HISTORICAL PERSPECTIVES ON PLANETARY DEFENSE
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BEGINNINGS: TUNGUSKA, IMPACT CRATERS, FIRST NEAS

1893: G.K. Gilbert suggests impact origin for lunar craters
1898: Discovery of Eros, first NEA
1908: Tunguska impact (5-10 Mt) in Russian Siberia
1932: Discovery of Apollo, first Earth-crossing NEA
1947: IAU Minor Planet Center established
1947: Sikhote-Alin iron meteorite strike in Russia
1949: R. Baldwin’s *The Face of the Moon* discusses impacts
1952: E. Opik estimates impact risk
1959: Pribram meteorite fall traced to asteroid belt
1961: E. Shoemaker impact origin of Meteor & Ries Craters
1964: R. Dietz Vredefort & Sudbury as impact structures
EARLY AWARENESS OF THE IMPACT HAZARD

1969: Icarus close encounter; first radar detection
1969: MIT study of deflection technology “Project Icarus”
1969: Allende and Murchison carbonaceous meteorite falls
1971: First IAU Colloquium Physical Studies of Minor Planets
1972: Daylight Fireball over U.S. and Canada
1977: Novel *Lucifer’s Hammer* depicts comet impact
1980: Identification of KT extinction with cosmic impact
1981: NASA workshop “Collision of Asteroids and Comets”
1981: Shoemaker: first modern estimate of impact hazard
1981: First Snowbird conference “Large Body Impacts”
1981: Chicxulub 180km suspected impact crater discovered
1983: First international ACM conference
1984: Spacewatch (Gehrels) first CCD discovery of NEAs
1989: Discovery of Toutatis, largest known hazardous asteroid
1989: First radar image of NEA (Castalia) using Arecibo
1990: AIAA recommends impact study to U.S. Congress
1991: House bill directs NASA to study impact risk and defense
1991: NASA International NEO Detection Workshops
CHICXULUB, SL-9, AND BIRTH OF SPACEGUARD

1991: Chicxulub impact crater linked with KT Extinction
1992: NEO Interception Workshop, Los Alamos NM
1992: Peekskill fireball, good orbit, meteorite struck car
1993: Tucson Workshop “Hazards Due to Comets & Asteroids”
1993: First Congress hearing on “Threat of Large NEAs”
1993: Erice Workshop on impact hazard
1994: Marshall Islands fireball & airburst, estimated 100 kT
1994: Collision of Comet S-L 9 with Jupiter
1994: IAU establishes Working Group on NEOs
1994: “Space Protection of Earth” Conference in Russia
1995: Report of Shoemaker NEO Survey study
1995: U.N. conference on NEOs, New York
NEW NEA SURVEY CAPABILITIES

1995: Start of JPL Near Earth Asteroid Tracking (NEAT)
1996: Council of Europe resolution on detection of asteroids and comets
1995: Foundation of Spaceguard Foundation in Italy
1996: Foundation of Japanese Spaceguard Association
1996: Foundation of Space Shield Foundation in Russia
1996: Foundation of Spaceguard UK
1997: Start Lincoln NEA Research (LINEAR)
1997: British TV documentary “The Day the Earth Got Hit”
1997: Comet Hale-Bopp visible to naked eye for 18 months
1998: Start of Lowell Observatory NEO Search (LONEOS)
1998: B. Marsden warns of possible impact by NEA 1997XF11
1998: Start of Catalina Sky Survey
SPACEGUARD SURVEY AND INTERNATIONAL INTEREST

1998: NASA announces start of Spaceguard Survey
1998: IAU: detection of NEOs is an “international responsibility”
1998: Spectacular Leonid meteor shower

1999: NASA NEO Program Office established at JPL
1999: Threat from NEOs is debated in UK Parliament
1999: Orbit analysis of 1999AN10 indicates resonant returns
1999: Fastest spinning NEA 1998KY26 (10 min) found
1999: NEO Dynamics (NEODyS) website established
1999: Torino Impact Hazard scale adopted by IAU & NASA

2000: Tagish Lake (Canada) primitive meteorite
2000: NEAR-Shoemaker spacecraft orbits NEA Eros
2000: Spaceguard Survey half done; 900 NEAs known
NEAR & HAYABUSA SPACECRAFT LAND ON NEAS

2001: NEAR spacecraft lands on Eros, operates for 10 days
2001: First double NEA 1999 KW4 found at Goldstone
2002: UN Action Team 14 formed
2002: Sentry automatic NEA monitoring system at JPL
2002: NEA 1950DA has collision probability of 1 in 300 in 2080
2002: NEA 2002MN reported as “near miss” at 120,000 km
2003: NASA workshop recommends survey down to 200m
2003: NASA NEO Science Definition Team reports
2004: Radar studies of Golevka demonstrate Yarkovksy Effect
2004: ESA recommends Don Quijote mission
2004: First biennial Planetary Defense Conference
2004: Apophis briefly at Torino 4 (2% impact probability)
2005: ICSU workshop on Impacts and Human Society
2005: Congress mandates NEA survey down to 140m
2005: Hayabusa reaches Itokawa & collects sample
RECENT EVENTS: APOPHIS TO CHELYABINSK

2005: NASA Deep Impact mission hits comet Tempel 1
2005: Gravity tractor concept proposed by E. Lu
2006: Apophis becomes focus of orbital dynamics
2007: Carancas meteorite impact in Peruvian Andes
2007: NASA Program Analysis proposes new surveys
2008: NEA 2008TC3 tracked for 19 hrs before hit in Sudan
2008: Almahata Sitta meteorites recovered from 2008TC3
2010: NASA EPOXI high-res images of Comet Hartley 2
2010: Pan-STARRS survey begins with USAF support
2010: NEOWISE space IR survey discovers 129 NEAs
2010: Hayabusa returns sample to Earth
2011: Data eliminate possibility of Apophis impact in 2036
2011: Spaceguard Survey reaches goal 90% of NEAs >1km
2013: NEA 2012DA14 passes Earth at 28,000 km altitude
2013: Chelyabinsk bolide explodes with 0.5Mt energy