulties in historical health care data reconstruction, more specifically on causes of death, is in the

1950 X-Rays Machine

In the 19th century, diagnostic tools, including the microscope and X-ray, helped provide hard data independent of subjective judgement and anecdote

diagnostic expressions used at the time since most of them do not match with any current classification. We must take into account that there was hardly any access to a physician or medical treatment and the parish or civil register did the registration of the cause of death, frequently done by someone either lacking of any medical knowledge or using popular expressions that had no direct relationship with the real cause of death. Cannonballs, war injuries and pandemics are described as cause of death throughout history. It is not until the 19th century when the first records of cause of death in the population can be found.

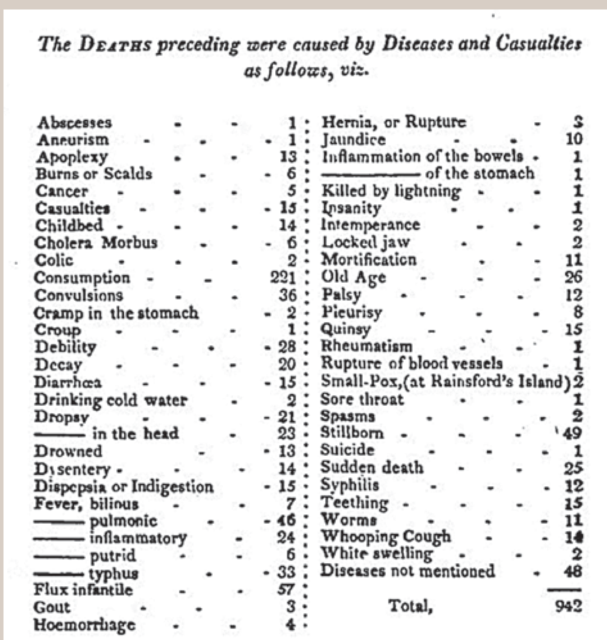
Teething stands out as the main cause of death in infants below the age of 5. This term refers to drooling when teething, which disappears when the process is over. The disease is present when dribble gets inside and therefore it must be taken out. This shows popular practice, attitudes, ideas and beliefs not participated at all by physicians.

In the United States, one of the first bills of mortality is from the Town of Boston. The main cause of death was tuberculosis, so then called "consumption" due to the consumption of body tissues caused by the infection.

Table 2: List of cause of death in Spain at the beginning of the 19th century.
Source: Compiled by author.

Inflammation	Pneumonia
Teething	Nerve impairment
Fever	Tysis
Irritation	Diarrhoea
Measles	Cholera
Bronchitis	Lockjaw
Apoplexy	Malaria
Congestion	Smallpox

Table 3: Causes of death in 1811.
Abstract of the Bill of Mortality for the Town of Boston.



The Deaths preceding were caused by Diseases and Casualties as follows, viz.

Abscesses	1	Hernia, or Rupture	3
Aneurism	1	Jaundice	10
Apoplexy	13	Inflammation of the bowels	1
Burns or Scalds	6	—— of the stomach	1
Cancer	5	Killed by lightning	1
Casualties	15	Insanity	1
Childbed	14	Intemperance	2
Cholera Morbus	6	Locked jaw	2
Colic	2	Mortification	11
Consumption	221	Old Age	26
Convulsions	36	Palsy	12
Cramp in the stomach	2	Pleurisy	8
Croup	1	Quinsy	15
Debility	28	Rheumatism	1
Decay	20	Rupture of blood vessels	1
Diarrhœa	15	Small-Pox,(at Rainsford's Island)	2
Drinking cold water	2	Sore throat	1
Dropsy	21	Spasms	2
—— in the head	23	Stillborn	49
Drowned	13	Suicide	1
Dysentery	14	Sudden death	25
Dispepsia or Indigestion	15	Syphilis	12
Fever, bilious	7	Teething	15
—— pulmonic	46	Worms	11
—— inflammatory	24	Whooping Cough	14
—— putrid	6	White swelling	2
—— typhus	33	Diseases not mentioned	48
Flux infantile	57		
Gout	3	Total,	942
Hoemorrhage	4		

Table 4: Top 10 causes of death: 1900 vs 2000.
Data from the Centre for Disease Control and Prevention of the United States.

1900	2000
Pneumonia	Heart disease
Tuberculosis	Cancer
Diarrhoea	Cerebrovascular disease
Heart disease	Respiratory diseases
Cerebrovascular disease	Accidents
Liver disease	Diabetes
Accidents	Pneumonia / Influenza
Cancer	Alzheimer
Age/ natural aging	Kidney disease
Diphtheria	Blood disorders

The most frequent causes of death from table 3 are:

- Consumption or tuberculosis.
- Flux infantile.
- Stillborn.
- Diseases not mentioned.
- Pulmonic fever.
- Convulsions.
- Typhus.
- Old age.
- Sudden death.

Thanks to development of medicine, the disease gathers its own identity and is defined by itself not by its symptoms.

The evolution of diseases is shown in table 4 with the comparison of the top 10 causes of death in 1900 vs 2000 published by the US Centre for Disease Control and Prevention.

Following this evolution, in 1900 we can see how infectious diseases are no longer the main causes of death and other impairments better defined by new technology are showing up. As economy improved, so did Public Health with the extension of sewage system for waste water collection, domestic water supply and scientific research outcomes with vaccination programs, treatment with antibiotics, the development of new diagnostic techniques and discovery of new diseases.

Health and country income

The best example of the evolution of the concept of health is in the mortality rates published by the WHO (World Health Organization), ranking causes of death by country income. This classification shows the intimate relationship between the concept of health and illness and the society we are living in.

Table 5 shows the top 10 leading causes of death nowadays. Countries are grouped according to the World Bank classification by country income. Last column refers to the global situation (Global-World).

From the analysis of the distribution of deaths per age group, we can find that:

- In low-income countries, less than a fourth of all people reach the age of 70 and more than a third of all deaths are among children below the age of 14. Infectious diseases such as lung infections, diarrhoeal diseases, HIV/AIDS, tuberculosis, and malaria claim many lives in these countries. Complications of pregnancy and childbirth together continue to be leading causes of death, claiming the lives of both infants and mothers.
- In middle-income countries, nearly half of all people live to the age of 70 and chronic diseases are the major killers, just as they are in high-income countries. Unlike in high-income countries, however, tuberculosis, HIV/AIDS and road traffic accidents also are leading causes of death.
- In high-income countries, more than two thirds of all people live beyond the age of 70 and predominantly die of chronic diseases: cardiovascular disease, chronic obstructive lung disease, cancers, diabetes or dementia. Lung infection remains the only leading infectious cause of death.

Teething was considered a disease, showing popular practice, attitudes, ideas and beliefs not participated at all by physicians

Modern Medicine

Modern medicine not only applies these technology advances to treating diseases but also learns from medical and epidemiological statistics to evaluate healthcare policies and encourages scientific research.

In industrialized countries, infections are no longer the leading cause of death; however, there are other social habits greatly affecting the health of the population.

Tobacco use is a major cause of many of the world's top killer diseases, including cardiovascular disease, chronic obstructive lung disease and lung cancer. It is responsible

Table 5. Top 10 leading cause of death by country income.
Source: World Health Organization (WHO) 2008.

Low-Income	Middle-Income	High-Income	Global-World
Lower respiratory infections	Ischaemic heart disease	Ischaemic heart disease	Ischaemic heart disease
Diarrhoeal diseases	Stroke and other cerebrovascular disease	Stroke and other cerebrovascular disease	Stroke and other cerebrovascular disease
HIV/AIDS	Chronic obstructive pulmonary disease	Trachea, bronchus, lung cancers	Lower respiratory infections
Ischaemic heart disease	Lower respiratory infections	Alzheimer and other dementias	Chronic obstructive pulmonary disease
Malaria	Diarrhoeal diseases	Lower respiratory infections	Diarrhoeal diseases
Stroke and other cerebrovascular disease	HIV/AIDS	Chronic obstructive pulmonary disease	HIV/AIDS
Tuberculosis	Road traffic accidents	Colon and rectum cancer	Trachea, bronchus, lung cancers
Prematurity and low birth weight	Tuberculosis	Diabetes	Tuberculosis
Birth asphyxia and birth trauma	Diabetes	Hypertensive heart disease	Diabetes
Neonatal infections	Hypertensive heart disease	Breast cancer	Road traffic accidents

Table 6: Death distribution in Low-income countries.
Source: World Health Organization (WHO) 2011.

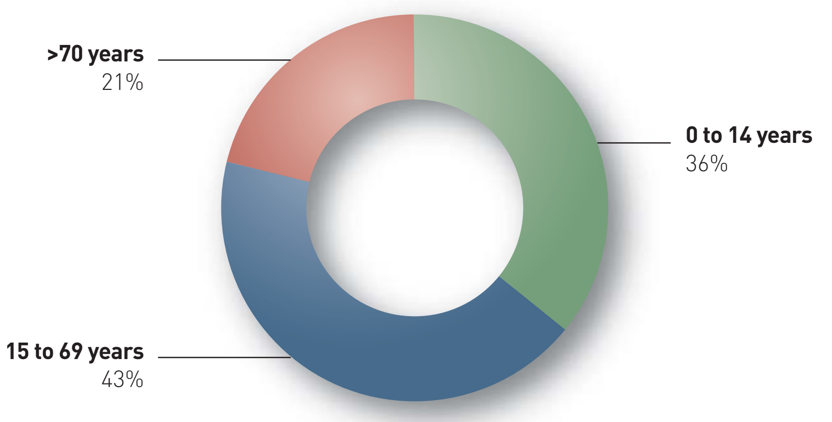


Table 7: Death distribution in Middle-income countries.
Source: World Health Organization (WHO) 2011.

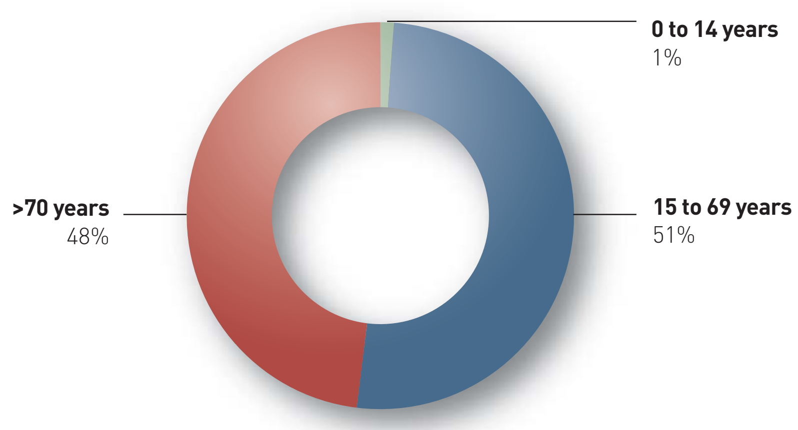
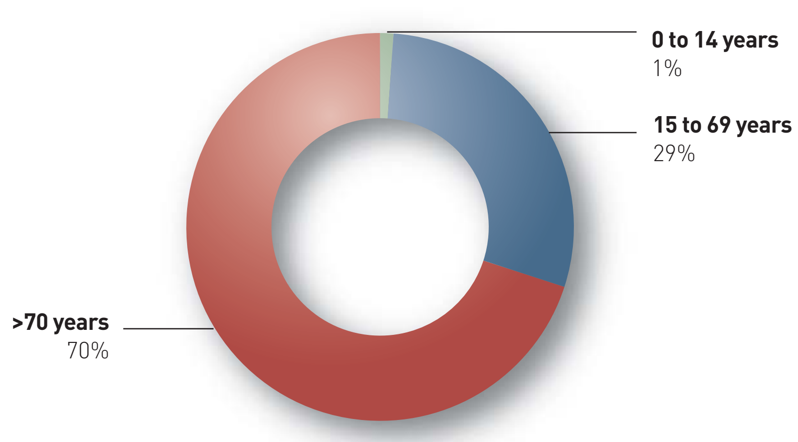


Table 8: Death distribution in High-income countries.
Source: World Health Organization (WHO) 2011.



for the death of almost one in 10 adults worldwide. Smoking is often the hidden cause of the disease reported as responsible for death.

Cardiovascular diseases kill more people each year than any others. In 2004, 7.2 million people died of ischaemic heart disease, 5.7 million from stroke or another form of cerebrovascular disease.

Current concept of health includes giving up habits and causing a negative effect on our life expectancy. We seek to live better and longer.

Modern medicine not only uses advanced technology for diagnosis and treatment but also applies scientific knowledge to the definition of disease. It is getting further from the external sign to dig in the behaviour of the molecules taking part in cells. The analysis of the molecular concepts links mechanisms, pathways and pathologies, such as cancer. Gene expression analysis leads to identify molecular subtypes related to certain outcomes or cell expression. The identification of certain genes expressed in certain types of cancer and the response to certain cancer treatments, the inhibition or activation of enzyme precursors that alter hormone production or the presence of cell membrane receptors represent the new concept of disease. We look for molecular alterations to work at this level to avoid the external symptoms that once described the disease causing death. Maybe, in the near future, diarrhoea will be a simple interleukin imbalance causing inflammation to alter the Na/K pump, thus creating a molecular imbalance causing contraction of colon muscular fibres and closing of cell channels.

Most likely Galen would have identified these molecular changes as humoral changes, as in his teachings.

How did medical knowledge fit in the development of insurance?

The first serious attempt to establish population mortality rates was made by John Graunt, a London draper's son, who analyzed the records of the christenings and burials in the City of London in his spare time, periodically published since the plague in 1603. In 1662, Graunt published a book called "Natural and Political Observations made upon the Bills of Mortality". From this information he compiled a "Table of survivors", which was to be a model for subsequent life tables.


Scanner

Some years later, Edmund Halley, an astronomer, published an essay "An Estimate of the Degrees of Mortality of Mankind drawn from Curious Tables of the Births at the city of Breslaw". It was the first work by a competent scientist using reasoning up-to-date statistics.

Although Halley's work, along with that of Newton and De Moivre, laid the foundation of actuarial science, it was not until the next generation that James Dobson, De Moivre's pupil, showed in 1756 that life assurance was practicable with premiums graduated according to age.

The passing of the Life Assurance Act by Parliament in 1774 did away with many of the old abuses, such as speculation on lives of other by people who had no real interest in those lives.

In 1837, the registration of births, marriages and deaths became compulsory in England, which enabled the development of the first official English life table in 1843.

The analysis of the molecular concepts links mechanisms, pathways and pathologies

In the earliest days of life insurance, it used to be sufficient for a candidate to appear before the board of directors, who assessed the candidate's health

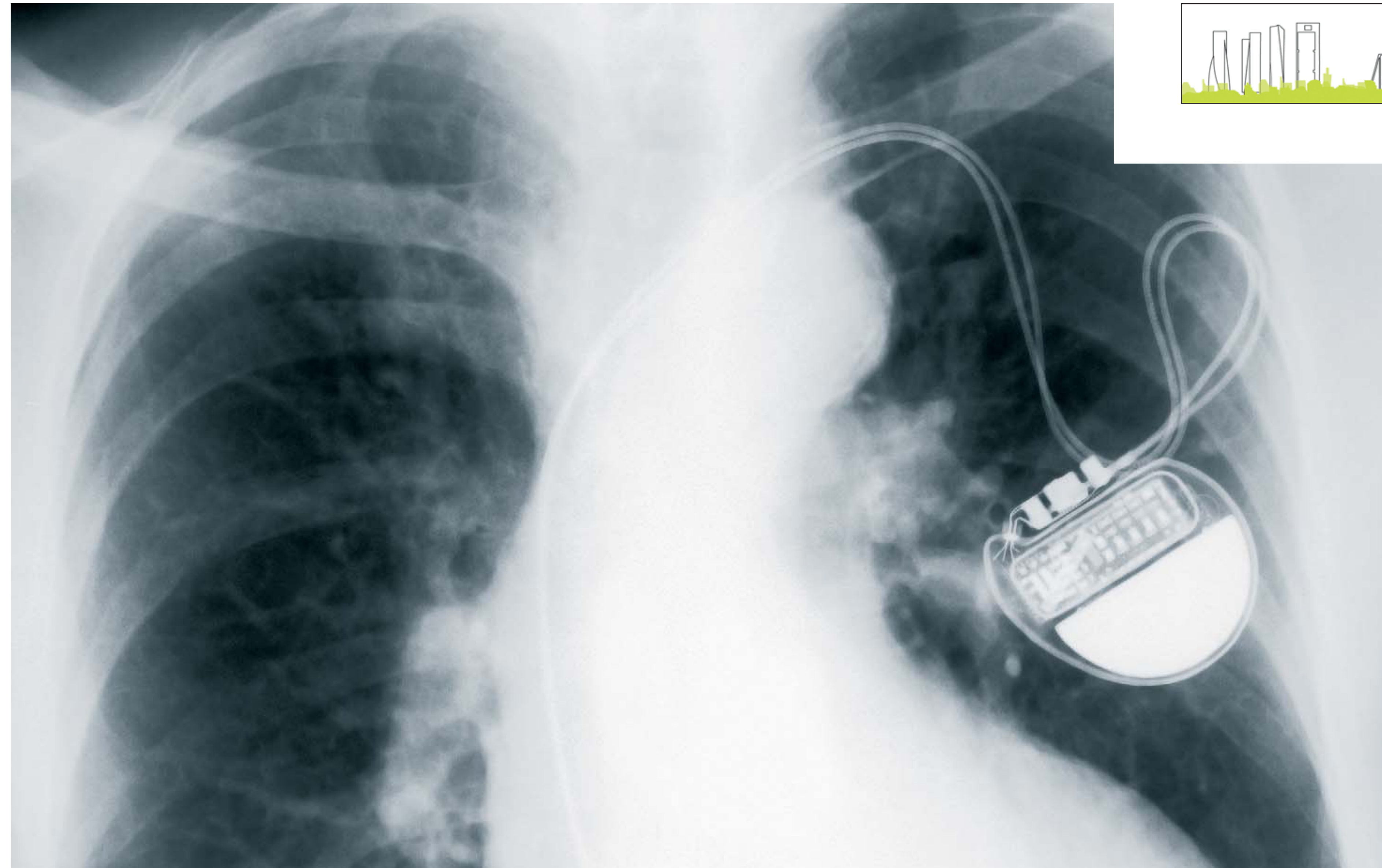
At the other side of the Atlantic, the USA life insurance developed in a similar manner to that in England. It was not until 1809, in Philadelphia, that the Pennsylvania Company for Insurance and Granting of Annuities started selling life insurance on strictly commercial basis. Its most important contribution was the innovation in its underwriting practice with the requirement of an application or proposal and a medical examination. Premiums were based on the age of the applicant. In 1823, the Massachusetts Hospital Life Insurance Company introduced a rate book.

Life business at the beginning of the 19th century existed mainly to facilitate commerce and was very restricted. It was not until the 1840s that the industry was given a boost.

In the earliest days of life insurance, it used to be sufficient for a candidate to appear before the board of directors, who assessed the candidate's health. Later on, a physician was invited to sit with and advice the directors on the state of health. As the volume of life business grew, a system of medical examination evolved. The practice started in the United States but it was not established in Great Britain until some time before the middle of the century.

In view of the technical requirements involved in medical selection, ALIMDA or Association of Life Insurance Medical Directors of America was founded in North America in 1889. In 1991 this association decided to change its name to the American Academy of Insurance Medicine, AAIM. It holds a worldwide known annual meeting. In England, the Assurance Medical Society was founded in 1893 holding evening meetings three times every year in London. Since 1985, the society has held biennial meetings in the UK jointly with the Institute of Actuaries.

The first International Congress for life assurance was held in Brussels in 1899. In 1931 a permanent international committee and a Bureau was set up to organize a congress every three years. The first official International Congress for Insurance Medicine was held in London in 1935, giving rise to ICLAM, International Committee for Insurance Medicine. Since then, this organization brings together medical experts, actuaries, lawyers and underwriters, holding a conference every three years in different parts of the world. Next May 2013, Madrid will hold its twenty-fourth edition. This forum will discuss medical issues related to life, disability, dependency, health and accident insurance.



Latest generation pacemaker compatible with magnetic resonance imaging

Logo of the ICLAM (International Committee for Insurance Medicine) Conference in 2013
https://www.iclam.org

The medical examination first started checking blood pressure, height & weight, and the lack of infectious diseases; later on, a medical questionnaire inquiring about the health status of the applicant through a set of questions was added. At the beginning of the 20th century laboratory testing is included, mainly to identify unknown or unreported diabetes and renal diseases. Years later X-rays joined and later on stress testing. In the last decade, echocardiography and Doppler echocardiography have become part of the testing for high sum assured.

Laboratory testing has not only evolved in quality and techniques but has developed three categories within risk assessment:

- **Screening tests** to find undisclosed conditions or identity use of substances such as cocaine, nicotine or alcohol.
- **Reflex tests** to control a follow-up of a disclosed impairment or rule out a transitory condition. Glycosylated haemoglobin is a good example. It shows how well the diabetes is under control or a temporary raise in blood sugar, which does not imply any additional risk.
- **Test for cause** are ordered based on a disclosed condition that requires additional information, usually ordered by Medical Directors or Advisors.

In the last 20 years, alternative testing to traditional blood tests have developed, mainly related to low sum assured.

Oral fluid testing or saliva test are a fast and inexpensive way to identify the presence of HIV, use of substances or smoking

Oral fluid testing or **saliva test** are a fast and inexpensive way to identify the presence of HIV, use of substances or smoking. It is important to mention that a positive response in any fluid or oral tests must be confirmed with a blood test. Some other tests for different parameters were developed but never were as successful as those used for HIV infection and the use of drugs. Insurance products with low sum make use of this fast and inexpensive test.

The medical questionnaire has also evolved, not only due to medical advances but also to new technologies and process cost.

The introduction of internet and rapid expansion of information technology have changed the process for gathering information about health status.

Problems such as the limited number of questions or cumbersome wording, which make it difficult for disclosing certain conditions, together with new distribution channels, have helped the development of expert systems for automated decision-making process and health questionnaires.

Expert systems contribute with diagnostic algorithms where a large amount of data is input, as in medical practice. Expert systems in risk assessments make easier the design of precise questionnaires, capable of gathering lots of additional information or even come up with a rating.

Last point to mention is the strong push diagnostic imaging is getting, especially in the area of cardiovascular. The ability to visualize the blood flow in the heart and precisely evaluate any stenosis makes us re-evaluate the use of other diagnostic techniques, such as stress testing.

It is also true that today the cost of this imaging technology is high but one cannot forget that other techniques were also expensive at their time and cost came down as use increased.

Market pressure to increase non-medical limits together with the continuous improvement of information technology are pushing to implement a risk selection process based more on the candidate's knowledge of his/her health and the use of specific tests based on the answer.

Reminder

Men and women live longer thanks to technical advances and scientific research. We must not forget that we want to live longer and better. To achieve this goal we must commit ourselves to improve health care. Luckily, we live in a time where living conditions are very nice despite the difficult economical times we face. Our duty is to cooperate with HealthCare policies that help us maintain a healthy lifestyle and prevent disease.

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A brief history of medical diagnosis and the birth of clinical laboratory.
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Tobacco use is a major cause of many of the world's top killer diseases including cardiovascular disease, chronic obstructive lung disease and lung cancer. It is responsible for the death of one in 10 adults worldwide

The Canterbury Earthquake Sequence of 2010-2011, New Zealand: a review of seismology, damage observations and consequences

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Christchurch aerial view in September 2011

"The lessons learned in Christchurch, in geotechnical, structural engineering and risk, are also being noted across the country"

Abstract

The M_w 7.1 Darfield earthquake rocked the Canterbury region of central South Island at 4.36 am on 4th September, 2010. No deaths and only two serious injuries resulted. It was the first large earthquake to impact upon a major New Zealand urban area since the 1931 Hawke's Bay event, which was the catalyst to the introduction of earthquake resistant construction in New Zealand. Over the intervening years, progressive upgrades of the seismic code have been implemented, but not tested under design levels of ground motion.

Following the Darfield earthquake hospitals continued to function, electricity was restored quickly, no buildings collapsed, and emergency response actions were prompt and effective. However the damage cost was at least USD 3 billion, much of it related to liquefaction and ground deformation which resulted in

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[2] 1 EUR = NZD 1.54;
1 USD = NZD 1.25
as at July 2012

Catholic cathedral at Madras Street after the 2011 Christchurch earthquake

near-collapse of several modern residences, and extensive damage to water and waste-water pipe networks. Unreinforced masonry buildings were also extensively damaged. The lack of deaths in this event can be attributed to the early morning timing of the earthquake, and good luck.

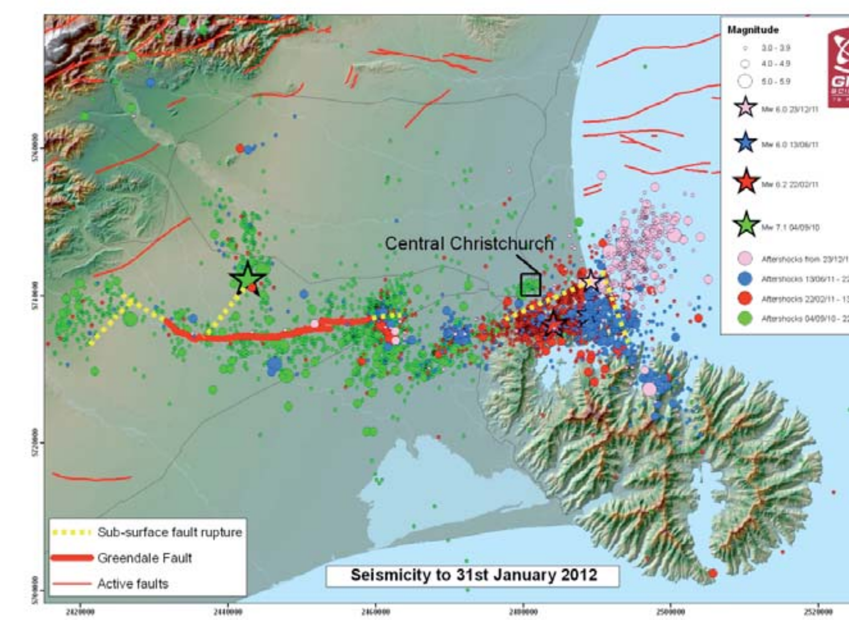
Almost six months later the devastating M_w 6.2 aftershock occurred close to Christchurch city, at the fringe of the expanding aftershock zone associated with the September main shock. The earthquake occurred at 12.51 pm when approximately 50,000 people were in the inner city area, well-known for its heritage buildings and abundance of unreinforced masonry buildings. There were many structural failures under the extreme ground motions that exceeded 100% of gravity in the inner parts of the city and hillside suburbs to the south of the city. The final death toll was 181 persons. Many perished in the collapse of two multi-storey buildings. In the residential suburbs strong earthquake shaking, but more importantly widespread destructive liquefaction caused severe damage. Buildings complying with modern earthquake resistant measures generally withstood ground motion at or above their design requirements. Estimates of the cost of this event are about USD 30 billion, and represent approximately 8% of New Zealand's annual GDP.

The earthquake sequence

September 2010 Darfield main shock

The M_w 7.1 Darfield earthquake occurred on 4th September 2010 at 04:35 NZST (3 September at 16:35 UTC) approximately 40 km west of Christchurch (a city of 375,000 population, the second-largest in New Zealand), on a previously unknown fault within the Canterbury Plains (Figure 1). This rare event, estimated to have a return period of more than several thousand years (Stirling et al., 2002) occurred

Figure 1: Earthquakes of the Canterbury sequence through to 31 January 2012. Major earthquakes are shown as stars, including the September 2010 Darfield main shock (green), the February (red), June (blue) and December (pink) 2011 Christchurch earthquakes. Yellow dashed lines represent subsurface rupture of subsidiary faults that ruptured in the Darfield earthquake (Holden, 2011), and the Christchurch earthquake of Feb 2011.



in a relatively low seismicity region of eastern South Island, New Zealand. There were no fatalities and just a few injuries. The shaking caused damage in Christchurch to older brick and masonry buildings, and to historical stone and timber buildings. The earthquake also caused liquefaction and lateral spreading along the lower reaches of rivers through Christchurch's eastern (near coastal) suburbs and the town of Kaiapoi, about 20 km north of the city. Water and sewer pipes were broken and many streets were flooded.

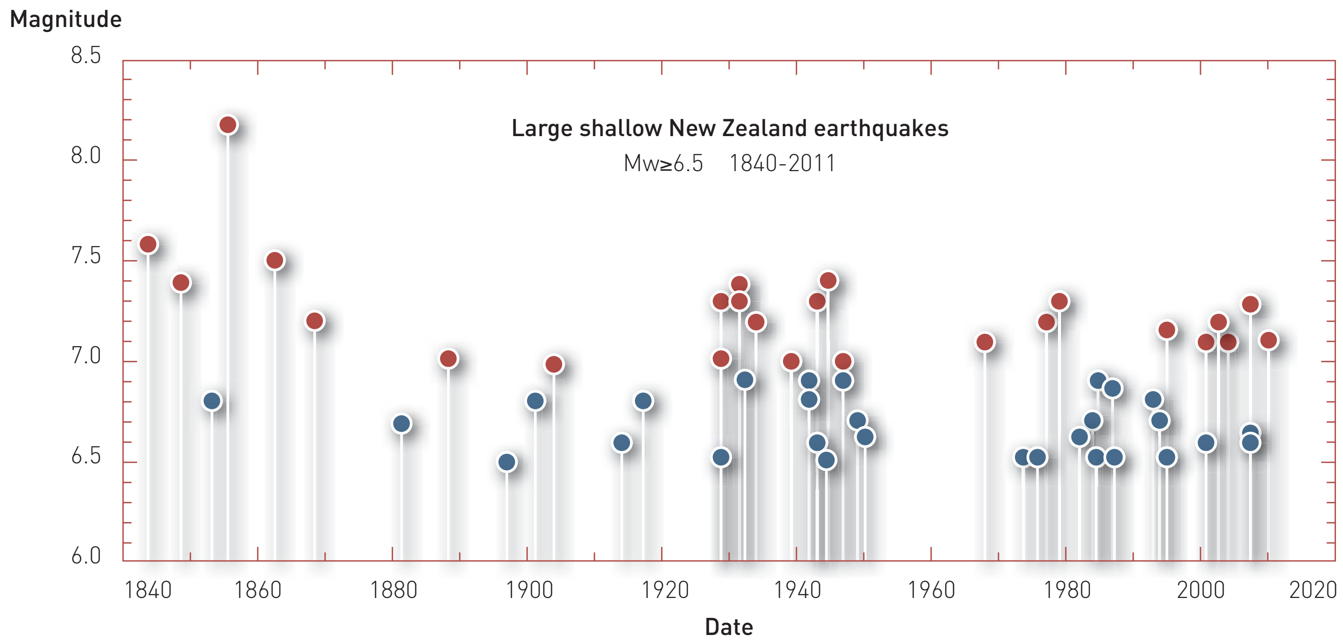
Since the Darfield earthquake, more than 7,000 aftershocks with magnitude (M_w) up to 6.2 have been recorded by the New Zealand national seismograph network (GeoNet; http://www.geonet.org.nz/). This sequence of earthquakes is termed the Canterbury earthquake sequence. In the months following the Darfield earthquake, aftershock activity was particularly concentrated at the eastern end of the Greendale Fault and extended eastward towards the city.

The February 2011 Christchurch earthquake

The most destructive earthquake of the Canterbury sequence occurred at 12.51 NZST on 22 February 2011, five and a half months after the Darfield main shock. This M_w 6.2 aftershock (termed the Christchurch earthquake) occurred toward the eastern end of the aftershock zone and with an epicentre just 6 km southeast of the Christchurch city centre (red star in Figure 1). Particularly high accelerations were recorded in the Christchurch earthquake, a factor which led to the severe building damage, widespread liquefaction and landslides. The February 22 earthquake led to an increase in aftershock activity, with several strong aftershocks of M_w>5.

The Christchurch earthquake was the most deadly in New Zealand since the 1931 Hawke's Bay (Napier) earthquake, with 181 people killed and several thousand injured. About two-thirds of the fatalities were

Figure 2: Large shallow New Zealand earthquakes. The distribution of earthquakes of magnitude 6.5 or greater from 1840 to the present showing a tendency toward clusters of large earthquake activity in the mid 1800's (earthquakes below magnitude 7 are probably under-recorded), and in the 1930's-1940's. The occurrence of M>7 earthquakes (points in red) has increased since about 1994, but it remains unclear whether this is the onset of a new cluster.



from the collapse of two multi-storey office buildings, one that was designed and built in the 1960's, the other in the 1980's. Many were killed in the streets by falling bricks and masonry, and in two buses crushed by collapsing buildings. Five people died in the hillside suburbs south of the city, killed by collapsing rock cliffs and falling boulders. The earthquake brought down many buildings previously damaged in the September 2010 earthquake. Many heritage buildings were heavily damaged. A number of modern buildings were also damaged beyond repair, including Christchurch's tallest building. Liquefaction was even more widespread than in the Darfield earthquake, occurring in a number of suburbs that had not been affected in September.

The June 2011 Christchurch earthquake

On 13 June 2011 at 14:20 NZST, an M_w 6.0 earthquake occurred near the suburb of Sumner (blue star in Figure 1). This earthquake resulted in one fatality and caused yet more damage in Christchurch, causing irreparable damage to many CBD (Christchurch Building District) buildings scheduled for repair. The earthquake once again produced high accelerations in the southern and eastern suburbs, causing more widespread liquefaction, and rockfalls from cliffs in hillside suburbs.

The December 2011 Christchurch earthquake

On 23 December, two days before Christmas Day, a M_w 5.8 earthquake struck east of Christchurch just off the coast at 1:58 pm. As with other earthquakes of this shaking intensity, liquefaction occurred in the eastern suburbs of Christchurch. This new sequence of earthquakes was further east again from the June 13 set of quakes. Being further from people, and coupled with the slightly lower magnitudes of the biggest shakes, the effects were less damaging to structures than on previous occasions. Because of the time of the year (just before Christmas holiday), the longevity of the whole Christchurch series (15 months since the beginning of the events), and the numerous aftershocks throughout that afternoon and overnight, several over magnitude 5, the December 2011 caused extreme anxiety and feelings of hopelessness in the population.

Earthquake forecasts

The level of seismic hazard in Canterbury is currently higher than the long-term average, and is likely to stay this way for several decades, as a combination of a rich aftershock sequence, and the possibility that an earthquake of a size comparable to the Darfield earthquake might be triggered within the region. This tendency for large earthquakes to be unevenly distributed in time, i.e., to group in time (these groups of earthquakes are denominated 'clusters') has been seen in New Zealand's historical large earthquakes. Figure 2 shows the time distribution of earthquakes of magnitude 6.5 and larger during historic times (from 1840) in New Zealand. Clusters of large earthquake occurred in the mid 1980's, 1930's and 1940's. The onset of a new cluster is probably occurring since 1994.

New Zealand seismic resistant design is provided by the New Zealand Loadings Standard (NZS 1170). That standard uses the normal background seismicity pre-2010 (Stirling et al., 2002). In order to provide the appropriate seismic design considered when reassessing the safety of existing structures and for the design of new buildings and infrastructure in and around Christchurch, the new increased levels of seismicity need to be incorporated into the code. For this purpose, a new seismic hazard model that includes time varying seismicity has been developed and new seismic design coefficients produced (Gerstenberger et al., 2011; Webb et al., 2011).

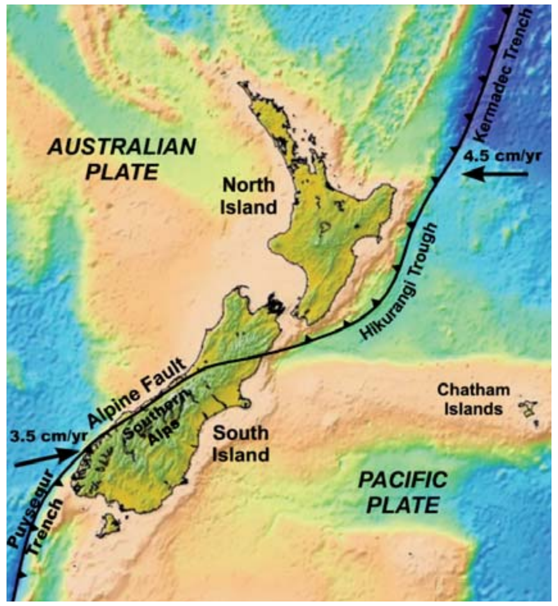
Tectonic setting

New Zealand straddles the boundary zone between the Australian and Pacific Plates, which are moving relative to each other at 35–45 mm/yr (Figure 3). In the North Island, the plates are converging, and the relatively thin ocean crust of the Pacific Plate subducts westward beneath the eastern North Island along the Hikurangi Trough. Subduction also occurs offshore and south of the South Island, except here the thin ocean crust of the Australian Plate subducts eastward beneath Fiordland along the offshore Puysegur Trench. In the central and northern South Island, however, both the Pacific and Australian plates have thick crust and subduction cannot occur. Tectonic deformation is achieved by strike slip along the boundary, with the west coast moving north-eastward relative to the rest of the South Island at a rate of ~30 mm/yr, largely on the Alpine fault (Berryman et al., 1992; Norris and Cooper, 2001). In addition to this, the Pacific and Australian plates collide head-on at ~5–10 mm/yr (Beavan et al., 2002), leading to the growth of the Southern Alps over the last few million years.

New Zealand straddles the boundary zone between the Australian and Pacific Plates, which are moving relative to each other at 35–45 mm/yr

The land to the east of the Alpine Fault is also broken up into a complex web of active geological faults - here the remaining 25% of the plate motion occurs through occasional

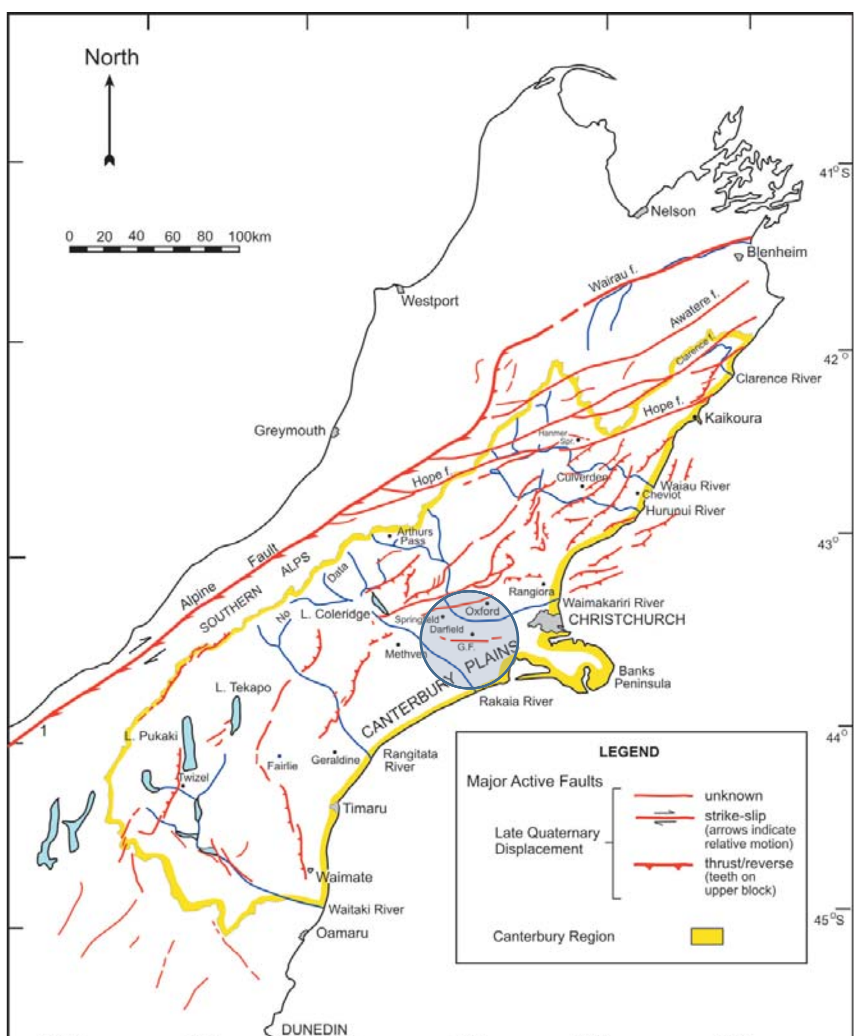
Figure 3: Plate tectonic setting of New Zealand. The westward pointing arrow in the upper, right corner shows movement of the Pacific Plate towards the Australian Plate in northern New Zealand, while the north-eastward pointing arrow in the lower left shows the movement of the Australian Plate relative to the Pacific Plate in southern New Zealand.



earthquakes on these faults (Cox and Sutherland, 2007; Pettinga et al., 2001, Wallace et al., 2007) (Figure 4).

GPS measurements suggest that fault lines beneath the Canterbury Plains region are accommodating ~5% of the overall Pacific/Australia plate motion, ~1-2 mm/yr on average (Wallace et al., 2007). Since September 2010, patterns of aftershocks, and subsurface geophysical studies, have revealed the existence of several previously unrecognized faults (Figure 1).

Figure 4: Map of the known active faults in the Canterbury region, including the recently formed Greendale fault (G.F.). Figure modified from Pettinga et al. (1998).



Strong ground motion and comparison New Zealand building code provisions

The New Zealand design standard NZS1170 sets guidelines for the levels of ground motion that are expected to occur at average intervals of 500 years, 1,000 years and 2,500 years for 'normal use', 'major use' and 'post-disaster use' structures, respectively. During the 2010-12 earthquake sequence, Christchurch city experienced different levels of strong ground motions and, in some occasions, they exceeded design levels as described next.

September 2010 Darfield main shock

The M_w 7.1 Darfield earthquake occurred on a fault that was previously unknown, the Greendale fault (Figure 1 and 5). The fault had not been mapped prior to 2010 and displacements along the fault during the 4th September Earthquake revealed a line rupturing the ground surface. The surface rupture extends for ~29.5 km, mainly across low-relief pastoral farmland (Figure 5). Displacement was predominantly horizontal (strike-slip) displacing farm fences, roads, power lines and railway trucks in a right-lateral sense. The average displacement was ~2.5 m (maximum of ~5 m) horizontal and ~1.5 m vertical (Quigley et al. 2010; 2011). Information from seismographs, GPS and processed satellite radar (InSAR) data showed the fault mapped was not the only fault rupture associated with the Mw 7.1 Darfield earthquake. The earthquake rupture was in fact a complex process involving rupture of several fault segments, including blind reverse (contractional), and strike-slip (Figure 1; Beavan et al., 2010, Holden et al. 2011).

The earthquake ground motions in the wider region during the Mw 7.1 Darfield event were very high. The ground accelerations reached 1.26 times the value of the Earth's acceleration (1g=9.8 m/seg^2) close to the fault, and up to 0.3g in central Christchurch, over 35 km from the epicentre. Horizontal ground accelerations were generally comparable to those predicted by the New Zealand models of seismic wave attenuation with distance (McVerry 2006; Figure 6), the principal model underpinning the National Building Code. The values observed were similar to the ones predicted by that model for waves with periods of 1.0 second which are important for building design codes, and for deep or very soft soils (attenuation is different for rock or soft soils). These accelerations were generally close to the ones design level in central Christchurch (0.3g), but exceeded the design level in the epicentral region. Maximum horizontal and vertical ground accelerations in the Christchurch city area were recorded in numerous seismographs and are shown on Figure 7. While accelerations are mainly small (all are <1g and most are < 0.3g), unusually high motions for short period waves were observed in a suburb to the south of the city (Figure 7A). Those higher accelerations could be due to amplification by local soft shallow soils and basin structure (the depth and changes in depth of the sedimentary basin can affect wave amplification).

The energy released (or stress drop) in the Darfield event was very high for a M_w 7.1 event (G. Choy, personal communication; Fry & Gerstenberger 2011). Similar high stress drop characteristics have been observed in all the larger events of the Canterbury sequence, and appears to correlate with regions of low seismicity were strain accumulates slowly and fault rupture has long recurrence intervals.

The February 2011 Christchurch earthquake

The M_w 6.2 February 22 Christchurch earthquake was by far the most destructive of the Canterbury sequence, with severe ground shaking occurring over much of the city (Figure 7C). The earthquake occurred on a northeast-southwest oriented fault and the epicentre was very shallow (7 km deep). Slip along the fault reached within ~1 km of the surface but did not break the surface. This fault was unknown prior to the earthquake, but aftershocks had occurred in the epicentral area in the months prior to the Christchurch earthquake. The rupture had oblique motion (a combination of right-lateral strike-slip and reverse). Because the fault did not rupture the ground, the amount

Figure 5: Example of farm fences displaced by surface rupture of the Greendale fault during the 4 September 2010 Earthquake. (Photo: Nicola Litchfield, GNS Science).

Figure 6: Observed ground accelerations (for waves of 1.0 second period) during the Darfield earthquake (green circles) compared to those predicted from the national attenuation model for deep or very soft soils (solid blue line; McVerry et al., 2006) at different distances (km) from the earthquake epicentre.

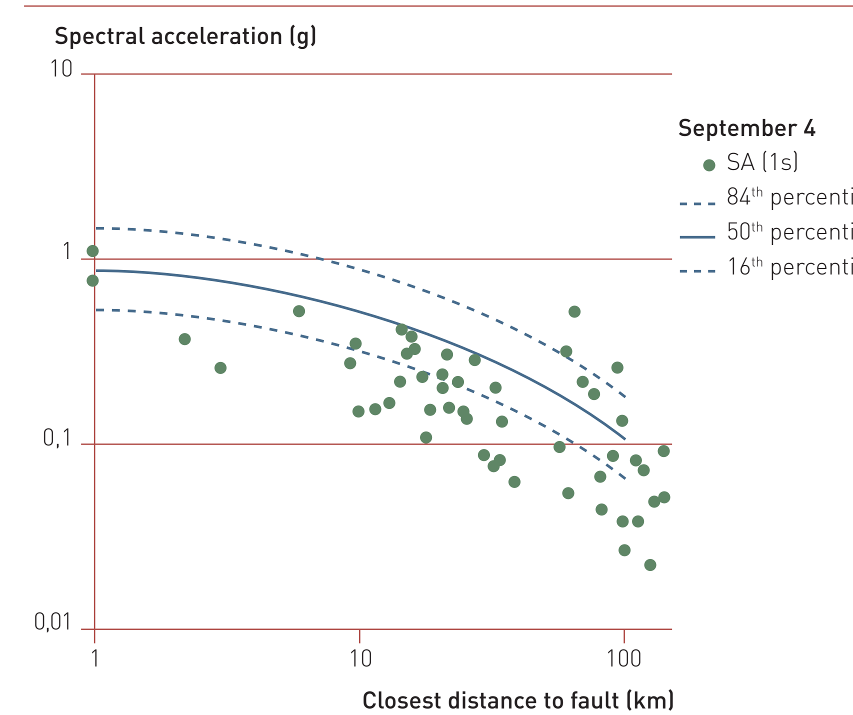
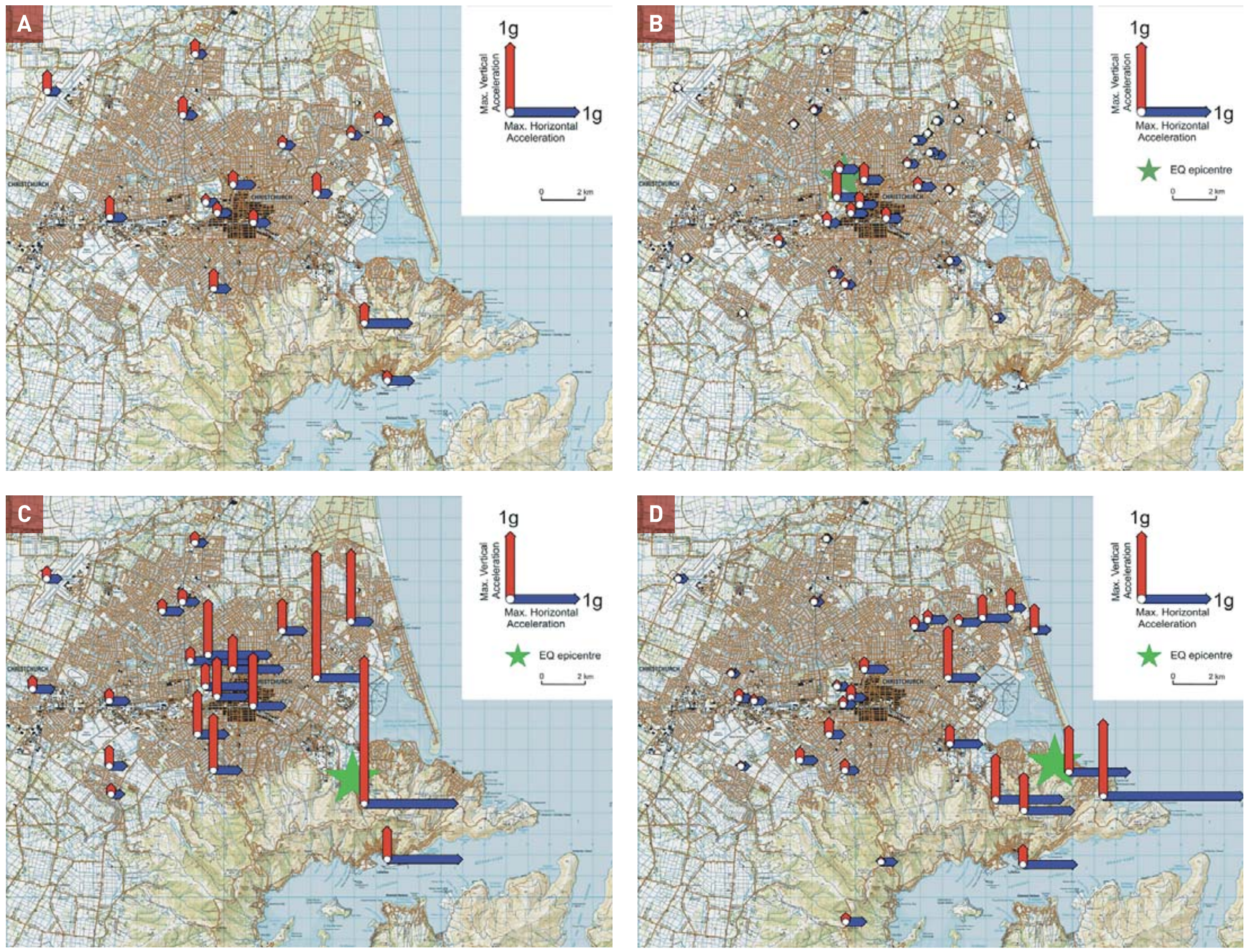


Figure 7: Maximum horizontal and vertical acceleration recorded during the 4th Sept. Darfield earthquake (A), 26th Dec. "Boxing Day Mw 4.7 earthquake" (B). 22nd Feb. Christchurch earthquake (C), and 13th June earthquake from GeoNet stations and temporary low-cost accelerometers (Quake-Catcher Network) (D).



of displacement could not be measured in the field, but based on geodetic and seismological data, the rupture produced maximum slip of 2.5–4.0 m at a depth of 4–5 km (Beavan et al. 2011; Holden 2011).

Ground motions in Christchurch city were extremely high during the February event, reaching 2.2 times the Earth's gravity (g) near the epicentre and up to 0.8 g in the CBD (Figure 7C). In areas close to the fault (less than 5 km away) horizontal accelerations were stronger in the Christchurch event than the Darfield main shock (Kaiser et al. 2011; Cousins & McVerry 2010).

The accelerations recorded during the 22nd February event were larger than those used in the New Zealand design standard for 'normal use' structures (average interval of 500 years), that is for building design (Webb et al., 2011). A number of factors are thought to have contributed to the high accelerations experienced in Christchurch city during the 22 February event (Fry et al. 2011a; Reyners 2011; Webb et al. 2011), including close proximity and shallow depth of epicentre, high stress drop (that is, a high energy event), and directivity of the fault rupture towards the city.

The June 2011 Christchurch earthquake

The epicentre of the M_w 6.0 earthquake on 13 June 2011 was located further to the east of the 22 February event (Figure 1). The June earthquake accompanied a rupture of a right-lateral strike-slip fault. As in the February 22 earthquake, ground accelerations in Christchurch were again very high, again associated with high stress drop, but not with the fault rupture directivity effects of February (Figure 7D).

Ground motion records for the 23rd December 2011 have not been analysed yet.

Ground deformation: uplift and subsidence, liquefaction, and slope failure

Uplift and Subsidence

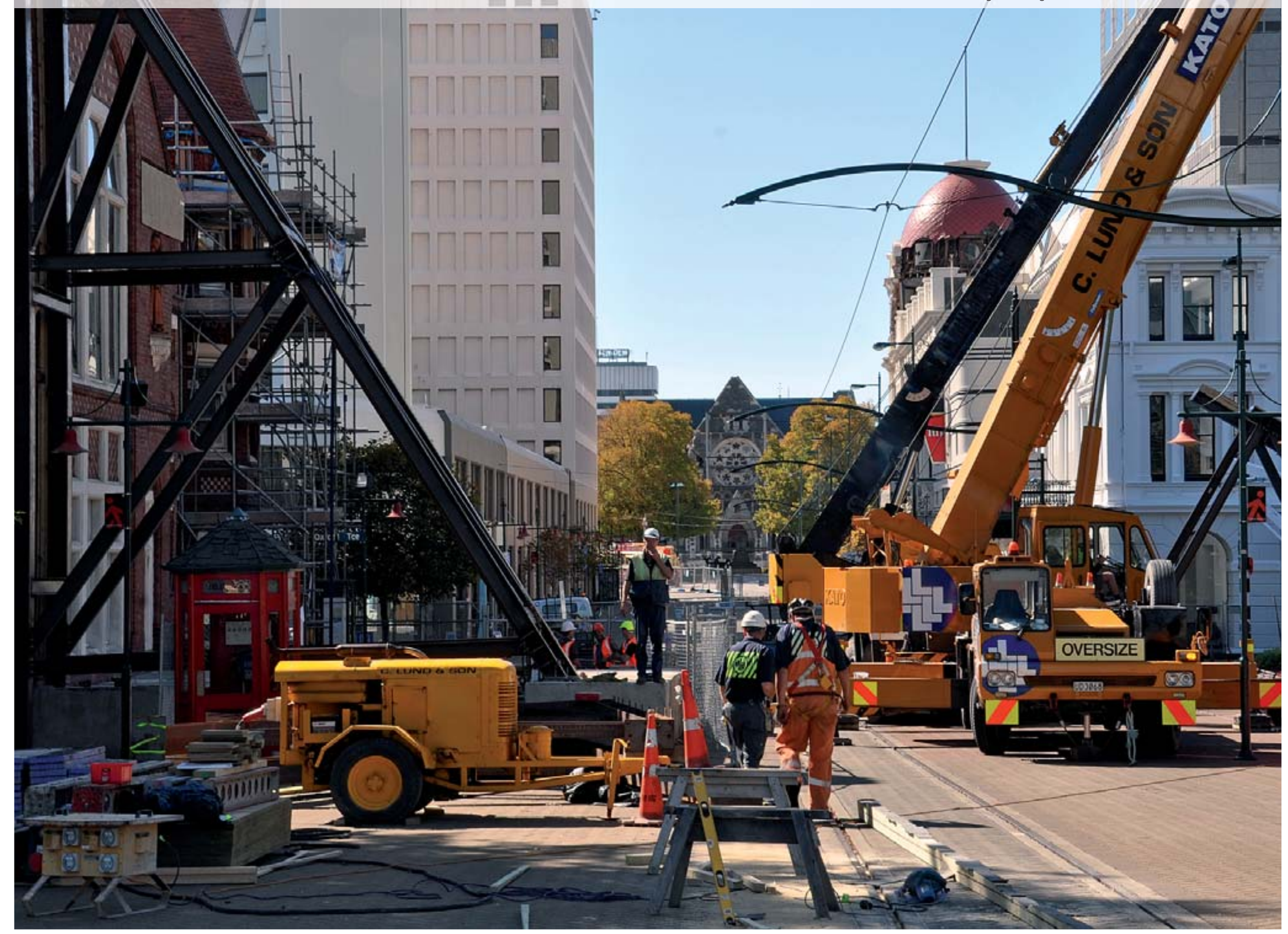
Land levels in the city area have been significantly changed as a result of the earthquake sequence. Two primary factors are responsible. There has been tectonic deformation from the blind reverse fault that ruptured in 22 February 2011 (shown as a dashed yellow line in Figure 1) resulting in uplift of up to 450 mm in the south of the city and southern hillside suburbs, and up to 150 mm of subsidence relative to sea level in coastal suburbs and along the lower reaches of the Avon River. Also lateral spreading and liquefaction (see more below) have resulted in up to 1 m of subsidence in some areas. Absolute changes in elevation with respect to see level have increased the flooding hazard in parts of the city.

Liquefaction

The February 22 earthquake was the most damaging event to Christchurch as a result of very high ground motions, and consequent extreme levels of liquefaction and lateral spreading (Cubrinovski and Taylor, 2011; Kaiser et al 2011). Christchurch is located on alluvial gravel deposits in the western suburbs, but from about the CBD to the coast the alluvial gravel units thin and many of the eastern suburbs are located on very recent (< 8000 years old), water-saturated, estuarine and fine-grained river sediments.

A range of liquefaction-induced phenomena were observed, including sand boils, lateral spread-induced settlement and rifting of structures of up to 3 m. Liquefaction occurred in a larger area (more than 50% of the city) than that predicted by pre-earthquake susceptibility maps, although the general indicators of susceptible areas were well known. The severity of the ground motions contributed to the extensive area of liquefaction, but also the threshold for damaging liquefaction occurrence was very low ground motions of only 0.1-0.15 g PGA in the most susceptible areas. Where lateral spreading occurred, the resulting damage to houses, underground

Figure 8: Liquefaction deposits in eastern Christchurch resulting from the 22nd February. Christchurch earthquake. Removal of this material has resulted in a significant land level lowering with respect to sea level and the water table.
(Photos: Tonkin & Taylor Ltd).



Workers stabilizing buildings at Worcester street, Christchurch

Liquefaction occurred in a larger area than that predicted by pre-earthquake susceptibility maps (more than 50% of the city), although the general indicators of susceptible areas were well known

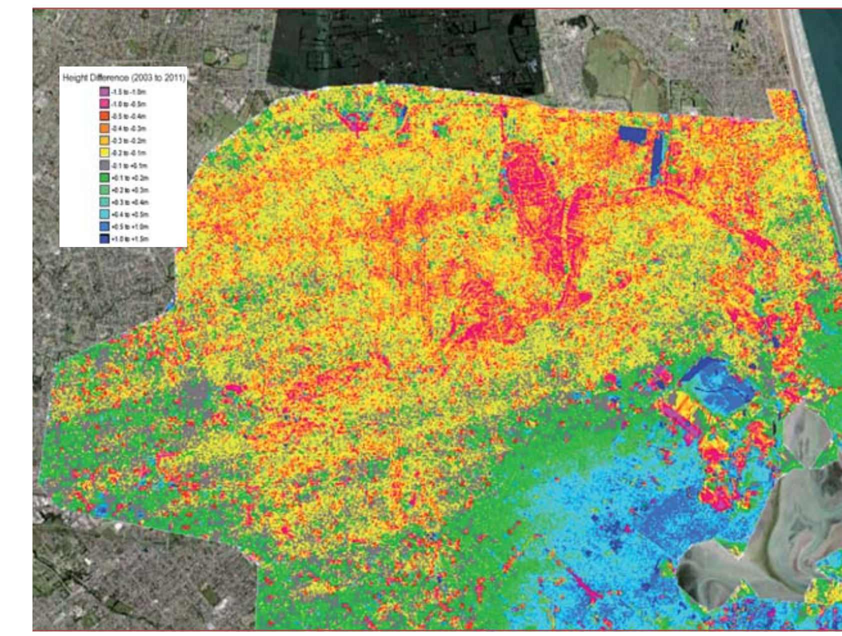
services, and to foundations of multi-story buildings in the CBD has often resulted in a total loss (Figure 10).

Slope Failure

There were five fatalities in the 22nd February Christchurch earthquake as a consequence of rock fall. These were on the hillside suburbs to the south of the Christchurch CBD where urban development has extended onto the northern sector of the eroded extinct Lyttleton basaltic volcano. The rocks forming the 400-500 m high ridge, slopes, and sea cliffs of the area are about 10-12 million years old (Forsyth et al., 2008) They result in a blocky rock mass of variable composition (including hard and soft rocks) that periodically releases individual or multiple blocks of rock that roll down the face and accumulate as a talus at the base of slopes (Hancox et al., 2011). Many natural slopes around Lyttelton Harbour stand at relatively steep angles, and form near-vertical coastal cliffs. The steep modern coastal cliffs are near-vertical (~75–85°) and 15-30 m high in many places, and have been locally quarried in many places. Homes now occupy both the old quarry floors and the cliff tops.

At least 100 boulders triggered by the 22nd February earthquake hit houses and there was extensive cliff collapse (Figure 11). As a consequence, about 450 residential properties in the hillside suburbs were issued with "red placards", meaning they were assessed as too dangerous to occupy. Further boulders crashed down the slopes and hit houses, and further cliff collapse occurred during the 13th June 2011. Currently a risk assessment is being undertaken to establish tolerable or intolerable life risk to the occupiers of the "red placard" houses measured against the probabilistic earthquake shaking model. Quantitative assessment will determine whether retreat in necessary, whether properties can be re-occupied after cost-effective slope remediation, or establish that it is already safe to re-occupy the properties.

Figure 9: LIDAR image showing cumulative land elevation differences resulting largely from tectonic deformation, lateral spreading, and removal of liquefaction deposits as a consequence of the Darfield (minor impact), and Chrischurch earthquakes (major impact). Note the uplift in the estuary area in the southeast quadrant and general subsidence with localised major differences in the northern half of the scene. The rectangular blue area showing uplift north of the estuary is a stockpile of liquefaction derived sediment removed from the eastern suburbs.
(Image courtesy NZ Aerial Mapping Ltd).



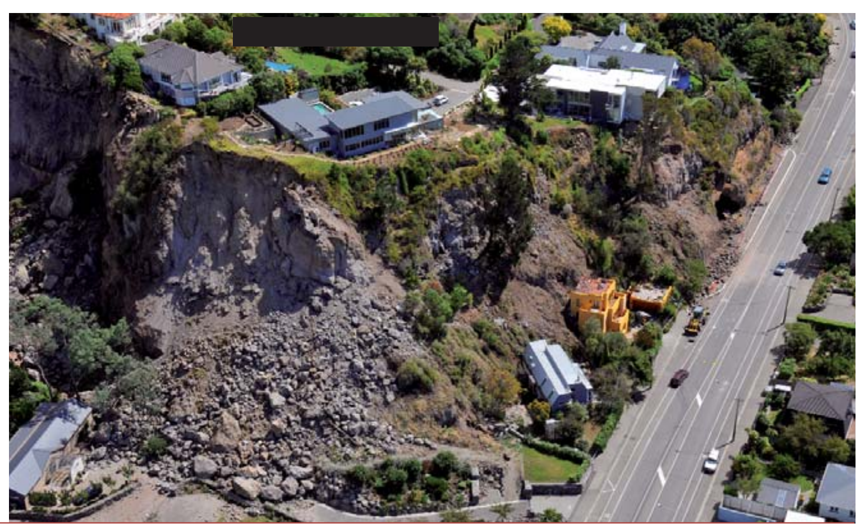
Damage to buildings and infrastructure

Residential Buildings

Most residential properties in the Christchurch region are one-story, an average of 150 m^2, and are built of light timber framing on concrete slab or pile foundations in accordance with NZStandard 3604 (first published in 1978). Common roofing materials include light metal, clay, or concrete, tiles. Timber weatherboard, plastered stucco or unreinforced brick veneer is used for exterior cladding. Average house values in Christchurch, including land, is approximately NZD 300,000[2].

Figure 10: Example of a total loss of a residence in the eastern suburbs due to lateral spreading (left).
(Photo: Tonkin & Taylor Ltd).

Figure 11: Example of boulder impact on house in the hillside suburbs (note the bounce mark in the foreground) (up), and cliff collapse threatening houses and occupants at both the top and base of the cliff (down).
(Images: D. Barrell & G. Hancox, GNS Science).



Approximately 30,000 houses have suffered a total loss in the earthquake sequence (3/4 in the February event) largely due to liquefaction-induced structural deformation. Shaking damage was more widespread in both events (c. 150,000 in September 2010, and 170,000 in February 2011) but the damage levels were generally lower, typically involving repair costs of NZD 5,000-60,000. This excessive level of damage due to liquefaction, coupled with the highly susceptible nature of foundation conditions in some suburbs, and the high likelihood of ground motions exceeding the trigger thresholds for further liquefaction in the design life for rebuilt properties in these suburbs, has led to the decision to retreat from some eastern Christchurch suburbs and other small areas. The total number of properties in this "red zone" number c. 6000, but the cost-benefit evaluation process of restoring the land to "good ground" condition and rebuilding in some further areas is not yet complete.

The earthquake shaking caused only limited structural damage to houses, but non-structural damage was widespread. Chimney failure, brick fence collapse, and plasterboard cracks were common in all of the earthquakes of the Canterbury earthquake sequence. Damage has continued to accumulate in successive events where ground motion has exceeded 0.2 PGA.

Commercial Buildings

Concrete and Reinforced Masonry

Two reinforced concrete office buildings, one designed and built in the early 1960's, the other in the mid-1980s, collapsed in the February, Christchurch earthquake resulting in more than two thirds of the 181 fatalities. At the same time, the majority of modern buildings performed well, even under the severe seismic loads corresponding to a c. 2500 year or longer return period motions. Variations in performance can be attributed to material type, year of construction, and differences in structural layouts, and variation in soil conditions and shaking (measured peak ground acceleration within the CBD varied from 0.36-0.72g) throughout the city.

Foundation types also varied in the CBD, ranging from shallow foundations to deep foundations with equal or unequal pile lengths and, in some cases, mixtures of shallow and deep foundations. Damage in concrete and reinforced masonry buildings was found in older as well as modern buildings, but was more prevalent in buildings constructed before the mid-1980s, when capacity design approaches were introduced in New Zealand.

URM buildings

Hundreds of unreinforced masonry (URM) buildings were heavily damaged or collapsed in the 22nd February earthquake, roughly two to three times the number similarly damaged in the 4th September earthquake. The number of deaths in URM buildings was probably reduced because a number of the buildings had been closed or cordoned off since September. Most URMs that had been renovated following seismic design (retrofitted URMs) before the 2010-12 events probably experienced ground motions well in excess of their design motions, and in some cases, higher-than-maximum-considered earthquake motions, and their performances varied widely: 70% were cordoned-off to prevent public entry, and only 9% were assessed as safe to enter. In many cases, prior damage in the September earthquake and the many subsequent aftershocks affected performance in February. Notwithstanding the failures, however, damage was generally significantly lower in retrofitted URMs than in nearby un-retrofitted URMs. Select heritage buildings that had been retrofitted to a high standard performed well.

Non-structural components

In the CBD, non-structural damage following the February earthquake was similar in many respects to the damage observed after the September earthquake. In office buildings and retail shops, there was typically damage to ceiling fixtures, overturned shelving, broken sprinkler pipes, and broke furniture and contents. An unexpected level of damage and indeed collapse of stairs in multi-story buildings was of particular concern. A significant lesson emerging from the Canterbury earthquake sequence is the importance of non-structural performance in commercial buildings. Socio-economic impacts have occurred because of the lack of functionality of commercial buildings even though the structure has performed well.

Infrastructure

There was extensive damage to lifelines, including potable water, wastewater, and drainage facilities, roads and highways, and electric power distribution in the Christchurch earthquake, much more so than in the larger, but more distant, Darfield earthquake.

Building bracing after the December 2010 Christchurch earthquake

The damage was caused predominantly by liquefaction. The impact on the electric power distribution network in February 2011 was approximately ten times that of the September 2010 earthquake in terms of service disruption and damage to facilities. The electric power administration buildings were badly damaged in February. All major underground cables supplying large areas of eastern Christchurch failed, and over 50% of all major underground cables were damaged at multiple locations by liquefaction-induced ground movement.

Bridges, roads and railways

Most bridges in the Christchurch area are short spans of regular configuration and sometimes monolithic or well-restrained,

Panoramic view of the Anglican cathedral ruins at Christchurch in March 2012

Socio-economic impacts have occurred because of the lack of functionality of commercial buildings even though the structure has performed well

and generally performed well during the earthquakes. Mostly, the only problems experienced were with settlement and lateral spread of the approaches, with consequent rotation of abutments. The road network, particularly in areas of liquefaction has been badly damaged, but is relatively easily repaired. The national network roads are largely outside the areas prone to liquefaction, so apart from discrete displacements of several metres across the surface trace of the Greendale fault, there was little disruption. The rail network was damaged in the 4th September Darfield earthquake by surface distortion where it crossed the north-eastern trace of the Greendale fault, and also where the approach to a rail bridge north of Christchurch suffered some lateral spread. Repairs in both locations took several days. No disruption has occurred in association with any of the other earthquakes of the sequence.

Socio-economic impacts and implications

The 4th September 2010 earthquake mostly impacted the rural area west of Christchurch and the liquefaction susceptible eastern suburbs, and relatively small areas of the CBD where URM building damage was most severe. In contrast the 22nd February 2011 earthquake, and to a lesser extent the 13th June 2011 event were very much city events with major impacts in the eastern suburbs (again), the CBD, and the hillside suburbs south of the city.

Within the CBD, an estimated 900 concrete and/or URM buildings sustained earthquake damage necessitating demolition, with this work needing to occur before reconstruction can begin. The majority of these buildings were relatively well insured by international standards, so flows of capital are likely to be available for rebuilding; however, this capital will not necessarily remain in Canterbury, with some reports indicating that some building owners may be looking to reinvest elsewhere in New Zealand. Further, there may not be sufficient business interruption insurance to cover what is expected to be an extended period before reconstruction can take place.

There were about 6,000 companies and/or institutions with over 50,000 employees in the CBD, or 25% of the total employment in the city. Of the 50,000 employees, 45% are in government, health care, or professions. These workers are likely to retain their employment, either in Christchurch or in another location. Other employees are in a variety of sectors including tourism, hospitality, retail, manufacturing, construction, wholesale, transport, communication, finance, insurance, and recreation. Many of these sectors have fared well, with Christchurch's role as a hub for Canterbury's regional, agriculture-based economy largely unaffected. While the tourism sector, in particular, may face rising unemployment, other sectors, such as construction, will be looking to significantly expand their workforces as the rebuild gets underway.

Unlike many post-disaster areas, disruption to economic activity from the earthquakes has not been significant at the aggregate level and official forecasts for the economic outlook in Canterbury are positive. Economic activity in Canterbury, according to the National Bank, rose by 1.9% in the June 2011 quarter, after a 2.5% contraction in the March 2011 quarter. Official forecasts in May 2011 showed New Zealand-wide economic growth rising to around 4 percent next year, with rebuilding activity adding around 2% growth next year. Overall, it is estimated that the rebuild will add around 8% to nationwide GDP over the next seven years.

There may not be sufficient business interruption insurance to cover what is expected to be an extended period before reconstruction can take place

The extended time period of the earthquake sequence has resulted in long term anxiety and concerns about safety, with the potential that widespread risk aversion may lead to unrealistic expectations of building performance in extreme events. Because of public perceptions of risk, code provisions that are limited to protecting life safety may be insufficient for future requirements in large cities, with the lessons learned in Christchurch, in geotechnical, structural engineering, and risk, also being noted across the country. Risk perception and the impact on international tourism, which accounts for 9% of New Zealand's GDP, is also a concern.

New Zealand is unique in the structure of its earthquake insurance scheme for residential property. The Earthquake Commission (EQC) is a New Zealand Government agency which provides natural disaster insurance to residential property owners. The EQC provides home owners with building, contents and land damage insurance. In the event of a natural disaster, the EQC pays the lower of the repair cost or the value of a damaged house (to a maximum of NZD 100,000 for the building and NZD 20,000 for its contents), and also repairs or pays out on land damage up to its pre-event value. The EQC sustains the first NZD 1.5 billion of losses for a major event, before NZD 2.5 billion of reinsurance cover attaches. This first loss, and any liability beyond the reinsurance cover, is funded through the Government's National Disaster Fund (also administered by the EQC). Before the Canterbury earthquakes this fund held approximately NZD 6.1 billion, but it is expected to become fully depleted as a result of the Canterbury events. If the EQC's reinsurance and the National Disaster Fund are insufficient to cover the full damage costs from an event, any residual is implicitly guaranteed and covered by the Government. This Government guarantee will likely be called on as a result of the Canterbury events.

Main shopping centre at Christchurch rebuilt using containers

Communication in the aftermath of the February earthquake was a high priority for public officials faced with reassuring the population that effective measures were in place to restore infrastructure and protect lives. Government actions have been crucial to provide certainty and to assist with the rebuild of Christchurch and the surrounding areas. In addition to the funds paid out by the EQC, the Government set up the Canterbury Earthquake Recovery Fund (CERF), with budget of NZD 5.5 billion. Together with recently revised estimates of the EQC's liability, total Crown earthquake spending is currently estimated at NZ$ 12.9 billion. In addition, the Government has set up a specialist agency, the Canterbury Earthquake Recovery Authority, to coordinate all aspects of the recovery.

Conclusions

The Canterbury earthquake sequence of 2010-2011 is widely regarded as the most serious natural hazard event in New Zealand in its European history of approximately 170 years, with impact costs of about 8% of annual GDP, approximately equal to the value of tourism to New Zealand on an annual basis. The impact, per capita, is 2-4 times the impact of Hurricane Katrina on the US economy.

Damage and socio-economic impacts in the region are largely as expected from what has been a very infrequent event, which is foreseen to impact Christchurch only once in several thousand years, on average. The on-going nature of the sequence has created a natural hazard event more akin to an extended volcanic eruption sequence than the usual earthquake pattern of mainshock (in which most of the damage is sustained) followed by an aftershock sequence. There remains a c. 10% likelihood of a further earthquake in this magnitude range in the coming year.

The extended period and continuing moderate likelihood of further earthquakes is impacting on the ability to purchase earthquake insurance cover for reconstruction because insurers and re-insurers have been taken large losses from this both infrequent and unusual sequence. The interaction between science, engineering, societal needs and expectations, business, insurance, re-insurance and government is complex where technical, social and financial obligations overlap in a rapidly evolving post-event recovery phase.

The level of seismic hazard in Canterbury is currently higher than the long-term average, and is likely to stay this way for several decades

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interview with **Jorge Martínez "Aspar"**

Aspar Team Manager

Héctor Barberá, 2011 Indianapolis Grand Prix

"Spanish motorcycling is an example to the world which we have to look after"

"Fortunately, within motorcycling there have been important changes in the area of safety, both on the street and in racing", says Jorge Martínez "Aspar". He is a legend in the world of two wheels, in which he continues to be involved as Manager of the Aspar Team, which he describes as "a close-knit big-image team in which the riders feel very much at home".

The world of motorcycling caught him very early on. When he was only seven years old, Jorge Martínez "Aspar"[1] was already dreaming of getting on a motorbike and would run away from home to "hit" two wheels with his older brother's gang. The opportunity soon arose and he did not miss it. In 1979 he ran his first race on a four-speed Derbi, which he still has, and finished second.

The dream had started to come true. Two years later, he won his first Spanish Championship title and, after signing a contract with Metrakit, made his first appearance on the World Championships podium. The arrival of the Derbi brand in his life, in 1984, finally launched his career, and from then on it became unstoppable, although there will always be a place in his memory for his first victory in the Dutch Grand Prix, in the 80cc class.

In 1985 he managed to win the Spanish Grand Prix held at the Jarama Circuit, and in 1986 his first World Championship title, retaining his crown in subsequent years. In 1988 he achieved the "double" by winning in both the 80cc and the 125cc classes.

His last season with Derbi, in 1989, was quite complicated because it was accompanied by various injuries and mechanical breakdowns. The following year, he embarked on the JJ-Cobas Project to compete in the 125cc and 250cc classes, first with a Rotas and then with a Honda engine, but things did not turn out quite as well as he hoped, although he did win some important titles. Then in 1992, still as a rider, he decided to set up his own team with an eye to the future. The Aspar Team had been born.

After a few difficult years and some brilliant but sporadic performances in the 250cc class, in 1994 Aspar continued his career riding a small-capacity Yamaha on which he won his final Grand Prix, in Argentina. After that, he began his stint with Aprilia and won the European Championship title. In 1997, he finally hung up his motorcycling kit, ending his career as a rider to concentrate on the team that he had created so as not to give up his dream: the world of two wheels.

[1] His nickname comes from the Catalan word *"espardanyer"* (pronounced "aspardanyer", meaning "espadrille maker"), the job his grandfather did in the town where he was born.

Today, how do you remember your first race in 1979?
I bring it to mind with a great deal of nostalgia. I was a child and was really excited about racing and, of course, winning. But at that time, I never imagined that I could end up being World Champion. The truth is that, back then, motorcycling was nothing like what it is today. The world of two wheels was frowned upon; many people thought it was just about a few madmen who raced motorbikes, but the great Spanish riders have shown quite the opposite: that a motorcycle rider has to be very sane not only for racing, but for racing, not falling off, servicing his bike, talking to technicians, engineers and the press. And the truth is that I will never forget that first race, any more than I will the other competitions throughout my sporting life.

What do you miss about your time as a rider?
Lots of things. It was all great fun. I was doing something I liked. I consider myself very lucky, because from 1979 to 1997, when I retired, I

A motorcycle rider has to be very sane, not only for racing, but for racing, not falling off, servicing his bike, talking to technicians, engineers and the press

What do you think about the first bend of the Cheste Circuit bearing your name? It is very nice, especially when you are no longer competing, because it means people remember you

was competing at the world level and achieved more sporting success than I ever thought possible. I remember very well all the things that happened during that time, the good as well as the bad, like the falls.

A fighting and winning spirit

When a rider is on the track, what does he think about?
When I was competing, all I thought about was racing, racing and racing; and of course about winning, winning and winning. I have always been a fighter and a winner, and when I got onto the track what I wanted to do was give 100% and achieve a victory.

Your career focused mainly on the 125cc class.
Times were different then. In the eighties, being able to compete in the 250cc class was a dream, and in the 500cc class something impossible. Fortunately, everything has changed and there are great Spanish riders who have reached the 500cc or MotoGP class, and we are leaders in any class; but in those years it was very complicated.

National Sports Award (1987); Gold Medal of the Royal Order of Sporting Merit (1993); Gold Medal for Sporting Merit of the Valencian Autonomous Government, 'Favourite Son' of the City of Alzira. How do you rate all these awards?
Many of them give you something extra, a special pleasure when you are the World, European or National Champion and you are recognised in your country, your city, your homeland. It gives you confidence and security. At the end of the day, there are lots of things that go to make the sportsman, but above all the person, and that fill you with pride.

"Without insurers, everything would be more complicated"

Racing at this level means facing big risks. Do riders receive training in the area of safety?
Fortunately, within motorcycling there have been great changes in the area of safety, in every sense, both on the street and in racing. It has to be said that the circuits where we compete each year are approved. Once a Grand Prix is over, a safety committee analyses the entire circuit, starting with the hard shoulders, the asphalt and the run-off area of a bend, amongst many other things. Improvements are requested and changes are followed up, and if they are not carried out no racing takes place. The level of safety is excellent in every respect: the track, helmets, riders' outfits, protection of the spine. Motorcycling has become very much more professional.

What does the insurance sector bring to the world of motorcycling?
It is an essential requirement to be insured as as a rider and as an individual. Without insurers, everything would be more complicated. Also, in the case of riders, if you have any problem you can go to the best doctor and get back to racing as soon as possible.

The number of motorcycle accidents has fallen by 40% in the last ten years. What still needs to be done?
There is still a great deal of work to be done. We must try whatever we can to improve road-safety education from the bottom up, with 12- to 14-year-old, in schools, with small road-safety circuits. So that everyone can learn and become aware of the importance of this subject from an early age. We are then unlikely to see riders racing on the streets, because they will know the risks. If we try to instill road safety right from childhood, I am sure things will be even better.

If we try to instill road safety right from childhood, I am sure that things will be even better

What do you think about the first bend of the Cheste Circuit bearing your name?
It is very nice, especially when you are no longer competing, because it means people remember you. In this case, the bend at Cheste is the first one of the circuit and a very fast one, but there are other bends named after me, in Albacete and Jerez, for example. And I also have streets named after me in various towns in Spain and I feel very pleased about that.

Aspar Team: a family

If you had to describe the Aspar Team to someone who never heard of it, how would you do it?
It is a special team, different, one big family. The Aspar Team came into being in 1992 when I was still competing, the idea being that when I hung up my motorcycle kit I would still be able to continue in this world, which is my world. There were a few difficult years, because it took a lot of effort for me to be a rider and the owner at the same time. But the truth is that we gradually found a way to create a close-knit big-image racing team in which the riders feel very much at home, and I am happy about the way we have grown.

What have been the greatest milestones for the team since its creation to the present time?
Since 2000-2001 we have not stopped growing as an outfit, at the rider level, the technical level and the results level. We have achieved 117 wins and 4 World Championship titles. The truth is that if we add up the team's awards, it is impressive.

Which season would you remember the most?
No particular one. Obviously the first title with Álvaro Bautista was very special, but every season is always different. Last year, for example, was a difficult one, with Julián Simón being

We look for riders with a strong mental outlook who like to win as much as I do or more, and who want to learn and share with the rest of the team

Héctor Barberá. 2011 Italy Grand Prix

Facts and figures

- **Name:** Jorge Martínez Salvadores "Aspar".
- **Place and date of birth:** Alzira (Valencia), 29 August 1962.
- **Four World Championship titles:** three in the 80cc class (in 1986, 1987 and 1988); and one in the 125cc class (1988).
- **One European Championship title:** in the 125cc class (1996).
- **Twelve National Championship titles:** two in the 50cc class (1981-1982); six in the 80cc class (1983-1984-1985-1986-1988-1989); three in the 125cc class (1988-1990-1994) and one in the 250cc class (1990).
- **37 Grand Prix wins and 24 podium appearances** (14 times runner-up and 10 times in third place).
- **42 pole positions and 30 fast laps.**
- **First Grand Prix:** Spain (Jarama), 1982.
- **First win:** Holland (Assen), 1984.
- **Last win:** Argentina, 1994.
- **Year retired:** 1997.
- **Motorbikes:** Bultaco (1982); Metrakit (1983); Derbi (1984, 1985, 1986, 1987, 1988, 1989); JJ-Cobas (1990); JJ-Cobas/ Honda (1991); Honda (1992); Honda (1993); Yamaha (1994 and 1995); Aprilia (1996 and 1997).

injured in Barcelona but then, we had the great pleasure of seeing a Valencian rider, Nico Terol, become World Champion again. You get these contrasts in the world of racing. We have three classes and everything is possible. Consequently, I do not remember any season in particular. Each of them has its special moments.

What characteristics govern your choice of riders?
We look for riders who are, on the one hand, winners and, on the other, good people who can adapt to our kind of team. We look for riders with a strong mental outlook who like to win as much as I do or more, and who want to learn and share with the rest of the team.

Sponsors and brands

What is the secret of having so many sponsors?
The secret is to work, give them what they are looking for, collaborate with them and find business synergies. There are lots of things but at the end of the day, the key is to have a good relationship and work together.

And how does the commitment to motorcycle brands come about?
Things have changed tremendously. A few years ago, in the world motorcycle racing championships, some factories dominated the classes and you had to negotiate or come to an agreement with them; but nowadays things are changing because, with the crisis situation, the brands are losing strength and the teams are gaining in importance, and this is helping us to get better conditions.

2011 has been a very important year for the team: the consolidation of a Valencian outfit in the top class; the debut of the first Spanish woman in the Moto2 World Championships; Nico Terol's win of the final title in the now extinct 125cc class. Which of these achievements do you remember the most?
I remember all three. Nico Terol's title is quite incredible, and even more so when you consider that he started with me as a boy when he was only ten; it is like a dream. But the case of Elena Rosell is also something very special. And, of course, I feel very happy being in all three classes. These are all very important achievements; I cannot choose among them.

What goals have been set for 2012?
The pre-season was quite good, but what is certain is that this does not always show what may happen. For example, in Moto3 there is a little uncertainty, and until we get from three to five races we will not know what the true situation is, but I am convinced that with both Héctor Faubel and Alberto Moncayo we can compete to be world champions.
In Moto2, with Toni Elías and Nico Terol, we can also be champions again. This is in fact the most difficult class, because the field is very even, but we are sure that we have great riders, a great motorcycle and every chance of winning.
And in MotoGP, we previously had one rider and now we have two: Randy de Puniet and Aleix Espargaró. We are starting a new project in the CRT class and I think we can be winners here too.

The world of motorcycling

Spanish motorcycling has been at the top, with champions and runners-up in all three classes. What remains to be done?
Carry on fighting to keep everything we have achieved. Spanish motorcycling is an example to the sporting world which we have to maintain.

What do you think about the changes to the FIM rules for 2012: cylinder capacities, training sessions, CRT?
Things are heading in the right direction, but one thing is very clear: in the current crisis situation that we are experiencing, the only solution is to change the rules in order to get costs down. For example, with the new CRT concept, the cost is much less and we also own the technology and the motorcycles. These changes are helping private outfits like ours to have potential for the future.

The percentage of women riders is increasing every year (there are now some 5 million). Why do you think that is?
The truth is that motorcycling would be inconceivable without women. There are more and more women competing: in the Spanish Championships and the World Championships; and the more there are, the better it is. I think it is great.

I think it is great that there are more and more women competing in the Spanish Championships and the World Championships

interview with **Anna Ferrer**

Ex-Director of the Directorate-General for Traffic's National Road Safety Observatory

"Insurance has been one of the main beneficiaries of the reduction in the number of accidents"

Anna Ferrer was born in Barcelona on 29 September 1957. She stayed there until 2004, when she moved to Madrid to work for the Directorate-General for Traffic.

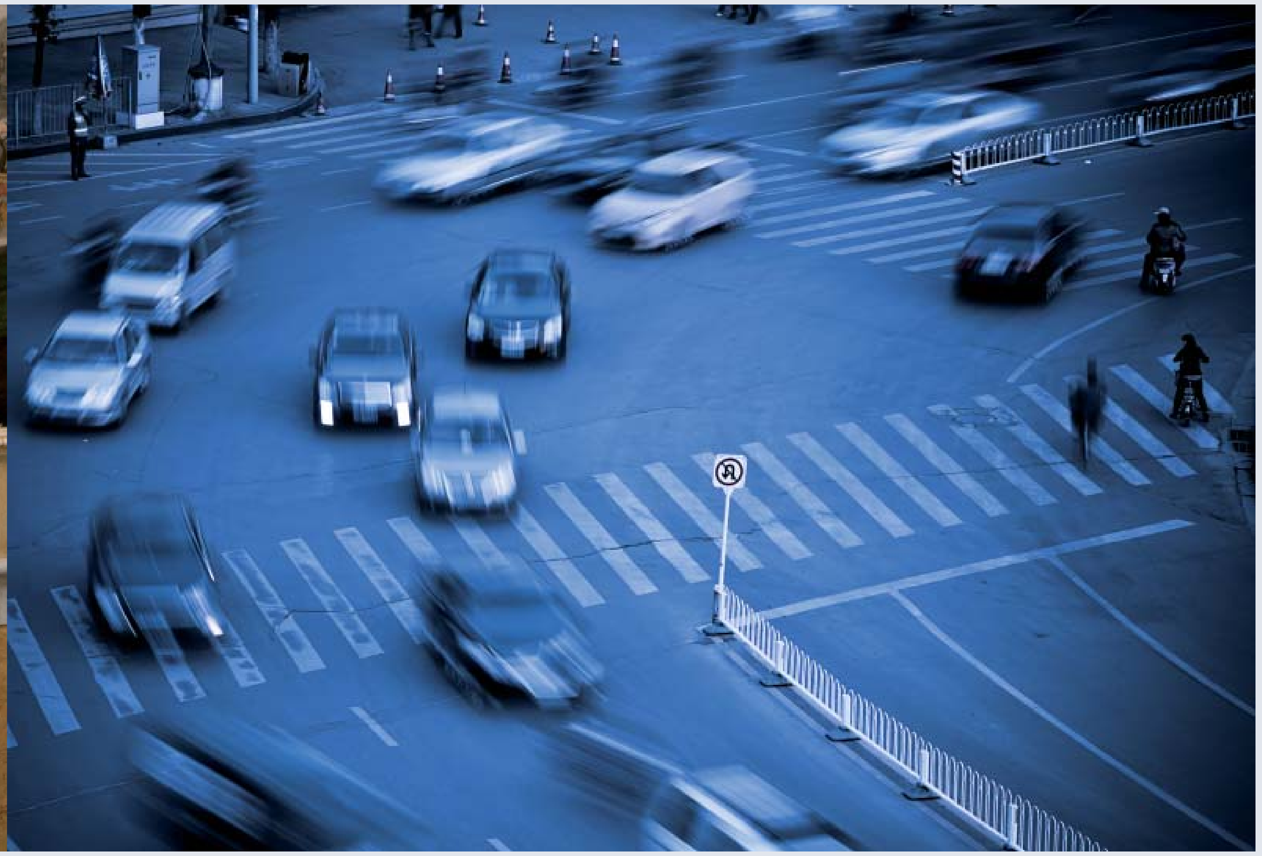
Trained as a pedagogue, she studied at *Universidad Autónoma* of Barcelona and got a degree from the University of Barcelona. From 1982 she was a civil servant at Barcelona City Council, where she began working on informal educational subjects in teams and services dedicated to childhood and youth. Later on, she dealt with subjects related to the training of social and sociocultural educators, within the field of staff training. There, at the end of the 1980s, she came into contact with new trends in the management of public policies. She coordinated training courses in public management at the ESADE Business School, where she herself also specialised in project management.

Interested in everything involved in policy design and information, she began to work with drivers at the start of the 1990s. In 1991 she joined Barcelona City Council's Public Highways section, documenting municipal street services activity: cleaning, traffic and maintenance. She managed information and data and made recommendations. She produced statistics and managed multisectoral projects like road safety, which tied in with the needs of a city like Barcelona when it was preparing for the 1992 Olympic Games.

In 2004 she joined the recently created National Road Safety Observatory, serving as its Director until 2012 when it ceased to exist.

During the eight-year life of the Directorate-General for Traffic's National Road Safety Observatory, Spain succeeded in significantly reducing the number of road accident fatalities - down from over 5,000 a year to over 2,000. A system designed to convince citizens, who are increasingly aware of the problem, that rules are there to be obeyed, together with a series of reforms with respect to penalties and surveillance, have produced these results, which cannot be satisfactory while there is a single fatality. A lot of small things still have to be done.

How did you get into the world of mobility?
When I started working in Barcelona City Council's Public Highways department at the start of the 1990s, I came into contact with the world of mobility through the information systems I managed. In Public Highways, I documented mobility policies and action plans through the information systems. All this brought me closer to road safety policy, which is necessarily cross-cutting and has to fit in with the information systems. That was how I met Pere Navarro, who joined the Barcelona City Council in 2000 to promote the Mobility Pact. His objective within the City Council was to design a mobility model for the city in which all sectors participated under a minimum of common agreements. When he was appointed Director-General for Traffic in 2004, one of his priorities was to promote information and participation. It was then that he called on me to join the National Road Safety Observatory.



One of the main problems we had in Spain in 2004 was that only 60% of drivers obeyed the rules

In 2003 we had 128 fatalities per million in road accidents. Today the figure is 59

This year the National Road Safety Observatory (*ONSV*[1]) ceased to exist as such, and with it went your job. How do you feel about that?
I have very positive memories of the work we did. We made a good team, with fantastic people who worked very hard, contributed all their knowledge and chose to go into areas they did not know. The truth is that I came for two years in 2004 and stayed eight, which was fortunate because, with a wonderful group of people, we were able to organise a work that combined planning and knowledge of key statistics. We continued building the team as needs arose. The more progress we made with road safety management, the more we knew, but at the same time, we were aware of what we still needed to know.

When the *ONSV* disappeared, where were the functions it performed moved to?
They were split between two areas. One for planning and the other for statistics.

What were the *ONSV's* objectives when it was created in 2004?
International institutions were saying that, in order for road safety policies to work, there had to be multisectoral objectives and action plans involving all private and public players. It was also vital for information to be released continuously. When I arrived, there was a Statistics Department and a Road Safety Council in which the conditions allowing all the players involved to be called together were met. A report was issued which was an aggregate of initiatives from each of the institutions or departments working on road safety, but we made a change to it, because strategy is not the sum of initiatives but must be structured on the basis of a number of objectives that have to be set out beforehand with regard to the problems one wishes to solve. This resulted in the action plan and the list of activities. In the end, the tools were the same but with a different focus. The aim was to reduce the number of fatalities.

Back then it was normal to talk about 5,000 deaths a year from road accidents. What was the starting point?
The statistical series built up over the last ten years gave this figure, which held steady, and when we compared it with statistics from other European countries it became clear that there was room for improvement. The other thing we needed to do was ascertain what the main problems were, because that was where we needed to focus our search for solutions. One of the main problems we had in Spain was that the rules were not being obeyed. For example, we knew that we had to wear seatbelts, but only 60% of users had them fastened. And then there were the motorcyclists who failed to wear crash helmets. We saw that helmet use and seatbelts were areas in which action was required, along with speed and alcohol.

1 Observatorio Nacional de Seguridad Vial.

Did the *ONSV* advise the Directorate-General for Traffic on this subject?
The *ONSV* documented problems and set out priorities. It helped to establish international benchmarking. It analysed how the problems had been solved in other countries, though then it was those in charge of the sub-departments of the Directorate-General for Traffic (DGT) who had to implement the solutions. With speed cameras, for example, the *ONSV* identified speed as a problem in Spain, but it was Traffic Management and Planning Regulations that drew up and implemented the Speed Camera Plan.

What phases did the *ONSV* go through following its establishment in 2004?
The *ONSV* had three different areas. The first was that of **sources of information**. The DGT received accident reports from the police, but had to improve on that information by incorporating data from health or forensic sources. The other important pillar comprised indicators - for example, what was happening in the street and on the road. We knew how many accident victims were not wearing seatbelts, but how many of all those on the roads were wearing them? At the European level, we knew how many people on the roads were not wearing seatbelts. What the *ONSV* did was analyse European standards of analysis in relation to the essential factors for reducing the number of accidents such as speed, seatbelts, helmets, alcohol and drugs, and apply them. We also compiled information related to the activity: what investment was being made in infrastructure or how many fines were being imposed, for example.
The second part was that relating to **planning**, which was based on data and always had an interest in both areas being together, because they provided continuous feedback.

The subject of motorcycles has been the one most discussed because of media coverage, with the involvement of manufacturers, users and insurers, amongst others

In order to know what to do, you have to know how something has happened. It is advisable to investigate how something has happened, which is why information needs to be received continuously.
The third key aspect is **involvement** of main players in order to identify which actions are adequate. Coordination between ministries or the support of civil society, because it is not a case of approving or proposing but rather of discussing the problems. The best-known subject, because of its media coverage, has been that of motorcycles, where each of those involved, be they manufacturers, users or insurers, were dealing with the problem of a growing number of accidents and had to seek a solution. This generated a valuable debate, with each party legitimately defending its interests and also blaming each other. But we continued with this valuable development until everyone ended up contributing imaginative solutions as a result of a coordinated effort.

So what bodies did the *ONSV* involve in the search for information and when it came to coordinating the solutions?
Practically, all the Ministries, Regional Governments and City Councils were invited. But I specifically wish to emphasise all the powers in relation to infrastructure. The Ministry of Development manages a small part of the road network, only 15%; the rest is the responsibility of other Administrations. For road safety, this dispersal is very complex in order to ensure improvements. Besides the Ministry of Development, the Ministry of Health took part because of its involvement with accident victims with regards to rescue, recovery and drivers' physical and psychological fitness. The Education authorities were also involved through everything related to teaching in schools. The Ministry of Labour took part because of its involvement with accidents at work and on the way to and from work. The Ministry of Transport was involved as far as driving professionals were concerned, as was the Ministry of Justice, which has a special prosecutor's office for road safety offences. It has been quite a development, and that is because road safety is achieved through process and project methodology and not only through content. We constructed a procedure for identifying the problem and creating a solution to it. Everyone spoke from their own perspective: the Civil Guard, the prosecutor's office, professionals, taxi drivers and lorry drivers. This was a quite considerable development representing a change in State administration.

Do you think that road safety is a priority of any Government?
It has to be, because it is a question of citizens' quality of life. Our children are driving now and are less afraid of doing so.

How have PR campaigns consolidated the change in mentality of all those involved?
There has been much more networking, carried out by those involved. What the Directorate-General for Traffic has succeeded in doing is raising private and public awareness of the fact that road safety is everyone's responsibility. Many companies are worried about reducing the number of their workers' driving accidents.
Let's just say that it is a whole set of small things, of actions, that are influential in shaping a new reality. When, a few years ago, there were conferences to explain how companies could reduce their accident rates, we were not able to give examples. It was the multinationals who explained what they were doing, because they had been told what to do by their parent companies. That has now changed.

Talking about results, when the EU stated that it was necessary to halve road traffic mortality in 2010, can you confirm that this goal was achieved?
Certainly, at least in Spain, and was even exceeded, but in other countries it was not. Perhaps because it started from lower positions and it was easier for us to reduce that ratio than it was for other European countries.

Why? Other countries are much more regulated and tend to have much stricter compliance with the standards. Maybe they are more educated.
Because we had more room for improvement. As far as the population was concerned, a Spaniard was twice as likely to die in a road accident as a Dutchman. The fact was the same, so we identified the differences and saw whether we could get closer to reaching the statistics for Holland. Paradoxically, in Spain we recorded 128 deaths per million inhabitants in 2003, whereas in Holland this parameter was 63. Spain currently has a value lower than Holland did then, having reached 59 fatalities per million inhabitants.

Has the policy of imposing penalties had any influence?
This policy exists everywhere. If a British citizen drives after consuming alcohol, he will be arrested by the police and will go to prison, just as he would in Sweden or France. Here, the case goes before a judge. And it is not only on the roads; many successes are being achieved in the cities through the raising of awareness. I remember talking to mayors or city councillors who would say: "How can I fine my neighbour's son?" But the change in society that has occurred now requires that mayors take measures. One of the things that the World Bank is promoting for developing countries when they want to tackle the subject of road safety is for them to look for an organisation that coordinates the entire strategy and look for someone who will lead and put a face to the job. In the cities it is the city council, the mayor and the city councillor.

What still has to be done?
The most important infrastructure in Spain has already been built. The quality of the cars on the road in Spain is improving despite the crisis. Driver behaviour has changed dramatically and the focus should now be on groups: companies, motorcyclists and pedestrians. One of the reasons for the good result of the measures adopted has been the loop created

The World Bank advises developing countries, once they decide to tackle the subject of road safety, to assign all the coordination of the strategy to a single organisation

Road Safety Lessons

On 11 May of this year, the *El País* newspaper published an article by Pere Navarro, Director-General for Traffic until February 2012, which under the title "Some road safety lessons" reflected on the importance of mobilising society and making it obey the law in order to achieve a significant reduction in the number of road accidents and the number of deaths they caused.

In the review that he offered since his arrival at the Directorate-General for Traffic in 2004, he warned of the poor level of awareness among the Spanish with regard to the number of deaths on the road: 5,400 in 2003. And in order to raise awareness of the fact that there was a problem, it was necessary to highlight this figure while producing a discourse on road safety and trying to ensure that everyone felt comfortable and citizens saw it as reasonable. "The discourse was prepared with victims' associations and essentially says that accidents are avoidable."

For the discourse to be more than just rhetoric, it was accompanied by measures which now seem normal to us: points system for driving licences; breathalyser checks; speed cameras; increase in police personnel; and amendment of the Penal Code. Navarro explained that every time a measure was announced there was debate, and this was good for road safety. "Contrary to what might appear, the aim of road safety policy was not to reduce the number of accidents but to change drivers' habits and behaviour, making them safer", he said.

The media were necessary allies in this task of changing behaviour. Civil society had understood this, and the reduction achieved in the number of road accident fatalities was a success for everyone. Pere Navarro's optimistic view was that, in the end, the secret of success appeared simple. It involved ensuring that the law was obeyed and persevering, but taking account of what was the right direction to take.

between information and action. When you find that almost a quarter of all fatalities are as a result of people being run over, you study the problem to see who has to act, how and when. Specifically, you look into whether there is a problem of speed on the road or in the streets, which cases are lethal and in what situation people survive. There is still a lot to be done, without any need for major investment.

What has been the role of motor insurers in all this process?

The debate on accidents has been one that has corroborated the development recorded. Insurance has been one of the main beneficiaries of the reduction in the number of accidents. Some insurers supported the proposal and have a role in consolidating positive driving behaviour. Some companies are doing this more than others by offering discounts to encourage positive driving behaviour, such as not getting speeding fines or not having had problems with alcohol. Or services giving notification of fines, or the black box for young people. The future will be characterised by initiatives of this kind. Accident rates will continue to fall provided we all act, because now there are no big problems to tackle. There are only small things that have to accompany this combination of initiatives.

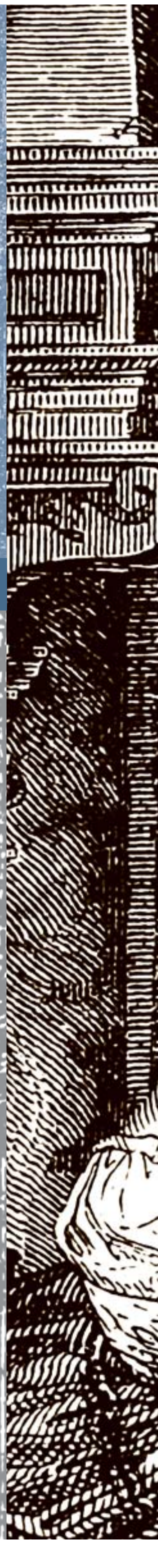
Does the Directorate-General for Traffic have appropriate means to implement these policies? For instance, is the number of active speed cameras on the roads sufficient?

Pressure and information have to be fine-tuned. Speaking of speed cameras, for example, in France the pressure has become excessive. You have to inform citizens and also try to convince them. It is true that the subject of speed is the most complicated, because the collective imagination has spent many years promoting speed as a positive value of individuality and freedom. The system has to remind people that rules must be obeyed, educating children and adults as they do in Sweden. It is a very good idea which should be passed on. But it is not only a question of citizens. Half of the deaths caused by road accidents in cities are the result of people being run over. And since it is difficult to change attitudes, the best thing is to get the rest of the system to protect pedestrians, for example by changing the design of cities to make them more for pedestrians and less for cars.

agenda

COURSES ORGANISED BY MAPFRE RE

Course	Method	Date	Venue
Risk and insurance on Machinery Breakdown	Attend in person	20th September 2012	Barcelona, Spain
Risk and insurance on Machinery Breakdown	Attend in person	27th September 2012	Madrid, Spain
Risk and insurance on Renewable Energy	Attend in person	14th-15^{h} November 2012	Istanbul, Turkey



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