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Occasional Paper No. 1

The Early History of "Non-Lethal" Weapons.

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December 2006

UNIVERSITY OF BRADFORD

MAKING KNOWLEDGE WORK

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1. Introduction

This paper explores the early history of "non-lethal"[1] weapons development covering the period from the 1960's, when several diverse weapons were first grouped together in one category and described as "non-lethal" by law enforcement end-users and policymakers, until 1989, just before the hugely increased interest in the field that developed during the 1990's amongst both police and military organisations. It describes the origins and emergence of new weapons, examining this process with reference to technological advances, wider socio-political context, legal developments, and evolution of associated institutional structures. Developments in both the policing and military spheres are considered as well as the interconnections between them. Necessarily this paper focuses on events in the US[2], in part because it led the way in this field but also because sources of information on US activities are more readily available.[3]

2. Early Outlooks: Developments in the 1960's and 1970's

2.1 Police and Military Developments

It was not until the 1960's that a group of varied weapons technologies began to be described collectively as "non-lethal" weapons.[4] Irritant chemical weapons were the most mature technology included in this category at that time, having been an integral part of military chemical weapons programmes since World War I and adopted by police forces around the world soon after for use in riot control. It is not surprising, therefore, that they were the primary "non-lethal" weapons used by police forces in the US during the 1960's and 1970's as alternatives or additions to batons and firearms for use in riots and other civil disturbances arising from the civil rights and anti-war movements, which had given rise to the consideration of new techniques and weapons for riot control. In the standard text on riot control for police of that era, *Riot Control – Materiel and Techniques* written by Rex Applegate and published in 1969, a large section of the book is devoted to uses of 'riot chemicals'.[5] The major advances at this time were military research and development of the more potent CS agent to replace CN as the main chemical irritant as well as associated development of new delivery systems. In the US, the law enforcement establishment, lacking any research budget of its own, took advantage of military investment. Writing in 1972 Coates observed that:

> Many of the easy gains that have been made in the development of non-lethal weapons have been based on the topical effects of tear agents. The basic agents and the innovations in their mode of delivery have come about, and found extensive use in the last few years, chiefly as a result of the large and expensive research and development programs of the military services: they are a civilian by-product of military research.[6]

In the law enforcement arena this military technology pull was combined with a policy push in the form of recommendations from two US Presidential Commissions in the late 1960's. In 1967 the report of the *President's Crime Commission on Law Enforcement and the Administration of Justice* recommended that the use of lethal force by the police be restricted.[7] The commission also recommended the wider application of the 'scientific and technological revolution' to the problems of law enforcement.[8] A second Presidential commission, which had been set-up to investigate the riots in Newark and Detroit in the summer of 1967 resulting from the gross racial inequality in the US at the time, delivered its advice in March 1968. The *Report of the National Advisory Commission on Civil Disorders* was more specific on the issue of weapons, recommending that local officials: "Develop guidelines governing the use of control equipment and provide alternatives to the use of lethal weapons. Federal support for research in this area is needed."[9]

In June 1968, as a result of recommendations from the 1967 President's Commission, the US Congress passed the *Omnibus Crime Control and Safe Streets Act*, which created the Law Enforcement Assistance Administration (LEAA) within the Department of Justice (DOJ) to provide grants to state and local police forces.[10] This soon had an impact on the deployment of irritant chemical weapons by police in the US, as Coates noted several years later:

> A major stimulus to the widespread use of tear gas was the Omnibus Crime Control and Safe Street [sic] Act of 1968, which made millions of dollars in federal money available to the states for general improvement of their criminal justice systems; … The first order of business for the police was to increase their immediate capabilities for dealing with violence. This meant the procurement of a wider range of lethal and non-lethal weapons.[11]

The 1968 Act also established the National Institute of Law Enforcement and Criminal Justice (NILECJ) within the LEAA to *inter alia* make grants for research and to develop new methods for law enforcement.[12] Encouraged by the legislation, proponents of "non-lethal" weapons were optimistic about the prospects for technological development. Writing in 1969, Applegate employed science fiction analogies, which have informed proponents' highest hopes for "non-lethal" weapons over the past 45 years or more,[13] to argue that:

> More Buck Rogers developments in nonlethal equipment and allied fields, relating to the control of mob and individual violence, are already on the drawing boards or yet to come.[14]

Furthermore he made the prediction that: "Far fetched as it may now seem, special riot and police units of the future may arrive on the scene of crime or civil disturbance by means of individual jet flying belts."[15] Less wide of the mark was his foreseeing of unmanned aerial vehicles:

> Unmanned, controlled, low-altitude, retrievable space platforms equipped with sound and area lighting systems, TV cameras, infra-red and other detection systems are already being suggested as possible aids to the riot commander in formulating and carrying out his mission.[16]

By 1971 Applegate's optimism was undiminished:

> …other programs of the development of riot-control weapons for the civil police probably will be funded by the Department of Justice under the Omnibus Crime Bill Authority.
>
> This means that no resource, idea, or known but unproved existing device will be neglected in the search for "softer" weapons. Many development items that have died in the recent past for lack of funding or governmental backing yet may be given a new lease of life.[17]

As one history of US police technology notes: "The early 1960s saw a technological explosion, with new devices created as a response to the era's protests and riots."[18] However, the nature of much innovation with regard to new "non-lethal" weapons, aside from military chemical weapons development, was defined by small-scale commercial undertakings with significant limitations, as Coates pointed out:

> Weapons research, conducted on very slim budgets, has largely taken the form of speculative enadeavors by commercial organization[s] serving an uncertain market. As a result, new materials are frequently introduced on a shockingly slim basis of evidence as to their effectiveness, reliability or safety.[19]

One such growth area was the development of kinetic energy impact projectiles. These new systems such as wooden, rubber, and 'bean-bag' projectiles particularly suffered from lack of testing prior to their introduction.[20] Another area of development was the emergence of electrical-shock weapons. From their origins as devices for controlling livestock (i.e. 'cattle prods' or 'stock prods') their design was advanced in the 1960's and 1970's as they were proposed as potential "non-lethal" weapons.[21]

In the 1960's and the 1970's the majority of literature on "non-lethal" weapons was focussed on new equipment for policing tasks with little reference to potential military application beyond policing-type situations such as riot control in which the military may be involved, although there had been discussions in both the military and peace research communities over the possibility of 'war without death'.[22] A significant exception was a paper by Coates, published in 1970 by the Institute for Defense Analyses in Washington, DC and entitled *Nonlethal and Nondestructive Combat in Cities Overseas*, which proposed a wider role for such weapons in "limited and low-intensity warfare." In a particularly prescient assessment of future conflict, and an argument that has become common in advocating the further development of "non-lethal" weapons,[23] Coates observed that:

> There will be both more intermingling of aggressors and civilians and a greater blurring of the distinction between the two in many anticipated types of conflict. This may be especially the case in urban combat.[24]

Having considered a whole range of potential mechanisms and techniques that could be incorporated in "non-lethal" weapons he concluded that:

> By far the post tactically versatile and useful antipersonnel mechanisms for urban combat are chemical. Other techniques relying on impact, light, sound, and heat, while affording some operational effectiveness and substantial decrements in deadliness, are generally more restricted in their application. They are less versatile and most particularly applicable to riot control.[25]

He noted that recent developments of "non-lethal" weapons had concentrated on irritant chemicals, in particular CS, but recommended that a research programme be undertaken to "…uncover, design, select, and evaluate nonlethal chemical agents with new or improved effects for urban combat…"[26] Amongst his other recommendations were that: "Systematic basic background studies are needed to define limits of safety for both existing and potential electrical and impact weapons."[27]

In addition to Coates's paper covering a variety of potential "non-lethal" weapons technologies there were a number of publications specifically addressing the utility of "non-lethal" chemicals for limited warfare and counterinsurgency operations, for example several military theses during the 1960's and 1970's focussed on this topic.[28]

In 1971 the US National Science Foundation (NSF) sponsored a study on "non-lethal" weapons under their broader programme to "identify areas in which scientific research can help solve social problems."[29] Central to the study was a two-day conference in Washington, DC co-sponsored by the NSF and the National Institute of Law Enforcement and Criminal Justice (NILECJ) of the Law Enforcement Assistance Administration (LEAA). The final report, entitled *Nonlethal Weapons for Law Enforcement: Research Needs and Priorities*, was prepared by the Security Planning Corporation and published in 1972. The 70 page report includes a discussion of the needs and requirements of law enforcement, an assessment of the current state of the various weapons technologies, examination of the problems associated with the commercial market for "non-lethal" weapons (particularly with regard to inadequate testing and evaluation), analysis of the objections or concerns expressed over these weapons, and finally, recommendations for research and development. In contrast to Applegate's earlier excitement about the promise of new technologies, the introduction to the Security Planning Corporation report reflected its' more scientific assessment of the state of "non-lethal" weapons development, arguing:

> There have been few advances in police weaponry in recent times. With the exception of chemical stream dispensers available to individual officers in some police departments, officers on the beat for the most part rely on the same weapons they did a century ago – their personal prowess, the nightstick, and the handgun.[30]

The report argued that most of the new weapons systems developed had not gained acceptance in large part due to over exaggerated claims on their effectiveness by the manufacturers and lack of sufficient testing and evaluation processes. However, as the framework for the study would suggest, the report was optimistic about the prospects for emerging technological solutions. This is evident in the discussion of concerns surrounding these types of weapons:

> In short, many of the objections to nonlethal weapons involve technical problems with specific weapons now in use or proposed. In theory, at least, most of these objections could be answered by improvement of the weapons. They should be the subject of research.[31]

Noting the already widespread use of irritant chemical weapons for controlling groups of people in riots or civil disturbances, the report emphasised that priority should be given to the development of "non-lethal" weapons for use by individual police officers in situations involving one or a few people.[32] As regards specific technologies the report echoed the conclusions of Coates's 1970 study on "non-lethal" weapons for the military:

> Chemical and electrical weapons offer the greatest promise in the short term and should be given highest priority in development efforts. Secondary priority should be focused on overcoming the problems related to risks of serious injuries from less-than-lethal kinetic energy impact weapons.[33]

The scarcity of data about the effectiveness and safety of existing weapons that could be used as a basis for future development informed a major recommendation of the report, which was for a government funding programme for: "Testing and evaluation of existing and newly developed nonlethal weapons."[34] The Law Enforcement Assistance Administration (LEAA) funded the US Army Human Engineering Laboratory to carry out this programme of work which they conducted over a period of several years in the early and mid-1970's.[35] As described in the 1977 Army technical report that brought together the results of these studies, the purpose was "…the development of a standardized methodology for the determination of less-lethal weapon effectiveness and safety characteristics."[36] The Army research effort covered the three categories of "non-lethal" weapons prevalent at the time: kinetic energy (or blunt trauma), chemical, and electrical. The model, designed to enable comparison of different weapons, was built around an assessment of the scenarios in which "non-lethal" weapons may be used and the desired outcome of their use together with their potential for causing adverse effects.

The 1972 Security Planning Corporation report and the US Army research, being the most comprehensive studies of "non-lethal" weapons available at the time, also received attention further afield. In the UK Deane-Drummond, an Army Officer, published a book in 1975 entitled *Riot Control* that drew the majority of its' information on "non-lethal" weapons from the US studies, acknowledging that the further development of these weapons was occurring primarily in the US.[37] Deane-Drummond, together with the Metropolitan Police commissioner had visited a number of regions during 1970 to gather information on riot control techniques.[38] The UK and the US also had an information sharing agreement covering "non-lethal" weapons research.[39] One area where the UK had carried out independent research and development work was in the design of new impact projectiles, namely the rubber bullet.

2.2 Irritant Chemical Weapons

When initial concepts of "non-lethal" weaponry were put forward in the 1960's the primary weapons technologies included in this group were the various irritant chemical agents or riot control agents (RCAs).[40] In general they are characterized by the intense sensory irritation and pain they cause to the eyes and respiratory tract and the temporary nature of these effects.[41] These agents, some of which are referred to as lachrymators for their tear producing irritant properties on the eyes, were first used by the French police in 1912 in Paris.[42] Irritant agents were also the first chemical weapons to be considered and then used during World War I before rapid escalation to more lethal agents.[43] A large variety of irritant agents including bromoacetone and adamsite (DM) were used by both sides during World War I.[44] Towards the end of World War I the US Army begun investigating chloroacetophenone (CN) as a new irritant agent and, as the landmark 1971 SIPRI study of chemical and biological warfare noted, this work was expanded in the post-war years with a renewed interest in the use of irritant chemical weapons for policing:

> In the 1920s the US Army Chemical Warfare Service (CWS) conducted more research on CN than on any other agent: in 1921 the CWS offered a CN device for experimental trial to the Philadelphia police, and built a manufacturing plant for the agent at Edgewood Arsenal the following year. [45]

A marketing effort orchestrated by the US Army's Chemical Warfare Service in the early 1920's to promote civilian use of irritant agents led to CN becoming a common US police weapon by the mid-1920's.[46]

With regard to military use, irritant agents were seen to have a specific function in chemical warfare doctrine as Volume II of the SIPRI study pointed out:

> …their function is not to cause casualties (although their use alongside other weapons may well increase overall casualties) but to lower enemy combat efficiency, thus extending their users' ability to manoeuvre.[47]

Subsequent to the US initiative militaries in other countries developed CN and by World War II it was the main irritant agent in the various countries' stockpiles,[48] although chemical weapons were not used during the War.[49]

Irritant chemical agents found widespread use amongst police around the world during the post-World War II period. Writing in 1971 the SIPRI authors note:

> For peacetime purposes irritant chemical agents were, and are, used by police forces to control riots and lesser civil disturbances, and to cope with situations such as those where an armed criminal barricades himself to resist capture. In some countries, for example the United States and South Africa, the agents are freely available commercially in "personal protectors" and similar devices;[50]

In 1928 two US chemists (Corson and Stoughton) had discovered a series of chemicals, including CS, with strong irritant effects on the respiratory tract.[51] In the mid-1950's CN had been found lacking by the British when using it during civil disorders in Cyprus and therefore they screened many compounds

to find a more effective irritant agent.[52] Following this search for a replacement they selected 2-chlorobenzalmalononitrile (CS, after the inventors), which had first been investigated as a new irritant chemical weapon during the 1930's and 1940's. [53] As Furmanski has noted, CS had a number of advantages over CN, in particular it was more potent:

> CS was more rapid in action, more severe in effect, and less toxic. While CN was a true "tear gas" affecting the eyes almost exclusively, CS was a general mucosal irritant, and affected the upper and lower airways as well as the eyes, and was capable of causing skin blistering and nausea in heavy exposures. While tight fitting goggles (or even tightly closing the eyes) could protect against CN effects, a full gas mask was necessary to protect against CS.[54]

CS was first used by the British in Cyprus in 1958-59 and irritant agents were used 124 times in the British colonies between 1960 and 1965.[55] After its' successful demonstration in Cyprus CS was soon standardized by the US Army.[56]

The Vietnam War saw massive use of CS by the US Army.[57] Promoted as a 'humane' weapon to limit civilian deaths and injuries for use only in riot control situations, it was soon being used in combat operations and with ever increasing regularity during 1968 and 1969.[58] The initial decision in 1965 to use CS on the battlefield prompted a period of rapid research and development, as described by a US Army historian in 1970:

> When the decision was made, half way through the decade, to employ CS weaponry in Vietnam, neither standardised munitions nor developed concepts for such employment existed. Yet in succeeding months and years weapons were designed, produced, and shipped, concepts were evolved, and effective employment was attained… [I]t represented the first effort by an American force in half a century to develop and utilize a group of chemical weapons in actual combat.[59]

The extensive nature of CS integration into US military operations is illustrated in the 1971 SIPRI study:

> Almost every type of weapons delivery system in Viet-Nam had a CS capability, so that CS could swiftly be spread over almost any size of target area, at any range and, if necessary, in close coordination with other forms of firepower.[60]

As Meselson and Robinson have pointed out more recently:

> …25 different types of weapon disseminating the irritant agent CS, including heavy munitions ranging up to 155-mm artillery shell and 750-pound aircraft bombs, were used in Viet Nam. Ultimately more than 15 million pounds of CS were dispensed in these munitions.[61]

CS was used without restriction[62] and in a manner entirely incompatible with any concept of reduced or "non-lethal" application of force. A post-war US Army report on CS use in Vietnam found no evidence of its use to prevent enemy or civilian casualties, quite the opposite:

> ...the reduction in casualties has not been in enemy or noncombatant personnel but, rather, friendly troops, as a result of using CS to make other fires more effective.[63]

Irritant agents were also being used by police forces worldwide[64] but in the mid 1960's CN remained the standard agent.[65] This began to change, however, following the US Army's experience in Vietnam as police forces gradually switched to CS in the late 1960's, taking advantage of recent military research and development.[66]

In the US, following the July 1967 riots in Newark and Detroit, the use of irritant chemical weapons in riot control gained increasing support.[67] The *Report of the National Advisory Commission on Civil Disorders* in March 1968 commented that the Army's experience with the "more effective and safer" agent CS (as opposed to CN) meant that there should no longer be concern about using "massive amounts of gas in densely populated areas."[68] Amongst the reports' specific recommendations, which overlooked the military use of CS in concert with conventional weapons, was the following:

> The commission recommends that in suppressing disorder, the police, whenever possible, follow the example of the U.S. Army in requiring the use of chemical agents before the use of deadly weapons.[69]

During student protests in Berkeley, California in May 1969 the National Guard sprayed CS from helicopters onto demonstrators.[70] CS was also used by the National Guard during anti-war demonstrations at Kent State University prior to their firing of live ammunition into the crowd, killing four students.[71]

Although the British had long used CS abroad it was first used on UK territory in 1969, during riots in Londonderry, Northern Ireland. Following this incident there was a public outcry and an enquiry, chaired by Harold Himsworth, was commissioned to investigate the health effects of CS.[72] The 'Himsworth Report', published in 1971, recommended that irritant agents should be subject to the level of testing required for pharmaceutical drugs.[73] CS was not used in mainland UK until the 1981 riots in Toxeth, Liverpool.[74]

A newer riot control agent, CR (dibenz(b,f)-1:4-oxazepine), which was synthesised by British scientists in 1962, was found to be more potent but less toxic than CS.[75] It was manufactured by the UK Ministry of Defence at a plant in Cornwall between 1968 and 1977.[76] Authorised by the Ministry of Defence for use in Northern Ireland from 1973[77] and approved by the US Army as a riot control agent in 1974,[78] it since found limited application in comparison with other agents in part due to the relative lack of studies of its toxic effects in comparison with other agents.[79] As Volume I of the SIPRI study of chemical and biological weapons notes, capsaicin, an extract from the capsicum plant that is a derivative of vanillylamide, was also proposed for use as an irritant chemical weapon as early as World War I and in the 1950's vanillylamides were considered alongside CS as a replacement for CN by the British.[80] By 1971 the SIPRI authors noted that a similar extract, oleoresin capsicum (OC), was already being used as an irritant agent in several commercially available self-defence spray devices in the US.[81]

A wide variety of devices were available to the military for dispersing CS and CN including various grenades, shells, bombs, and bulk dispensers.[82] A US Army technical report from 1977 described three main methods for

disseminating irritant chemicals: burning a solid agent to produce a smoke, micropulversing the agent for release as a fine powder or dust, and suspension in liquid that is then sprayed, projected or vaporised.[83] Two types of powdered CS were developed: CS1 and CS2. CS1 was a micronized powder mixed with silica to aid dispersion. CS2 was CS1 with added water repellent agent that meant it remained active for up to 45 days.[84]

In the policing arena the development of hand-held liquid irritant projectors that fired a stream of irritant agent in solution (as opposed to dry agent) was one of the most significant innovations in the field of "non-lethal" weaponry. Introduced in the US in 1965 under the name 'Chemical Mace', these new systems were soon being used widely and described by some experts as the most important development in police weaponry since the advent of the handgun.[85] The projectors generally employed CN as it was easier to deliver in solution[86] but a CS version was also developed at the suggestion of the US Army.[87] Hand-held projectors for the police and self-defence purposes had existed prior to the idea of putting the irritant agent in solution but they relied on explosive dissemination of powdered agent producing a cloud of agent that could not be directed at any one person.[88]

2.3 Kinetic Energy Impact Projectiles

In the 1960's the existing "non-lethal" weaponry, namely irritant chemical weapons, batons (or truncheons) and the water cannon[89], was supplemented by the development of various impact projectiles as alternatives to bullets. Earlier examples were cylindrical inch-long wooden bullets made of teak that were fired at demonstrators in Hong Kong as early as 1958. These projectiles were 'skip fired' off the ground with the aim of striking people in the legs since direct fire was liable to cause broken bones or death. Despite this technique they could cause serious injury especially given the unpredictable ricochet off the ground putting anyone in the vicinity at risk.[90] Termed 'baton rounds' because they were deemed a substitute for wooden batons at longer ranges,[91] their limitations apparently precluded them from being considered by the British for use in Northern Ireland. Instead a much larger projectile, the L2A2, made of hard rubber (15cm long, 3.5cm in diameter and weighing 140g[92]) was developed by the UK in a nine month research effort and first introduced in Northern Ireland in July 1970. The rubber bullet was specifically developed by the Ministry of Defence for the British Army in Northern Ireland and the request of Army officers who wanted a weapon for use in civil disturbances with a range beyond stone-throwing distance.[93] Highly inaccurate, it caused numerous severe injuries and several deaths, which were compounded by misuse in the form of direct firing and firing at very short range (since it was designed to be 'skip fired' at ranges of >30m) and unpredictable ricochets. [94] From its initial deployment until the end of 1974 over 55,000 rubber bullets were fired in Northern Ireland. A shorter, lighter, more accurate projectile with a PVC outer layer, the plastic bullet (LR L3A1), was developed in 1972 and first used in 1973. Initially presented as a complement to the rubber bullet for use at longer ranges, in the mid-1970's it replaced the rubber bullet and, unlike its predecessor, it was designed to be

fired directly at a person. It proved even more dangerous than its predecessor at short range.[95]

In the US other projectiles to emerge in the late 1960's and early 1970's included the 37-mm wooden block projectiles, used against protestors in Berkley California in 1969, 'bean bag' projectiles that consisted of a canvas pouch filled with lead shot, and 12 gauge shotgun cartridges filled with plastic pellets.[96] Golf ball-like projectiles and rubber projectiles filled with liquid were also developed.[97] The US Army developed a new projectile called the Ring Airfoil Grenade (RAG). Initial research in the early 1970's focussed on developing a "lethal" fragmentation grenade with a flat trajectory and longer range than existing systems for use in Vietnam. However, the research focus shifted due to technical difficulties and increasing interest in "non-lethal" weapons. Two ring shaped rubber projectiles were developed, the XM742 Soft Ring Airfoil Grenade, which contained a CS payload release on impact, and the XM743 Sting Ring Airfoil Grenade, made of solid rubber. The Soft RAG and Sting RAG, launched from an adapter on an M16 rifle, were 'type classified' by the Army in 1978. Over 500,000 Sting RAG's were produced but they were never used by the Army up until they were declared obsolete in 1995. The Soft RAG never entered production.[98]

Concerns were expressed on both sides of the Atlantic over the apparent lack of testing of all these new projectiles before their introduction in the 1960's and 1970's and the dearth of data on their effects on the human body.[99] These seemed to be well-founded given the observations of US Army researchers at the outset of their study on police "non-lethal" weaponry, which began in the early 1970's, that "very little quantitative data on blunt trauma to the body were available."[100] The US Army study encompassed tests on various projectiles including a 'bean-bag' type projectile called the Stun-bag, which they found highly likely to cause "unsatisfactory" levels of injury at all ranges considered. Research on the UK's rubber bullet reached similar conclusions.[101] A 1978 SIPRI study noted the enduring problem with designing projectiles intended to be "non-lethal":

> Obviously, the basic laws of physics apply as much to non-penetrating as to penetrating kinetic energy projectiles: additional energy applied to propel the missile further results in unnecessarily severe injuries at close range.[102]

2.4 Electrical Weapons

Electrical-shock weapons have their roots not in policing or riot control but in farming and torture. In Argentina the barbed cattle prod was replaced with an electrical version, the picana electrica, in the 1930's. As Rejali observes, "the picana electrica combines portability, flexibility and low amperage. It is also cheap. In this sense, it qualifies as the first electric stun technology…"[103] It was soon adopted by the Argentinean police as a torture device for use during interrogation:

> In 1932, it entered into police work in Buenos Aires and little has changed in its usage since that time. Victims are strapped to a wooden table and wetted down to aid the current. The prod operator applies the wand to sensitive parts of the body (head,

> temples, mouth, genitalia, breasts) while the machine operator works the bobbin, raising and reducing voltage. The victim often bites on rubber or lead to make sure that the tongue is not bit off during the shocks.[104]

Rejali argues that the requirements of the torturer in terms of electrical weaponry are similar to those of the police officer using them as "non-lethal" weapons. The device must deliver the "maximal amount of shock and pain" to stun the victim without killing and, in addition, the weapon should be portable. His examination of the US patent record illustrates the close connection between the development of electrical weapons for use against animals, which had been patented from the early 1900's onwards, and those for use against humans:

> …a new kind of cattleprod was used as the basis for a new kind of stun gun, a new kind of stun gun handle was then reused for a better stockprod. The same patent string included prods, grips, canes, flashlights, forks, guns and batons.[105]

He argues that the calls in the US during the 1960's and 1970's for the development of "non-lethal" weapons simply led to a re-branding of existing electrical weaponry with the same devices patented as cattle prods now characterised as "non-lethal" weapons. As in Argentina, the police in the US had already adopted the electric cattle prod, which was used against civil rights activists in the Southern states as early as the 1950's[106] and caused widespread public outrage.[107]

In his 1969 book on riot control Applegate mounted a defence of the police, characterizing their use of the cattle prod, perplexingly, as a "non violent" technique. In an attempt to draw a line under the adverse publicity he describes the 'shock baton', a product of military-sponsored development (and essentially a repackaged and redesigned cattle prod), as an important and "humane tool" for police.[108] His proposals for its use present it primarily as a compliance tool for police rather than an alternative to lethal force:

> Non violent individuals in its path will quickly "melt away." With it [shock baton], the passive laydown resister can be easily discouraged without having to carry him away.
> …
> Police on the beat can use it to handle and move, with a minimum of force, drunks of both sexes, teenagers, alcoholics, derelicts, etc. Prison guards, attendants at mental facilities, and plant security forces are also potential users.[109]

Worryingly, these comments are echoed in some of the policy underpinning police use of electrical weapons in the US today.[110]

In the 1970's two major studies of "non lethal" weapons saw electrical weapons as one of the most promising technologies for further development.[111] The final report of the US Army research into "non-lethal" weapons also argued that electrical weapons offered many advantages over existing chemical and kinetic energy weapons: "Some of the advantages are: Broad spectrum of incapacitation, predictable physiological effect, controllability of dose, rapid incapacitation etc."[112] Nevertheless public aversion to electrical weapons in the US was pervasive and it limited research and development. The US Army report noted:

> It is rather strange that this particular area of less-lethal weapons has been curtailed because as shown above, electrical devices have, in concept, many of the desirable features of less-lethal devices except, of course, the most critical feature of public acceptance.[113]

But this should not, perhaps, have come as such a surprise. The very reason Applegate gives to promote electrical weapons is that which underlies unease about them amongst the majority of people: "Almost all people have an instinctive dislike and fear of electricity and the shock effect which it produces, and will retreat when in this danger."[114] This feeling is, of course, compounded by the history of torture with electrical-shock devices. However, Rejali argues that a misunderstanding about the origins of electrical torture, particularly the role of technological development, "… allows ordinary people, on the one hand, to condemn the diffusion of electric torture instruments and on the other hand, to tolerate its everyday use in their communities."[115]

SIPRI's 1978 study of anti-personnel weapons noted: "Patents for electric guns, spears, arrows and harpoons have been awarded over the past 100 years but few have come into operation."[116] The most significant exception was the Taser, invented by John Cover and patented in 1974. As Lauer has described, Cover reportedly developed the Taser, incorporating a high voltage low amperage pulsed electric current, in response to the recommendations of the Presidential Crime Commission of the late 1960's and:

> By 1970, Cover had built his first prototype electrical weapon which he called the "TASER," an acronym for the "Thomas A Swift's Electrical Rifle," which was named after the Tom Swift fantasy stories of Cover's childhood.[117]

Overcoming the range limitations of an electric baton or 'touch stun' device, the Taser design was summarised in the original patent as follows:

> A weapon for subduing and restraining includes a harmless projectile that is connected by means of a relatively fine, conductive wire to a launcher which contains an electrical power supply. The projectile is intended to contact a living target without serious trauma and to deliver an electric charge thereto sufficient to immobilize.[118]

Cover also envisioned the capability to control the magnitude of the electrical current at the weapon so that it would "…range in effect from immobilizing to potentially "lethal" levels."[119] The idea for using pulsed (or intermittent) electric currents arose from published safety studies on the use of electric fences.[120]

The initial model was called the TF-1 was marketed by Cover's company Taser Systems with an electrical power output of 5-7 watts.[121] It was demonstrated to a number of law enforcement agencies in the US, the majority of which were unimpressed,[122] in part due to the unfavourable public opinion about electrical weapons at the time. However, civilian markets, including the US airline industry showed greater interest and over 2,000 Tasers were sold in 1975 to members of the public, security guards and some policemen.[123] However, later in 1975 sales were halted by the US Consumer Product Safety Commission pending an investigation. In 1976 the

Commission concluded that the Taser was "non-lethal" to healthy individuals and lifted its ban.[124] But also in 1976 the US Bureau of Alcohol, Tobacco and Firearms classified the Taser as a firearm, requiring registration and severely restricting sales. The State Department also limited its' sale overseas due to concerns that it may be used for torture. Concerns that, given the historical precedent, were well founded. Taser's profile was further raised as it was used in crimes such as robberies across the US. As a result two states, Michigan and New York, passed laws prohibiting the possession of Tasers by members of the public. Buying, selling or possessing a Taser was made illegal in Canada.[125]

Another method for extending the range of electrical weapons was conceived by Wall, who patented the concept of using two water jets with opposing charges to convey an electrical charge to the victim. The patent was filed in 1965 and accepted in 1968 but the device was not developed at the time.[126]

2.5 Other technologies

Writing in 1977 Ackroyd et al. observed:

> Most of the new riot-control weapons produce their effect by impact or chemical harassment. But the technological/political imagination has not been idle. Other devices have been proposed, developed or marketed in these boom years of law-enforcement technology.[127]

In addition to the burgeoning development of electrical weapons, discussed in the previous section, interest in "non-lethal" weapons during the 1960's and 1970's generated numerous other ideas. In fact, all the major concepts and technologies that are considered for use in "non-lethal" weapons today were either proposed, in development, or in use in some form by the late 1970's, as illustrated in Table 1 below.

Aside from irritant agents such as CS a number of other types of chemical were either being employed or suggested for use as "non-lethal" weapons including incapacitating agents, smokes, lubricants, foams, and malodorants. The major military chemical weapons development effort in the 1960's focussed on incapacitating agents. Like irritant agents these emerged from long established chemical weapons programmes of the US, UK and several other countries.[128] Whereas irritant agents (riot control agents) act peripherally on the body, causing intense sensory irritation primarily of the eyes, skin and respiratory tract for a short time, incapacitating agents act centrally producing profound effects on physiological processes that last for a longer period.[129] SIPRI's 1973 study of chemical and biological weapons observed:

> The objective of research on incapacitants is to find substances capable of reducing military effectiveness for lengthy periods without endangering life or causing permanent injury, and to do so at dosages comparable with the effective dosages of existing CW agents.[130]

The 1997 US Army Textbook of Military Medicine entitled *Medical Aspects of Chemical and Biological Warfare* summarised the history of US research on incapacitating agents during the 1950's, 60's and early 70's:

> Virtually every imaginable chemical technique for producing military incapacitation has been tried at some time. Between 1953 and 1973, at the predecessor laboratories to what is now the U.S. Army Medical Research Institute of Chemical Defense, many of these were discussed and, when deemed feasible, systematically tested. Chemicals whose predominant effects were in the central nervous system were of primary interest and received the most intensive study. But other substances capable of disrupting military performance were also investigated, including some biological toxins.[131]

Interestingly this text acknowledges the link between the search for incapacitating agents and research on other means to achieve military incapacitation:

> Nor were chemical agents and toxins the only possibilities considered; other candidates included noise, microwaves, light, and foul odors.[132]

Table 1: Status of "Non-Lethal" Weapons Concepts and Technologies in the Late 1970's[133]

Technology	**Type**	**Status (late 1970's)**
Kinetic Energy	Baton	In use
	Water cannon	In use
	Impact projectiles	In use
	Nets	Available, not in use
Electrical	'Stun baton' / 'stun gun'	In use
	Taser	In use
	Wireless electrical weapon	Proposed
Chemical	Irritant / riot control agents (CS/CN/CR/OC)	In use
	Smokes	In use
	Lubricants	Available, not in use
	Aqueous foams	Available, not in use
	Sticky foams	R&D
	Malodorants	R&D
Biochemical	Incapacitating agents (midspectrum)	Available, stockpiled
Biological	Incapacitating bacteria, viruses, toxins	Prohibited, 1972 BTWC
Optical	Light-flash / flash-bang grenades	In use
	High intensity lights	Limited use
	Stroboscopic lights	R&D
Acoustic	Audible sound generator	Limited use
	Infrasound / ultrasound generator	R&D
	Vortex generator	Proposed
Directed Energy	Lasers (low power)	R&D
	Lasers (high power)	R&D
	Radiofrequency (RF) / microwave	R&D
Delivery Systems	Cartridges, grenades, mortars	In use
	Encapsulated projectiles	R&D

	Dart / injector gun	R&D
	Unmanned platforms	Proposed

The focus on chemicals acting on the central nervous system was due to particular developments in the civil sector, as noted by Robinson in volume I of the SIPRI study of chemical and biological weapons in 1971:

> The US Army's interest in psychochemicals was probably stimulated by the rapid development of psychotropic drugs by a number of chemical manufacturers after World War II. With the increasing use and availability of tranquilizers, stimulants and even hard drugs for the general public, it was perhaps inevitable that the possible military uses of the new substances should be investigated.[134]

In the US the intensive search for an incapacitating agent resulted in the production, stockpiling and standardization, in 1962, of munitions filled with a glycollate agent, 3-quinuclidinyl benzilate, given the codename BZ, which was capable of causing physical weakness, delirium and hallucinations in very small doses.[135] Development of new agents to replace BZ, which was considered an unsatisfactory weapon due to its unpredictable effects, continued under a program that finished in 1975 after which interest in these agents apparently declined and BZ was no longer included in the US chemical weapons arsenal.[136] As Robinson has observed:

> By 1976, BZ had been declared obsolete, but the agent which the Chemical Corp has selected to replace it … was not standardized: the US military were in the process of reconsidering their requirement for such weapons.[137]

In the law enforcement field during the 1960's and 1970's the application of dart guns delivering incapacitating chemicals, long used to immobilize wild animals, was suggested for use against people.[138] The US Army had not overlooked the potential application of its' research to the police search for new weaponry. An Army technical report entitled *Nonlethal Agents in Crime and Riot Control* pointed out:

> The intensive search at Edgewood to find incapacitating agents for military application has led to the discovery of several types of nonlethal agents with properties suitable for use in crime and riot control.[139]

A number of different classes of compounds were under investigation as promising centrally acting agents including: anaesthetics, analgesics, tranquilizing agents, anticholinergics (e.g. glycollates such as BZ), and vomiting agents.[140]

Biological agents, including certain bacteria, viruses and toxins, were also developed for use as incapacitating agents as part of military biological weapons programmes in the post World War II period. The US military, for example, standardized viral agents *Coxiella burnetii* (Q fever) and Venezuelan equine encephalitis (VEE), bacterial agent *Brucella suis* (brucellosis), and toxin agent staphylococcal enterotoxin B (SEB), as incapacitating biological weapons (BW).[141]

From a military point of view the development of incapacitating agents, whether biological or chemical, was carried out to enable greater flexibility in the use of chemical and biological weapons through promoting their diversity. As SIPRI's 1973 study of chemical and biological warfare noted, the political advantages of these agents were that their forseen limited "lethality", (the aim was to develop agents with a 1-2% lethality), would enable greater freedom in the use of force. From a tactical perspective these agents might be used to cause large-scale incapacitation and thus overwhelm medical and logistical services. They may also be used in situations where there was a risk to civilian or friendly forces.[142] In the US BW programme, other factors, namely the relative ease of weaponizing and conducting human tests with incapacitants as opposed to "lethal" agents, meant that they were standardized earlier and investigated more fully.[143]

In his May 1970 paper Coates considered biological agents as potential "non-lethal" weapons for the military[144]:

> The biological agents, while having much of the versatility of chemicals, lack a rapid onset of effect. Their tactical incisiveness is severely limited so they are less applicable to the class of conflict discussed in this paper [limited and urban warfare]. They may, however, have a substantial application in capturing and neutralizing hostile cities at highly intense levels of limited warfare.[145]

It is strange that biological agents were even considered given the timing. President Nixon had unilaterally renounced biological warfare and announced the closure of the US BW programme in November 1969.[146] Biological weapons were subsequently banned under international law by the 1972 Biological and Toxin Weapons Convention (BWC).

The military have long used smoke on the battlefield to obscure visibility and HC smoke, consisting of zinc oxide, hexachloroethane, and aluminium, resulted from a World War I research effort in the US and France to find an alternative to white phosphorous as an obscurant.[147] Writing in 1969 Applegate advocated the use of HC by police, arguing that "obscuring smoke, one of history's oldest forms of chemical warfare, has emerged as one of the best, nonlethal, mob control tools."[148] However, the 1972 US National Science Foundation study of "non-lethal" weapons maintained that smoke was only useful to police in a few specialised situations because it impeded both the police and the crowd and could make crowd dispersal even more difficult.[149] Contrary to early assertions concerning its' safety,[150] HC material was found to be toxic if inhaled potentially resulting in lung damage or death at high concentrations, a fact recognised at least by the late 1970's.[151]

Another proposal was to use polymers mixed with water as lubricants to restrict movement of people (or vehicles) for area denial. The concept was demonstrated in the mid 1960's and dubbed 'instant banana peel' at the time. Two products, Riotrol and Separan AP-30, were marketed to the police and the military and tests were carried out but the compounds did not enter service.[152] Writing in 1969 Applegate described one of these lubricant agents:

> A new product, Riotrol, has recently been introduced to law enforcement agencies and taken under study by military agencies for possible use. When applied to a hard surface and wetted down, this dry, relatively-inexpensive, non-toxic, noncorrosive white powder becomes ice slick. It becomes virtually impossible for an individual to move or stand up on a hard surface so treated.[153]

Aqueous foams were also proposed for use as a temporary barrier or to disorient groups of people in a crowd control situation. At the time rapid foam-producing machines were being used for fire-fighting in the US.[154] Applegate was optimistic about the potential for adding other chemical agents:

> With foam, a suggestion of "witchcraft" can be enlarged upon. Its effects can be increased by the addition of dyes, stenches, eye irritants, tear-gas, slippery-footing material and special lighting effects. Doubtless few rioters, once subjected to foam treatment, would desire a second immersion.[155]

There was also interest in the development of foam materials that would rapidly become sticky or rigid. The US Army were exploring use of such foams to form barriers that would last for days, weeks, or months.[156]

The use of foul smelling chemical compounds, or malodorants, was considered as a potential means of area denial for military operations in the 1960's.[157] The origins of this type of weapon reached back to World War II when the US Office of Strategic Services developed a compound sprayed via an atomiser, known as Who me?, which was designed to be used by the French resistance against German officers.[158] The British developed a similar device, the "S Liquid Projector" in the 1940's.[159] US military studies were conducted by the Battelle Memorial Institute in 1966 as part of the Advanced Research Projects Agency's (ARPA) Project Agile with a view to using malodorous substances in Vietnam.[160] One study sought cultural differences in olfaction (sense of smell) that could be exploited through use of malodorous chemicals. The 1966 report aimed:

> …to determine whether intercultural differences in olfaction exist, particularly with respect to offensive smells, and if they do, to what extent they can be utilized in psychological warfare.[161]

In the 1970's malodorants were also suggested as a possible weapon for crowd control in the law enforcement arena.[162]

Writing in 1978, the authors of SIPRI's study of anti-personnel weapons observed: "New developments in anti-personnel weapons derive from three main areas of physics: electricity, acoustics, and electromagnetic radiation."[163] In the chapter on these weapons they address electrical, acoustic, optical, and directed energy weapons and conclude:

> A part from nuclear, biological and chemical weapons, they appear to offer the only possibilities for utilizing new scientific principles in the production of anti-personnel weapons.[164]

They go on to point out:

> None of the devices discussed has at present any significant battlefield application. It is noteworthy that a high proportion of the devices described have been used for paramilitary and police purposes, ranging from dispersing crowds of demonstrators to interrogating prisoners. [165]

Optical devices specifically designed to temporarily blind by producing flashes of bright light were under development and in limited use at this time. However, as the SIPRI book noted, conventional military illuminating munitions were already in widespread use.[166] These munitions, designed to light up areas at night for a brief period, had the secondary effect of causing temporary flash blindness to those adversaries nearby. For example the MK1 Illuminating Grenade, which produced bright light for 25 seconds, was used in Vietnam by the US military.[167] In the late 1960's Applegate had proposed that the use of military training grenades that produced a bright flash of light and a loud bang would be useful for police riot control operations.[168] A similar device was used in 1977 by German forces to overcome plane hijackers in Somalia.[169] Police in the US had also experimented with high-intensity light systems mounted on vehicles and flashed on and off to impair night vision.[170]

Stroboscopic lights were also investigated as a means of crowd control both in the UK and the US. In 1973 the *New Scientist* reported that a UK company had developed a device called the Photic Driver, which reportedly combined a strobe light and low frequency sound with the aim of disabling people in crowd control situations and that the US military funded research on similar devices in 1964.[171] It had long been known that strobes at a certain frequency could cause physical symptoms, such as disorientation and vomiting, and also trigger photosensitive epileptic fits in a small percentage of people. These were the effects the weapons designers sought to induce. In the 1950's investigations of US military helicopter crashes found that the pilots had become disorientated by the stroboscopic effect produced by the sun shining through rotating rotor blades.[172] Interest in the early 1970's coincided with concerns over the frequencies of strobes in London discothèques. [173]

The use of audible sound as well as high frequency (ultrasound) and low frequency (infrasound) were explored for potential military application. A powerful sound system called the HPS-1 was developed for the US military and used for psychological warfare in Vietnam, particularly to transmit messages or sounds over long distances from the air. An associated 'Curdler' unit could be fitted to the HPS-1 to enable the projection of unpleasant sounds at high volumes. It was taken up by some US police forces for use in riot control and the British Army also acquired some units for use in Northern Ireland.[174] During the 1970's there was also research into the potential of ultrasound and infrasound to cause adverse physiological effects. In 1973 *New Scientist* reported that a device called the Squawk Box that employed ultrasonic and infrasonic frequencies was being developed for the British Army but it is unclear whether or not it was actually developed.[175] Coates had also proposed the use of vortex rings and wind generation machines as possible "non-lethal" weapons.[176]

Directed Energy weapons were in the very early stages of development during this period. Research and development was ongoing in the late 1960's

and 1970's on laser weapons but primarily as alternatives or additions to conventional "lethal" weaponry rather than "non-lethal" weapons. By the late 1970's there was considerable investment by the US military but also programmes in other countries such as the UK, Germany, and USSR. The potential anti-personnel effects perceived by SIPRI authors in 1978 could not be described as "non-lethal" and included heat-induced damage to skin and soft tissue and eye damage.[177] In the US, work began on the development of tactical laser weapons for use against optical equipment or the human eye. These were distinct from the lasers already entering use as rangefinders and target designators for conventional weapons systems.[178] Consideration was also given to the use of microwaves as weapons during the 1970's with initial research carried out on the potential biological effects of this type of radiation.[179]

The design of delivery systems was also an important part of "non-lethal" weapons development at this time. The new kinetic energy projectiles were fired either with adaptations of existing pistols, rifles, shotguns, grenade launchers, or specially designed weapons such as the US Federal Riot Gun.[180] A wide variety of munitions and dispensers were developed for military use of irritant agents during the 1960's as discussed above, and some of these systems were taken up for law enforcement use. Some companies were seeking to adapt dart-guns used in the capture of animals for use against people.[181] Initial designs of frangible projectiles containing water, designed to rupture on impact, were also under development at this time.[182]

2.6 Legal Issues

There were a number of legal developments related to "non-lethal" weapons during the 1960's and 1970's, particularly in relation to chemical and biological weapons. The use of chemical and bateriological weapons had long been prohibited under international law by the 1925 *Protocol for The Prohibition of The Use in War of Asphyxiating, Poisonous or other Gases, and of Bacteriological Methods of Warfare*, known as the Geneva Protocol.[183] However, the Protocol did not prohibit research, development, and possession of these weapons. Essentially it was seen as a 'no first use' agreement as expressed in the reservations given by some signatories.[184] Significantly the Geneva Protocol had not been ratified by the Unites States. Despite the Protocol chemical weapons were used by Italy during its invasion of Ethiopia in 1935-36 and Japan used chemical, and later biological, weapons against China during the Sino-Japanese War (1933-45).[185] As regards so called "non-lethal" chemical weapons, irritant agents were used extensively by the Japanese.[186] Large stockpiles of chemical weapons were built up during World War II but remained unused due to fears of retaliation in kind and doubts over their military utility.[187] However, as Furmanski has discussed, in 1944 the US improvised using FS smoke munitions as irritant agents to drive Japanese soldiers from a cave system on Biak Island and subsequently developed plans to use chemical weapons against Japan, although these were never initiated.[188] However, it was the large scale use of irritant agents, namely CS, and herbicides by the US in Vietnam that brought

international criticism and increased attention to the issue of chemical weapons arms control during the 1960's.[189] As Furmanski has described:

> The US faced increasing condemnation of its RCA [riot control agent] policy at home and abroad, and in 1966 faced a UN resolution calling for all states to abide by the 1925 Geneva Protocol banning chemical and biological warfare. … the US supported the resolution and voted in favour, but contended, contrary to the general international consensus, that use of RCAs in war, because they were non-lethal agents, was not prohibited by the 1925 Geneva Protocol…[190]

Indeed, during the 1960's, the US military had intensified research, development and testing of irritant agents as well as incapacitating agents, both chemical and biological.[191]

As a result of US activity in Vietnam the UN General Assembly discussed the issue of chemical and biological weapons and in 1969 a report by the Secretary General called for States to affirm that the Geneva Protocol applied to all chemical weapons including irritants.[192] Discussions in the Conference of the Committee on Disarmament (CCD) concurred and the Swedish Ambassador warned of the dangers of escalation from the use of "non-lethal" agents to use of "lethal" agents, a warning also made in a World Health Organisation report on the subject in 1970.[193] Use of chemical weapons during World War I had of course begun with use of irritant agents.

In July 1969 the UK tabled a draft treaty banning biological weapons[194] and several months later in November 1969 President Nixon announced the closure of the US biological weapons programme, renouncing the use of all biological agents including incapacitating agents and in 1970 he extended this decision to toxins, whether of natural or synthetic origin.[195] As regards chemical weapons he affirmed the non-first use of both lethal and incapacitating agents as US policy.[196] He also announced the resubmission of the Geneva Protocol to the US Senate for ratification although the US still maintained that it would reserve right to use irritant chemical weapons (or riot control agents) in combat.[197] This issue held up ratification until the Ford administration launched an initiative that led to ratification of the Protocol in 1975 under an agreement with the US military that would restrict, but not prohibit, the use of riot control agents in combat.[198] In April 1975 President Ford signed Executive Order 11850 concerning use of riot control agents and herbicides in warfare. It renounced first use of riot control agents except under certain circumstances under Presidential approval:

> (a) Use of riot control agents in riot control situations in areas under direct and distinct U.S. military control, to include controlling rioting prisoners of war.
> (b) Use of riot control agents in situations in which civilians are used to mask or screen attacks and civilian casualties can be reduced or avoided.
> (c) Use of riot control agents in rescue missions in remotely isolated areas, of downed aircrews and passengers, and escaping prisoners.
> (d) Use of riot control agents in rear echelon areas outside the zone of immediate combat to protect convoys from civil disturbances, terrorists and paramilitary organizations.[199]

Importantly, however, EO 11850 still permitted use in combat, particularly in view of provision (b). Furthermore Furmanski points out:

> After the US acceded to the 1925 Geneva Protocol in 1976, a US policy was articulated that stated the US did not consider LLICAs [low lethality irritant chemical agents] such as CS gas to be chemical weapons and hence the Geneva Protocol did not apply to them.[200]

As regards biological weapons the *Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction*, was agreed and signed in 1972 and came into force in 1975. It was the first treaty to ban an entire class of weapons and, critically, it prohibited the development, production, acquisition, and stockpiling of all biological weapons (including incapacitating biological agents), whereas the Geneva Protocol had only prohibited their use in warfare. However the treaty did not contain any provisions for verification of compliance.[201]

Other relevant arms control discussions during the 1970's centred on weapons that may cause unnecessary suffering of have indiscriminate effects. In 1973 the International Committee of the Red Cross (ICRC) published a report drawing attention to certain weapons, including laser weapons, in this context and subsequently convened two meetings of government experts in Switzerland under the name *Conference of Government Experts on Weapons which May Cause Unnecessary Suffering or have Indiscriminate Effects*. The first meeting was held in Lucerne in 1974 and the second in Lugano in 1976. Primarily the meetings addressed certain conventional weapons such as incendiary weapons and cluster bombs, however brief reference was also made to new weapons that didn't fit into categories such as 'conventional' or 'chemical'. Many of these were technologies that would become relevant to proposed "non-lethal" weapons including directed energy (specifically laser and microwave devices), acoustic (specifically infrasound devices), and optical (specifically light-flash or stroboscopic devices).[202]

3. Relative Quiet: Developments In the 1980's

3.1 Police Developments

In the United States new impetus was given to "non-lethal" weapons development as a result of a Supreme Court decision, Tennessee v. Garner (1985), which limited the use of lethal force against fleeing suspects.[203] The case concerned an unarmed 15 year-old boy who was shot and killed by police in 1974 as he fled the scene of a burglary having stolen $10. The court ruled the existing Tennessee law unconstitutional, concluding:

> …that such [deadly] force may not be used unless it is necessary to prevent the escape and the officer has probable cause to believe that the suspect poses a significant threat of death or serious physical injury to the officer or others.[204]

In part as a response to this ruling then US Attorney General Edwin Meese convened a second conference on "non-lethal" (or "less-than-lethal" in US Department of Justice terminology) weapons in 1986.[205] The conference was

held by the National Institute of Justice (NIJ); the research arm of the Department of Justice that prior to 1978 was called the National Institute of Law Enforcement and Criminal Justice (NILECJ).[206] A final report, entitled *Report of the Attorney General's Conference on Less Than Lethal Weapons*, was prepared by Abt Associates and published in 1987. The purpose of the conference, attended by 150 specialists, was to assess the progress in "non-lethal" weapons development since the 1971 conference and to develop ideas for new weapons and a plan for future research and development. [207] The Foreword to the report illustrates the dual humanitarian-economic drivers behind the search for alternatives to use of "lethal" force for police officers at the time:

> First, the use of deadly force frequently offends some of our highest national ideals – the preservation of life, and the right of a suspect to due process. Second, a growing number of communities are suffering financial hardship as a result of civil liability suits alleging the use of excessive force by law enforcement officers.[208]

The conference focussed on the three main types of "non-lethal" weapons technologies available at the time: electrical, chemical, and impact weapons. However the participants observed a lack of progress since the previous conference:

> Notably, most of the current weapons reviewed here were also available in 1972. The apparent lack of significant innovation in the years between 1972 and 1986 indicated to participants the crucial need for central coordination and support of future development efforts.[209]

In terms of operational requirements the report of the conference described five different types of situation for the use of "non-lethal" weapons: "…close proximity encounters; fleeing persons; hostage/terrorist situations; barricade situations; and crowd/riot control."[210] Requirements and available options for these situations were discussed and ideas for the future development of "non-lethal" weapons were put forward. The need for new weapons for close-proximity encounters was considered the most urgent and, in keeping with assessments in the 1970's, the focus here was on improvements to existing electrical weapons and the development of weapons to deliver chemical incapacitating agents such as tranquilizers via a dart gun. The second priority was hostage situations and here chemical incapacitants, delivered as a gas or aerosol, were also considered to be the most promising option. [211] The focus for research and development was clearly on centrally acting incapacitating chemicals rather than on peripherally acting irritant agents. The 1987 report concluded: "Given the rapid pace of development in the drug industry, participants were optimistic that a targeted effort could produce effective, acceptable chemical agents."[212] Indeed this targeted effort to develop incapacitating agents was the first major activity to emerge from a newly established "Less-Than-Lethal Technology Program." Writing in 2002, Sarah Hart, then Director of the US National Institute of Justice (NIJ), recalled:

> After the 1986 conference, NIJ established a less-than-lethal technologies program. The first research award under this program was made in 1987 to the U.S. Army Chemical Research, Development, and Engineering Center at Aberdeen Proving Ground for a single project -- an assessment of the feasibility of a dart that could

> deliver a safe but incapacitating chemical to a fleeing suspect. The project evolved to the identification of a candidate chemical and the production of a prototype delivery system.[213]

The initial feasibility study was completed in 1989 after which the NIJ added additional funds to the research and development effort.[214]

The final chapter of the 1986 NIJ conference report emphasized the role of numerous factors on the "non-lethal" weapons development progress aside from technological innovation, making recommendations relating to: operational requirements, police end-user acceptability, testing and evaluation, public acceptability, liability, information gathering, guidelines for use, funding research and development, and collaboration between various groups. With regard to latter factor the author noted:

> If there is any single lesson to be learned from past attempts to develop less than lethal devices, it is surely that development cannot be pursued haphazardly as too many factors complicate the introduction of a new weapon. Participants cautioned that to view the development process as purely a scientific exercise would pose formidable constraints on the effective applications of new less than lethal weapons technology.[215]

In the UK during the 1980's the focus was not on developing new "non-lethal" weapons but rather on introducing existing weapons to the police forces of the UK mainland that were already in use in Northern Ireland. Northam's 1988 book, *Shooting in the Dark*, chronicles the dramatic changes in police tactics and equipment during the 1980's. A number of riots occurred across England in 1980 and 1981, notably in the Brixton area of London in April 1981 and in the Toxeth area of Liverpool in July 1981, where the irritant agent CS was first used by police. Following these events the Association of Chief Police Officers (ACPO) instigated a change in policy for dealing with public order situations with paramilitary style tactics and techniques imported from the Hong Kong police. By 1983 ACPO had drawn up a new Public Order Manual incorporating sections on the use of plastic bullets and CS. ACPO and the Home Office oversaw training of police forces all over the country in these new weapons and tactics and, with riots in 1985 giving further impetus to the changes and the Home Office pushing for increased availability of plastic bullets and CS, these weapons were available to all major police forces by the summer of 1986.[216]

3.2 Military Developments

Many of the "non-lethal" weapons available to the police and the military at this time were products of military programmes: chemical weapons programmes incorporated irritant chemicals and incapacitating agents amongst lethal agents as part of a diverse range of agents enabling use for varied military tasks; and kinetic impact projectiles such as the Ring Airfoil Grenade (US) and the rubber or plastic bullet (UK) had been developed by the military for specific purposes. This was unsurprising since law enforcement organisations lacked the necessary research and development capabilities for independent development. However the military were yet to take a significant interest a concept of "non-lethal" weaponry that brought

together varied weapons technologies for a common purpose, as was happening in law enforcement community. During the 1980's this situation did not change greatly since the technological arms race was entirely driven by the Cold War stand-off between NATO and the Warsaw Pact countries focussing primarily on nuclear weapons development.[217] As Lewer and Schofield have pointed out:

> …many of the technologies that might form the basis of a non-lethal armoury had already been identified in the 1960s and 1970s but they were given no real priority in context of Cold War military planning.[218]

Nevertheless military research on unconventional weapons technologies at this time would provide a basis from which new "non-lethal" weapons would later be put forward. As the report of the 1986 National Institute of Justice (NIJ) conference remarked:

> The military has undoubtedly conducted research and testing pertinent to the development of less than lethal weapons, but much of such work is classified.[219]

This secrecy concealed research and development of unconventional or 'exotic' weapons systems, such as directed energy weapons, which were given particular attention under the US Strategic Defense Initiative (SDI) in 1983 that sought various methods for defending against ballistic missiles.[220] The directed energy part of the SDI focussed on high-energy lasers for strategic defence but the development of tactical laser weapons targeted at optical equipment and the human eye, that had begun in the 1970's also intensified in the 1980's.[221]

In the late 1980's John Alexander, a Program Manager in the Special Technologies Group at Los Alamos National Laboratory in the US who would soon emerge as one of the major advocates of "non-lethal" weapons, was proposing the development of new technologies to disable military equipment such as tanks.[222] In a 1989 article in *Military Review* Alexander argued for the use of a variety of technologies such as chemicals, lasers, high-power microwaves and high intensity light to disable equipment and to a lesser extent personnel, describing these techniques collectively as "antimateriel technology".[223] However, in contrast to the emphasis on less-injurious weapons seen in law enforcement discussions,[224] Alexander's proposal was that these weapons would be force multipliers to enhance the lethality of existing weapons against the perceived Soviet threat at the time, to increase the "kill ratio". [225] Later, in his 1999 book *Future War*, he would describe the central difference between law enforcement and military rationales underpinning the early development of "non-lethal" weapons technology:

> The recent development of military non-lethal concepts arose from very lethal roots. While law enforcement has always been charged with using the minimum force necessary to restrain assailants, the post-Vietnam military embraced the concepts of overmatching enemy weapons and the use of overwhelming force.[226]

3.3 Electrical Weapons

By the mid-1980's the Taser had been adopted by some police departments in the US but it was not widely used.[227] In 1980 the Los Angeles Police Department (LAPD) had purchased 700 of the TF-76 model Taser, originally introduced in 1976, for patrol use.[228] In 1982 the LAPD approved the Taser for use and officers at the 1986 National Institute of Justice conference reported relatively low-level use, around two times per month in the three to four years preceding the conference.[229] In a 1991 article Kornblum and Reddy reported that the Taser had been used "several thousand times" by the LAPD since its approval in 1982.[230] The electrical power output of the TF-76 was larger than previous models at 11 watts.[231] The Taser was considered to have limitations in reliability and effectiveness, particularly against those under the influence of drugs and those wearing heavy clothing, and the participants at the NIJ conference considered improvements to the device of high priority.[232] By the time of the conference the Taser Systems Company had filed for bankruptcy in large part due to restrictions on sales to members of the public and to foreign countries resulting from the classification of Taser as a firearm.[233] Taser Systems was sold to investors who, from 1986 onwards, operated the company under the name Tasertron.[234] The first model they introduced was the TE-86, a two shot Taser with a power output of 5-7 watts. [235] Tasertron electrical weapons were only sold to authorised police, security, and military agencies and were not made available to the civilian market.[236]

A variety of other hand-held 'stun guns', used at arms length with no projectiles, were available at the time and, with less restrictions on their sale (they were not classified as firearms in the US), they were widely marketed to the US public as well as the police.[237] One new device that became available during the 1980's was the Nova XR-5000 Stun Gun, which is still sold today. The 1987 NIJ conference report estimated:

> The number of Tasers in use (or purchased) probably numbers in the thousands. The number of Novas in circulation may be in the order of a few hundred thousand.[238]

Another available device was a glove fitted with an electrical generator that was in use in US prisons. The report noted that these devices, like the Taser, were limited in terms of effectiveness.[239] Another issue raised at the conference was the police concern over the availability of stun weapons to the general public.[240]

With increasing adoption of Tasers and other 'stun guns' by a few US police departments during the 1980's scientific attention was drawn to the health effects of these weapons. The use of Tasers had been followed by a number of deaths during the 1980's and, echoing contemporary debates, opinion was divided on the role of Taser.[241] Pathologists, Kornblum and Reddy, considered 16 deaths in the Los Angeles area following Taser use by police and concluded that drug overdose was the cause of death in the majority of cases.[242] Allen contested this conclusion arguing that:

> As pathologists, we should warn law-enforcement agencies that tasers can cause death. It seems only logical that a device capable of depolarizing skeletal muscle can also depolarize heart muscle and cause fibrillation under certain circumstances.

> Furthermore, while the use of tasers may be generally safe in healthy adults, preexisitng heart disease, psychosis, and the use of drugs including cocaine, PCP, amphetamine and alcohol may substantially increase the risk of fatality.[243]

Amnesty International drew attention to the use of electrical-shock weapons for torture and in the 1980's they campaigned against the proliferation of these weapons to South Korea, Taiwan and China. Amnesty's 1997 report, *Arming the Torturers: Electro-shock Torture and the Spread of Stun Technology*, observed that Taiwan and China subsequently became leading manufacturers of these weapons and "during the 1980s and 1990s production of stun weapons began in several other countries such as Brazil, France, Germany, Israel, Mexico and South Africa."[244]

3.4 Other Technologies

Participants in the 1986 National Institute of Justice (NIJ) conference on "non-lethal" weapons had found few advances in available weapons since the 1970's. There had been no significant development of kinetic impact projectiles and little use of these in the US, although rubber and plastic bullets were still being used widely in by the British in Northern Ireland.[245] The conference report noted:

> Few new concepts for impact weapons were presented to the conference. A host of unused impact weapons already exist, and most are generally considered ineffective or excessively dangerous.[246]

In terms of irritant chemical agents, CS and CN remained the agents of choice and were widely deployed. In the US for example the report noted:

> Tear gas has been standard in police inventories since the late 1960's. Officers frequently carry personal-issue hand dispensers, and most departments have tear gas shells for shooting dispensers past barricades. Large-volume dispensers can be used for crowd control.[247]

However concerns prevailed over the safety of these irritant chemical weapons, as described in a 1989 paper in the *Journal of the American Medical Association*:

> Proponents of their use claim that, if used correctly, the noxious effects of exposure are transient and of no long-term consequences. The use of tear gas in recent situations of civil unrest, however, demonstrates that exposure to the weapon is difficult to control and indiscriminate, and the weapon is often not used correctly. Severe traumatic injury from exploding tear gas bombs as well as lethal toxic injury have been documented. Moreover, available toxicological data are deficient as to the potential of tear gas agents to cause long-term pulmonary, carcinogenic, and reproductive effects. Published and recent unpublished in vitro tests have shown o-chlorobenzylidenemalononitrile to be both clastogenic and mutagenic. … There is an ongoing need for investigation into the full toxicological potential of tear gas chemicals and renewed debate on whether their use can be condoned under any circumstances. [248]

As discussed above, a major focus at the 1986 conference was on chemical incapacitating agents, which were the subject of the National Institute of Justice's first research grant to the US Army following the conference in 1987.

Conference participants had noted past military research on these types of chemical weapons: "Military researchers have investigated a large number of tranquilizers; some of those not suitable for battle may well prove useful for law enforcement."[249] In fact military attention to the development of these weapons, which in the US had been conducted intensively from the 1950's through to the mid 1970's, had waned during the 1980's.[250] BZ weapons, having been declared obsolete in 1976, were not replaced with another incapacitating agent[251] and stockpiles BZ weapons entered a destruction programme in the 1980's with incineration taking place between 1988 and 1990.[252] Exploratory research and development on incapacitating agents had continued at the US Army's Edgewood Arsenal during the 1980's but increased interest in military applications developed in the late 1980's,[253] perhaps as a result of the contracts awarded to the Army by the National Institute of Justice to study chemical incapacitants delivered by dart for law enforcement purposes. The initial NIJ-sponsored feasibility study, completed in 1989, favoured the fentanyl derivatives as the most promising agents for use by police. However, the enduring problem remained that these potent compounds had low safety margins and potentially fatal 'side effects', namely respiratory depression, that would require close control of the dose received.[254]

Several other technologies were discussed at the 1986 NIJ conference. The report noted research on stroboscopic light devices by a number of groups including testing on 100 people that produced discomfort and disorientation. Military tests had produced similar effects. Consideration had also been given to the optimal frequencies and waveforms for inducing these effects. [255] The report argued: "The fact that the brain can be severely affected by optic stimulation of a specific type offers clear possibilities for the development of less than lethal weapons."[256]

In terms of directed energy weapons, the report described research on the use of long exposures to extremely low frequency (ELF) radiation to cause nausea and disorientation. The potential for use of microwave frequencies was also discussed, although no mention was made of ongoing military research on directed energy weapons such as tactical lasers.[257] By 1980 low power lasers had become commonplace in military systems as range finders and target designators.[258] But the development of low power lasers as tactical weapons had also heightened. The British Navy, for example, deployed a shipboard laser system used to "dazzle" aircraft pilots as early as 1982, during the Falklands war.[259] In the early 1980's the US military had funded work on aircraft mounted laser weapons but the focus shifted to ground based systems. In addition to vehicle mounted systems, the development of portable laser weapons was initiated with three companies competing to develop such a system for the military. [260] These battlefield lasers were being designed to target optical equipment, include night vision devices, but also to cause permanent damage to the human eye,[261] with some proponents arguing that it was better to be blinded than killed.[262] One proposed "non-lethal" use of these lasers was to "dazzle", as described in a 1987 article in *Military Review*: "Here, the weapons would prevent useful vision while being used and for a short time afterward. They could

incapacitate but not damage optical systems or eyes."[263] The central problem highlighted at the time that remains an issue today is that lasers designed to temporarily blind at a certain range can cause permanent damage and blindness at shorter ranges.[264] There was no mention of acoustic weapons in the report of the 1986 NIJ conference. However, research was continuing during the 1980's on the effects of infrasound on humans.[265]

3.5 Legal Issues

Arms control discussions in the 1970's had led to a UN Conference on the issue of inhumane weapons, which was held from 1979-1980. The result was the adoption in October 1980 of the *Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May be Deemed to be Excessively Injurious or to Have Indiscriminate Effects*,[266] which came into force in 1983 and would soon become relevant to proposed "non-lethal" weapons. Future weapons including lasers, microwaves, infrasound, light-flash, environmental warfare, and electronic warfare had been discussed in the preceding experts meetings in 1974 and 1976 but it was considered too early to discuss restrictions on weapons still at the early stages of development. However, continued development of laser weapons during the 1980's led to particular concerns over those anti-personnel laser weapons designed to blind.[267] The issue was raised by the Government's of Sweden and Switzerland at the 25th International Conference of the Red Cross in 1986 who put forward a resolution proposing that they should be considered illegal but these calls were resisted by a few States who were developing such weapons. The International Committee of the Red Cross (ICRC) subsequently took an active interest in the issue and convened a meeting of experts in June 1989. The purpose of this meeting, which brought together technical, military, medical, and international legal experts, was later described by Doswald-Beck:

> …to establish whether such weapons were likely to be manufactured on any scale, whether they would indeed blind in most cases of anti-personnel use, whether such use would already be a violation of international humanitarian law and whether a legal regulation was possible or desirable. [268]

This turned out to be the first of a series of four meetings since the participants had recommended further investigation of the subject. [269]

4. Conclusion

It is clear that police and military interest in "non-lethal" weapons did not share a common origin. In the 1960's and 1970's law enforcement organisations were responding to public, political and legal pressure in their pursuit of weapons and tactics that would reduce the incidence of death and serious injury resulting from police use of force. Generally speaking "non-lethal" weapons were sought as *alternatives* to "lethal" weapons.[270] This process was catalysed by the riots arising from the US civil rights movement and, in particular, government commissions that warned against the militarisation of police but recommended that alternative weapons be developed, essentially

with a view maintaining control without the use of "lethal" force.[271] A legal ruling in the mid-1980's restricting police use of "lethal" force gave renewed impetus to "non-lethal" weapons development and resulted in the establishment of the 'Less-Lethal Technology Program' at the National Institute of Justice in 1986.

During this period the US military did not have a particular interest in a wide concept of "non-lethal" weaponry. However, they had long incorporated "non-lethal" irritant agents into their chemical weapons stockpiles and were actively pursuing the development of incapacitating chemical agents.[272] In contrast to the police, the military viewed these chemical weapons as *adjuncts* to "lethal" weapons, developed and deployed to enable flexibility in achieving a military task rather than specifically with the aim of limiting death and serious injury. Although the potential for reducing the numbers of civilian casualties through use of "non-lethal" weapons in certain conflict situations had been put forward, this had not been borne out by their use in practice, the most striking example being the widespread use of CS in the Vietnam War to enhance the killing power of conventional weapons. During the 1980's the Cold War stand-off left little room for considerations of "non-lethal" weapons and those ideas that were put forward stressed the potential of new incapacitating weapons technologies as force multipliers.

Despite the absence of an overall US military programme to develop "non-lethal" weapons, the majority of relevant technological advances were generated through military research and development. These emerged from existing unconventional weapons programmes. The law enforcement community largely relied on this research base with little of its own funding or expertise and only small-scale efforts in the private sector. Like the introduction of irritant agent CN to US policing forty years before, the widespread adoption of CS by police forces in the late 1960's as a replacement for CN followed intensive development by the military, this time complemented by extensive experience of combat use. In the law enforcement arena the new hand-held dispensers for delivery of irritant agents were considered the most influential development. There was also great attention during the 1960's and early 1970's to the development of incapacitating agents within military chemical and biological weapons programmes as a result of advances in the civil pharmaceutical industry. It was this military expertise that the US Department of Justice subsequently sought to exploit in its' renewed search for new "non-lethal" weapons during the late 1980's. Military research on directed energy systems as potential new unconventional weapons was in its' early stages but "non-lethal" applications were soon proposed. Although more conventional, kinetic energy impact projectiles, developed as alternatives to bullets in the 1960's and 1970's, also emerged from military research laboratories for use in controlling civil disturbances.[273]

Concerns over particular military unconventional weapons, namely biological agents, had led to their international prohibition under the 1972 Biological Weapons Convention (BWC) and, during the 1980's, similar sentiment was developing with regard to laser weapons targeting the human eye. Meanwhile

efforts reaffirm the 1925 Geneva Protocol were faltering, in large part due to US refusal to accept that irritant agents (or riot control agents) were chemical weapons.

The most significant technology development in the commercial sector was the advent of electrical-shock weapons. These were adapted from existing farming and torture technologies in response to the demand for new police weaponry in the 1960's and 1970's but lack of public acceptance precluded their initial uptake by police forces. Usage increased in the 1980's, particularly of hand-held 'stun guns' that, like hand-held chemical irritant sprays, were marketed to the general public as well as the police. However, doubts over their effectiveness meant they did not become standard police weapons during this period.

Following the development of kinetic impact projectiles and electrical-shock weapons and the adoption of agent CS in the 1960's, numerous other technologies were considered for use by police including smoke, lubricants, foams, malodorants, high intensity and stroboscopic lights, as well as acoustic and electromagnetic generators. Indeed this historical overview shows that the majority of weapons technologies under consideration as part of "non-lethal" weapons programmes today were either in operation in some form, under research and development, or at least had been proposed by the late 1970's. However, these various devices and technologies were found wanting and by the late 1980's available "non-lethal" weaponry had changed little from its' 1960's roots, comprising irritant chemical weapons, kinetic impact projectiles, and electrical-shock devices. And these weapons themselves suffered from significant deficiencies in terms of safety and effectiveness.

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[1] Quotation marks are used in recognition of enduring concerns over use of the term 'non-lethal' or other terms related to lethality (such as 'less-lethal') when applied to a weapon or group of weapons. It has long been acknowledged that no weapon can be entirely non-lethal.

[2] And to a latter extent the UK.

[3] Other countries no doubt share a history of interest in many of these weapons and likely carried out various research and development activities during this period.

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[5] Applegate, R. (1969) Part II Using Riot Chemicals. In: Applegate, R. *Riot Control – Materiel and Techniques*. First edition, Harrisburg, PA: Stackpole Books, pp. 126-211.

[6] Coates, J. (1972) Non-Lethal Police Weapons. *Technology Review*, June, pp. 49-56.

[7] *Ibid.*: The Commissions' report was published in February 1967 and entitled *The Challenge of Crime in a Free Society*.

[8] Seaskate Inc. (1998) The *Evolution and Development of Police Technology*. Washington, DC: National Institute of Justice, US Department of Justice, p. 27.

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[10] O'Bryant, J. (2003) *Issue Brief for Congress, Crime Control: The Federal Response*. Washington, DC: Congressional Research Service, Library of Congress, pp. 2-3.

[11] Coates, J. (1972) Non-Lethal Police Weapons. *Technology Review*, June, pp. 49-56.

[12] O'Bryant, J. (2003) *Issue Brief for Congress, Crime Control: The Federal Response*. Washington, DC: Congressional Research Service, pp. 2-3.
[13] For two recent examples see: Davison, N. and Lewer, N. (2004) BNLWRP Research Report No. 5. Centre for Conflict Resolution, Department of Peace Studies, University of Bradford, pp. 4 & 21.
[14] Applegate, R. (1969) *Riot Control – Materiel and Techniques*. 1st edition, Harrisburg, PA: Stackpole Books. Also see: Feakin, T. (2005) *Non-lethal weapons: technology for lowering casualties?* Ph.D. thesis, Department of Peace Studies, University of Bradford, p. 283.
[15] *Ibid.*
[16] *Ibid.*
[17] Applegate, R. (1971) Nonlethal Police Weapons. *Ordnance*, July-August, pp. 62-66.
[18] Seaskate Inc. (1998) The *Evolution and Development of Police Technology*. Washington, DC: National Institute of Justice, US Department of Justice, p. 39.
[19] Coates, J. (1972) Non-Lethal Police Weapons. *Technology Review*, June, pp. 49-56.
[20] Ackroyd, C., Margolis, K., Rosenhead, J., and Shallice, T. (1980) *The Technology of Political Control*. Second edition, London: Pluto Press, pp. 205-212. (First edition 1977, Penguin Books).
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[22] Dando, M. (1996) *A New Form of Warfare: The Rise of Non-Lethal Weapons*. London: Brassey's, p. 10.
[23] See for example: Alexander, J. (2001) An overview of the future of non-lethal weapons. Medicine, Conflict and Survival, July-September, Vol. 17, No. 3, pp. 180-193.
[24] Coates, J. (1970) *Nonlethal and Nondestructive Combat in Cities Overseas*. Washington, DC: Institute for Defense Analyses, Science and Technology Division, p. 1
[25] *Ibid.,* p. 107.
[26] *Ibid.,* p. 108.
[27] *Ibid.,* p. 110.
[28] As seen in a Internet bibliography on "non-lethal" weapons - Hyatt, J (1995) Non-Lethal Weapons. Air University Library, Maxwell AFB, AL. Available December 2006 at: http://www.au.af.mil/au/aul/bibs/soft/softkill.htm. Documents listed in the bibliography include the following: Ehmke, C. (1966) Use *of Non-Lethal Chemical Agents in Limited Warfare*. Maxwell AFB, AL: Air University, Air Command and Staff College, Thesis; Hansen, G. (1966) Non-Lethal Gases for Guerrilla Warfare. Maxwell AFB, AL: Air University, Air War College, Professional study; Higgins, J. (1967) Non-Lethal Chemical Weapons in Counterinsurgency. Maxwell AFB, AL: Air University, Air Command and Staff College, Thesis; Stuck, M. (1972) Future U.S. use of non-lethal chemical agents in warfare, Norfolk, Va.: Armed Forces Staff College.
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[30] *Ibid.*, p. 11.
[31] *Ibid.*, p. 43.
[32] *Ibid.*, p. 7.
[33] *Ibid.*, pp. 7-8.
[34] *Ibid.*, p. 8.
[35] Egner, D. (1977) The *Evaluation of Less-Lethal Weapons, Technical Memorandum 37-77*. Aberdeen Proving Ground, MD: US Army Human Engineering Laboratory, pp. 9-12.
[36] *Ibid.*, p. 9.
[37] Deane-Drummond, A. (1975) Equipments. In: Deane-Drummond, A. *Riot Control*. London: Royal United Services Institute, pp. 121-129.
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[40] Applegate, R. (1969) Part II Using Riot Chemicals. In: Applegate, R. *Riot Control – Materiel and Techniques*. First edition, Harrisburg, PA: Stackpole Books, pp. 126-211.
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[45] *Ibid.,* p. 59-60.
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[55] Stockholm International Peace Research Institute (SIPRI) (1971) *The Problem of Chemical and Biological Warfare. Volume I: The Rise of CB Weapons.* Stockholm: Almqvist & Wiksell, pp. 212-213.
[56] *Ibid.*
[57] *Ibid.,* pp. 85-203.
[58] *Ibid.,* pp. 187-190.
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Biological Weapons Conventions. *Paper given at the 20th Pugwash Workshop Study Group on the Implementation of the CBW Conventions: The BWC Intersessional Process towards the Sixth Review Conference and Beyond, Geneva, Switzerland, 8-9 November 2003*.

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[81] *Ibid.*

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[270] This did not mean that they were necessarily always used as alternatives or free from misuse.
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[272] The military had little interest in kinetic impact projectiles and electrical-shock weapons, aside from potential use when the military were employed during civil disturbances.
[273] The main example is the use of the rubber bullet by the British Army in Northern Ireland. The US Army developed the rubber ring airfoil grenade (RAG) but this was never used and the numerous commercially developed impact projectiles were not readily adopted by police forces.